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THE MINDS OF ANIMALS

BY

PROFESSOR J. ARTHUR THOMSON

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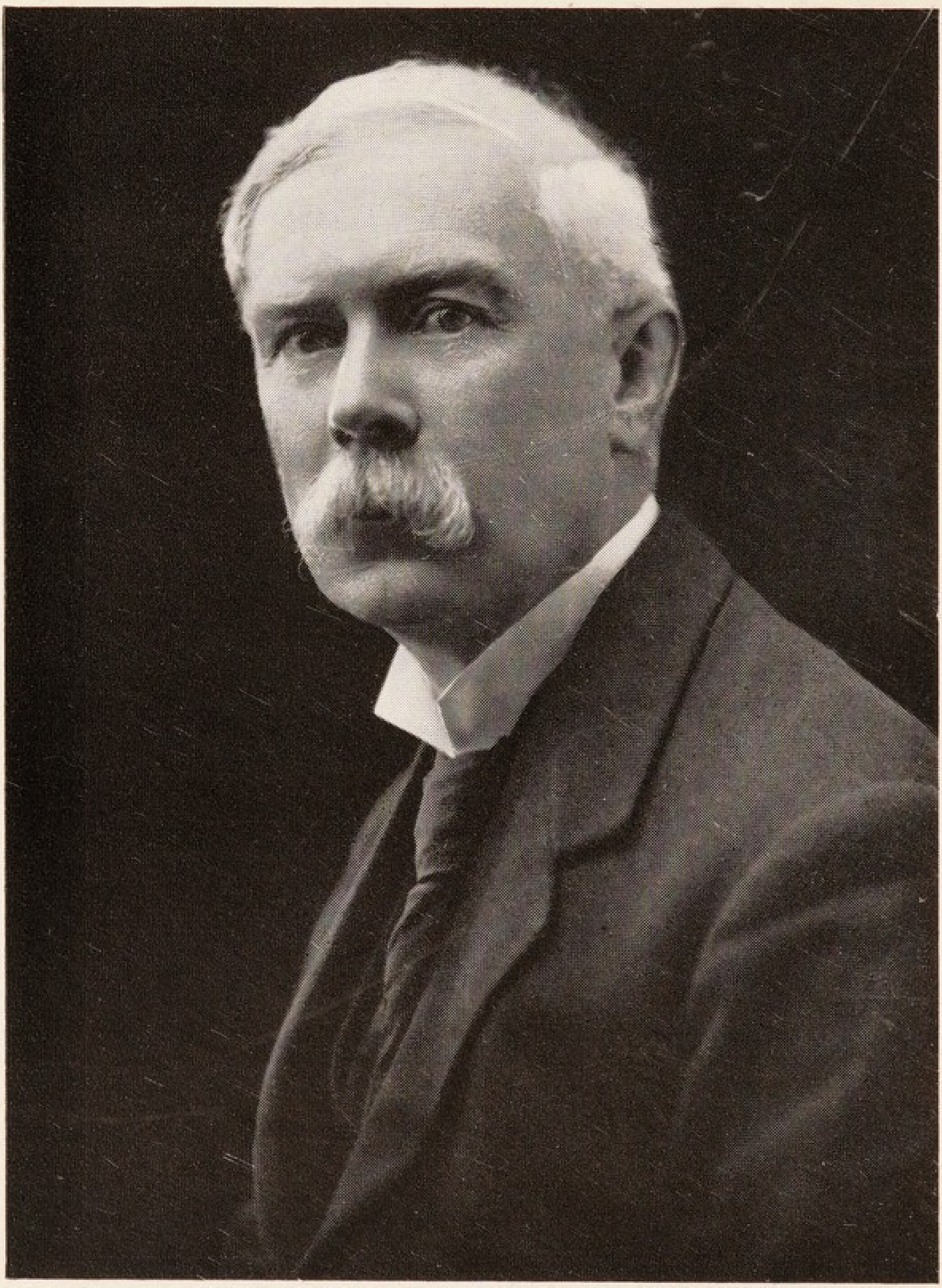

J. ARTHUR THOMSON, M.A., LL.D. (EDIN. et McGILL),
REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF ABERDEEN.

THE MINDS OF ANIMALS

AN INTRODUCTION TO THE STUDY OF ANIMAL BEHAVIOUR

BY

J. ARTHUR THOMSON,
M.A., LL.D. (EDIN. et McGILL),
Regius Professor of Natural History in the University of Aberdeen; Author of *The New Natural History The Gospel of Evolution*, *The Study of Animal Life*, *The System of Animate Nature*, etc.

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PREFACE

ANIMAL Behaviour is one of the most fascinating of subjects, partly because it is so puzzling, partly because it sometimes overlaps our own and yet is usually very different, and partly because the study discloses a long inclined plane, with great diversity, from the relatively simple to the extraordinarily subtle. Another charm lies in the fact that the ways of animals are in most cases very beautiful.

It seems to us that the living creature has two aspects which are equally real: the bodily and the mental, the physiological and the psychical, the objective and the subjective. Except for purposes of study, they are inseparable, but sometimes the bodily aspect is more prominent and sometimes the mental. The living creature or organism seems sometimes more of a "mind-BODY," at other times more of a "body-MIND." On the one hand, the inquirer must try to discover what the body as body can do; on the other hand, he must inquire whether the animal has an active inner life—a psychical aspect—that counts. Our personal prejudice, which we regard as a scientific prejudice, is all against the mechanistic belief, which we regard as a superstition, that "mind" does not count.

The interest in Animal Behaviour is widespread, and many thousands of observers are noticing very interesting facts every year. In the course of a large correspondence, we have come to think that a very simple introductory book might be of use to those who observe with more joy than insight, who mix up observation and inference, who confuse "instinct" and "habit," "intelligence" and "reason," and who can hardly be persuaded that the most generous interpretation of an animal's ways is not necessarily the most accurate. The book is intended to help amateurs in the best sense to make their observations even more valuable

J. ARTHUR THOMSON.

University of Aberdeen,
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THE MINDS OF ANIMALS

CHAPTER I

THE MINDS OF ANIMALS

We mean by " mind " in animals what corresponds in them to feeling, imagination and judgment in ourselves. Mind is one aspect of that unique kind of activity which we call life. It is the *inner* life, the subjective side of objective behaviour, the psychical as distinguished from the physiological. Perhaps, in the mundane conditions we are familiar with, it cannot be separated from the activities of the body in general and of the nervous system in particular, yet it cannot be described or formulated in chemico-physical terms. Mental activity may be measured, or the bodily accompaniments of it may be measured, but mind belongs to the imponderables. Perhaps there is no bodily activity—certainly not digestion !—that is not in some degree thrilled with mind ; perhaps there is no mental activity—certainly not imagining—that is not thirled to the body ; yet everyone knows that there are times when the bodily is much more in evidence than the mental, and other times when the mental is much more in evidence than the bodily. At one time we act as mind-*body*, at another as body-*mind*. In other words, it may be that all living is at once *biosis* and *psychosis*, *psychosis* and *biosis*. With words like these we try to hide our discomfiture at being unable to understand this ancient problem of the relation of "mind" and "body."

There is no doubt, however, that mundane mind has had a history or gradual expression, with ever increasing fulness, fineness, and freedom. The long process of organic evolution is in part the story of the gradual emancipation of mind—not a sudden epiphany, but a slow dawn, growing into a perfect day. It is one of the delights of Natural History to follow the growing freedom of mind through all the "spires of form" from worm to man. What one must avoid, however, is any use of words that would suggest that "mind" suddenly appeared as a bolt from the blue, intruding into an apsychic organic world. Great men have held this view, but it is not reconcilable with the evolutionist outlook, from which no one can turn away. Evolutionists regard all becoming as a process in which each stage emerges naturally out of its antecedent stage, without intrusion of impulses or forces from without. The Scylla to be avoided is the theory that mind was interjected from without like a wind-borne seed that found in protoplasm a soil suitable for germination. The Charybdis to be shunned is the theory that mind originated from something that was not mind. We must steer between (*a*) "the bolt from the blue" negation of evolution and (*b*) the materialistic fallacy of trying to derive the mental from the mechanical, the psychical from the physical.

Those who are in doubt in regard to the efficacy of mind in animal life should concentrate attention in the first instance on creatures like dogs and horses, elephants and apes, where the evidence is strong that intelligence counts. To begin with the lowest animals is like beginning with infants of a day; in both cases the evidences of intelligence or of mind are very unconvincing. Yet there is great gain in patiently inquiring into such hints of mind as we may find in the simplest animals. To be sure, there are only hints, but they are like the slender rills to which we can trace the great river. What then do the simplest animals or Protozoa show in the way of mind ?

CHAPTER II

THE DAWN OF MIND

HUNDREDS of millions of years ago, before the Cambrian rocks were laid down, the highest animals in the world were creatures somewhat like our present-day amœbæ and simple infusorians. For the time being they formed the microscopically minute crown of creation. Our question is whether they showed mind as well as movement. Was mentality struggling then for racial expression as it does in the individual infant a few weeks old, when there is no language but a cry and a smile ?

No one can give us much direct information in regard to the activities, still less the inner life, of animals that lived hundreds of millions of years ago, but we have a safe basis for inference in the behaviour of the simple amœbæ and infusorians of to-day, for they cannot be very different from their inconceivably remote ancestors. Thus the question is whether what we observe in the behaviour of present-day Protozoa warrants us in crediting them with the stirrings of mind. Do they do anything which cannot be fully described in purely physiological terms ?

An amœba moves about in an effective way in the field of our microscope, and while its movements are not so simple as those of a drop of quicksilver on the shrugged tablecloth, they can be understood to some extent in terms of surface tension and the properties of colloids. The amœba certainly uses chemical and physical means, though a knowledge of these does not seem to us to suffice to describe what happens when one individual amœba goes on the hunt after another. We can understand the amœba's behaviour a little more if we use such biological terms as irritability, enregistration, and impulse or urge. But do we need to postulate " mind " ?

Amœbæ are sometimes cannibalistic, and Professor Jennings tells us how a large one pursued a small one, overtook it, partially engulfed it, and then lost it ; whereupon the large amœba turned on its course, pursued its booty afresh, recaptured it, and lost it a second time, this being the end of the story. Various plants, such as the insectivorous sundews, make successive effective movements, yet we do not feel it necessary to credit them with mind. Is there any reason for being more generous to amœbæ ? All that we can say is that the amœba on the hunt shows hints of awareness, of a choice of alternatives, and of a persistent purposiveness. It is in vague expressions of qualities such as these that we should expect to detect the dawn of mind.

Numerous experiments have shown that an amœba will move towards nutritive substances and away from certain chemicals, that it will withdraw from a warm place and seek out a cooler one, that if isolated in water it will protrude tentative finger-like lobes as if probing for a surface on which to glide, that it will persist in the attempt to get itself outside a difficult food particle, and so on ; but when the results are all added up they cannot be said to compel us to credit the amœba with mind. It has enregistered within its protoplasm an effective rule of life, obedience to which usually serves it well. Even when the significant fact is noticed that one and the same amœba may react differently at different times to the same stimulus, as if showing some degree of indeterminism, it has to be remembered that even an amœba is a very complex colloid mixture, and that its physiological condition is often changing. All that is proved by the idiosyncrasies of certain amœbæ is some degree of protoplasmic individuality, and this is a far cry from mind.

Professor Mast observed that several amœbæ became more and more chary, so to speak, of exploring a brilliantly illuminated part of a microscopic field ; but we do not know of any other experiments indicating that an amœba can "learn." No doubt it is influenced by its experiences, but can it revive them so that subsequent behaviour is affected ? As Miss Washburn says in her "Animal Mind," it is possible that the stream of consciousness for an amœba may not be a continuous stream at all. "The amœba's conscious experience may be rather a series of 'flashes' than a steady stream. Each moment of consciousness is as if there were no world beyond, before, and after it."

An intimate study of the common slipper animalcule, Paramecium, which has a more complicated structure than the amœba, shows a more monotonous behaviour. For this little infusorian has but one of two answers to every question. That is to say, it has practically only two reactions to all sorts of stimuli. Swimming in an open spiral, it comes within the influence of something antagonistic—mechanical, thermal, or chemical. It reverses its cilia, backs off, twists round towards its aboral surface, or turns its anterior end a little as if testing the water, and then pushes ahead at full speed. The changing of direction after reversing the engine often enables the Paramecium to avoid the obstacle or obnoxious influence when it goes ahead again. But if it encounters the obstacle again, the simple manœuvre is repeated and repeated, till success or final failure results.

Besides the retreating or reversing reaction, followed by full steam ahead, the slipper animalcule sometimes shows a positive movement towards certain food materials, chemicals, and temperatures. And it sometimes happens that it arrests its movements altogether in contact with loose fibrous material, water weed, gelatinous collections of bacteria, and the like. It cannot be said, however, that the slipper animalcule betrays much more mind than the probably more primeval amœba. Perhaps the only advance is an approach to "learning," as distinguished, of course, from becoming dulled to, or fatigued by, the repeated recurrence of the same stimulus. When slipper animalcules are shut up in a capillary tube whose calibre is less than their length (about a hundredth of an inch), and when the lower end of the tube is plunged into water, the little creatures learn to alter their shape and movements in relation to the confined space so that they effect escape—a sort of exercise that they are not unfamiliar with in natural conditions when they twist in and out amongst the narrow passages of water plants. But the interesting point is that while the individuals experimented with began by taking five minutes to escape, they ended by doing the same thing in a second. This may be no more than protoplasmic learning, but perhaps it contains a hint of mind.

A more emphatic advance is marked by the beautiful trumpet-shaped infusorian called Stentor, that usually lives attached to water-weed by its narrow end, and wafts food into its mouth by means of a strong wreath of circumoral cilia. It secretes basally an irregular gelatinous investment into which it can retract itself when disturbed. Professor Jennings allowed a minute douche of carmine particles to drop from a pipette on to the mouth region of a Stentor, and the animal's first reaction was to twist itself to one side. This proved unavailing, and the second reaction was that the Stentor repeatedly reversed the action of its circumoral cilia, so that the particles were driven outwards instead of inwards. But the carmine shower continued, and the Stentor's third reaction was to draw back into its gelatinous investment. After remaining contracted for a short time, it expanded again, only to receive more particles of carmine. It repeated this reaction several times during a quarter of an hour, remaining for a longer time contracted on each successive occasion. But whenever it expanded again there was a continuation of the carmine shower. The final reaction was that the Stentor drew very forcibly back into its sheath, loosened itself from its support, and swam away. This was a very instructive set of observations, for it illustrated on the animal's part the so-called "trial and error method," which is common among more highly endowed creatures, and has probably a psychical background. Moreover, it was found that an experienced Stentor, subjected to a strong carmine douche, skipped the first and second gentler reactions, and tried the third first. We are inclined to think that this indicates a very simple expression of " mind."

Many Protozoa secrete extraordinarily beautiful shells of flint or of lime, and some naturalists have tried to discover evidence of mind in this astounding artistry. But the same argument would apply to the skeleton-making cells of many of the exquisitely decorative multicellular animals, such as sponges and starfishes. A stronger case might perhaps be made out for those Foraminifera that build up beautiful shells out of extrinsic minutiæ such as sponge spicules, or the minute sclerites of a tiny sea-urchin, or the infinitesimal particles of some mineral, and so on. But here again, just as in the study of Protozoan movements, we cannot describe the activities as showing more than vague hints of mind. Perhaps this is just what should be expected, for it seems as if mundane mind could not definitely express itself until there was a nervous system for its homestead.

CHAPTER III

THE BEHAVIOUR OF SEA-ANEMONES

VERY familiar are the sea-anemones that live in shore pools on all our coasts. They nestle in the niches of the rocks, and their pleasant colours and radiating tentacles, sometimes suggestive of chrysanthemums, often make a pool like a flower-bed. The wreaths of usually retractile tentacles around the mouth are often mobile, for they are used in paralysing and gripping the animals that serve as food, and one tentacle may be seen passing the captured booty to another nearer the central mouth.

Unlike their not very distant relatives the jellyfishes or medusæ which swim in the open sea, sea-anemones are sluggish animals. Some of them can move for a short distance on the rock to which they are normally attached, and some large ones loosen themselves off and, turning upside down, creep about on their tentacles. This is interesting, for it betokens a capacity for unified action on the part of an animal that has no central nervous system. Indeed, there are not even minor nerve centres or ganglia in the sea-anemone's body—a fact which lends a peculiar interest to an inquiry into the animal's behaviour. Can there be mind where there is no brain ?

When the tentacle of a sea-anemone is touched by a fragment of flesh, it first curves slightly round the food so as to grip it, and then bends in towards the mouth. In many cases it passes on the booty to another tentacle, which continues the transport. This is a very simple reflex action, and it suffices for a considerable part of the sea-anemone's everyday life. A stimulus affects a superficial sensitive cell in the skin ; the thrill is passed by a nerve fibre to a slightly deeper ganglion cell with branching processes ; and thence it is continued as a motor impulse to the muscle cells of the tentacle.

Certain inedible objects brought into contact with the tentacles evoke no response, but this varies considerably according to the species of sea-anemone, some being more discriminating than others. In some cases an unpalatable fragment is not merely refused: it is positively rejected.

Occasionally, as with a pill of filter-paper dipped in fish-juice, the useless object is passed from tentacle to tentacle towards the mouth, and then passed back again and dropped off. This probably means that the chemical stimulus of the fish juice becomes gradually weaker in the course of transport.

In some cases when a sea-anemone is fed with crab's flesh and filter-paper in rapid alternation, it soon comes to reject the filter-paper. This may mean that the creature is learning to discriminate, but it may also mean that it is becoming tired, for then it would naturally begin by rejecting the less stimulating object. These details are samples of the results reached by numerous careful experimenters, and they are interesting in disclosing considerable variety in the reflex reaction. There is not such stereotyped automatism as might be supposed at first sight.

A very instructive experiment was made by Fleure and Walton on the common Actinia. They gave it a scrap of filter-paper every twenty-four hours, placing it on the same tentacles, which usually carried it to the mouth. There it was swallowed, though soon ejected again. But after two to five days the mouth declined to swallow any more filter-paper, and after another two days the tentacles refused to take hold.

A lesson had been learned, and an interesting point was that when inexperienced tentacles were tested they fell into the trap, but only once or twice. The profiting by experience was somehow transferred by the network of nerve cells to neighbouring tentacles. It is difficult to think of this without giving the sea-anemone credit for a glimmering of awareness. When Professor G. H. Parker cheated the tentacles of one side of an anemone till they would not be cheated any more, he found that those on the other side were quite liable to be deceived by faked food. Owing to the absence of a central nervous system, the sea-anemone is not much of a unity !

Our view is that most sea-anemones get along very well without "mind"; they have inborn or enregistered neuro-muscular linkages which serve very effectively in ordinary circumstances. Yet sometimes there is a hint of mind in the background, of an inner awareness that enables the sea-anemone to use its reflexes in a somewhat new and more unified way. Thus there is a beautiful Anthea that allows a spider-crab to shelter between its base and the rock, and stretches down one of its long tentacles to grip the booty that the crustacean has lugged home to its retreat.

When a mutually beneficial partnership or commensalism is established between a hermit-crab and a sea-anemone, the polyp is usually acquiescent in a passive sort of way. It is in most cases the crustacean that takes the initiative, levering the anemone off the rock and holding it on to the back of its borrowed whelk-shell until attachment is effected. In some species, however, the anemone seems to seek for the partner who will carry it about and give it crumbs from its table. In one carefully studied case the anemone was forcibly removed from a crab's back and placed at a distance in the aquarium. It crawled about a little and then came to rest upside down. It waited until it was touched by the leg of a wandering crab of the proper kind, whereupon the anemone effected attachment and climbed on to the crustacean's back ! This comes near adventure, and while the behaviour can be for the most part adequately described in purely physiological terms, we are inclined to think that there is also the stirring of a very simple kind of mind.

CHAPTER IV

THE WAYS OF WORMS

When we speak of " worms " we immediately picture earthworms ; but there are, of course, many other animals to which the word may be applied. Thus there are Planarian worms, many of which glide along like " living films " on the fronds of sea-weeds and the leaves of fresh-water plants ; there are the parasitic flukes and tapeworms ; there are roundworms or threadworms, half of them parasitic and half of them free-living ; there are the elastic ribbon-worms of the seashore, sometimes found coiled up under flat stones and sometimes attaining a prodigious length of several yards ! Apart from these and other " lower worms," there are the ringed or segmented worms (the Annelids), including the bristle-footed Chætopods and the sucker-bearing leeches. The bristle-footed worms are represented by marine forms like the active sea-mouse and scale-back, the burrowing lobworms (which the fishermen dig for bait), the tube-inhabiting Serpulids, and others that fashion encasements of sand. In the fresh-water and terrestrial Chætopods the appendages or limbs have disappeared, and only the bristles are left. Our common earthworms have eight bristles on each of the numerous rings of the body. It is evident, then, that the word " worm " is little more than a name for an elongated shape.

A special evolutionary interest attaches to " worms," for some of the Planarians are the humblest multicellular animals to be found away from the water. In other words, certain pioneer worms began long ago the first colonisation of the dry land—a colonisation that led eventually to earthworms, well known to be the chief makers of the fertile soil. We look back to " worms " with some gratitude, for they were the first many-celled animals to move with one end of the body always in front, the first animals to have head-brains and bilateral symmetry. The ribbon-worms were the first animals to have blood, a very important acquisition ; and some of them have the same oxygen-capturing blood pigment (hæmoglobin) as backboned animals have. The bristle-footed worms show a well-developed body cavity between the food canal and the body wall. The threadworms are the first animals to have a through-and-through food canal, for in still lower forms the mouth is the only opening. It is plain, then, that many new steps of much importance were taken by " worms," and they form, as it were, a great central pool, from which streams of evolving life have flowed in many directions—towards Echinoderms (the starfish group), towards the jointed-footed Arthropods, and probably towards backboned animals. It is interesting, therefore, to ask what the pioneering " worms " show in the way of mind.

One of the ways of worms that has been very carefully studied is the appearance and disappearance of the little green Convoluta which occurs in myriads on the flat beach at Roscoff, in Brittany. It is a narrow worm, about an eighth of an inch in length, and owes its colour to having formed an internal partnership with microscopic greenish Algæ. The sugar and other carbon compounds which are built up by these minute symbion plants in the sunlit hours are utilised by the adult Convoluta as its food. When the tide goes down the worms come to the surface, and there may be thousands in a little patch. When the tide comes in, there is a rapid retreat of the Convolutas into the sand. Perhaps the most interesting fact of all is that when these little worms are transferred to a tideless aquarium they exhibit the same rhythm as in the open, and continue appearing and disappearing with regularity for over a week. But we dare not use any psychological word like "memory"; what happens is due to a racial bodily enregistration. There is a hereditary rhythmic reaction to the periodic changes in the gravitational conditions, but the awakening of the reaction is probably helped by the change in the amount of water and light. In a dark aquarium the rhythm disappears quickly. There is probably no more *memory* here than in the opening and closing of flowers.

There is a common seashore worm called Terebella that makes tubes of sand and shell fragments, and its architectural activities are very remarkable. They were studied carefully many years ago by Mr. Arnold T. Watson. The body is several inches long and bears at its anterior end a large number of thread-like tentacles, springing from the back of a hood (or prostomium) about the mouth. These tentacles are used in the building operations and are helped a little by a protruding lower lip, and more than a little by the pre-oral hood, which may be called, for simplicity's sake, the upper lip. The edges of the tentacles can be folded together longitudinally so as to form a hollow cylinder or an open channel. This infolding, combined with the secretion of glutinous slime, enables the tentacles to grip minute pebbles, grains of sand, and fragments of shell. The building material is handed on to the upper lip, "which organ stretches up in a most eager manner to receive it, bending expectantly towards the tentacles, and turning now this way and now that until satisfied, reminding one of the action of an elephant's trunk." The material is quickly rolled into the mouth, and there it is covered with a white translucent cement. After that the worm bends down and deposits the mortared material on the free margin of the sandy tube. It then holds up its lips for more!

Thus the tube is gradually added to at its upper edge, keeping pace with the worm's own growth. But around the mouth of the tube there are delicate branched threads, also built of sand; and the making of these is very extraordinary. The worm lays a foundation stone for each of the filaments, and then with great rapidity adds grain after grain in a longitudinal line, holding each grain for a brief moment in its place until the cement sets. In a general way, no doubt, the worm is obeying its inborn or instinctive promptings, but the peculiar interest of this case is that the builder can deal effectively with heterogeneous material. A pebble of unusually large size may be held in position by several tentacles while the upper lip packs it round about with small grains. Mr. Watson compared the upper lip to a bricklayer, but it is more like a builder constructing a wall by the roadside and using skilfully the diversified material that comes to his hand. We cannot study the tube of Terebella without at once recognising efficiency in the use of heterogeneous material. But must we not go further? It seems difficult to describe the process of tube construction without using some word that implies not only awareness, but some spice of judgment. Perhaps, however, it is safer to conclude that animals of low degree have not got much of an inner psychical life. Perhaps it is not possible at the level of worms to distinguish the body-mind from the mind-body.

Darwin was impressed by the effective way in which earthworms deal with difficult leaves in drawing them down into their burrows. Thus the twin needles of the Scotch fir are usually seized by the united base, which is just what an intelligent man would do with a great double fork of proportionate size. He noticed that the worms tackled exotic leaves in an effective way, and he tried them with cut pieces of paper, which they drew into the ground in what seemed to be the most reasonable fashion. This would hint at some discrimination of the contours of bodies ; but Darwin, with his habitual caution, suggested that in some cases there might be a difference of taste at the base and the tip of a leaf, and that worms established an association on that basis.

Numerous recent experiments are on the whole against the conclusion that earthworms have any sense of form. With leaves that they are not accustomed to they make many mistakes, and all that can be said is that they pursue the method of " trial and error," and that they may in course of time establish an association based on the " feel " of the part gripped. When an earthworm is confined in a T-shaped tube, with a mild electric shock at the end of one of the branches of the T, it learns in the course of many lessons to avoid exploring the branch that turns out to be unpleasant. After 120 to 180 lessons it will not make more than three mistakes in twenty tests, and perhaps it will go wrong only once. But it gives one pause to know that it can learn its lesson even if it has previously lost its head. So we dare not speak of intelligence here.

CHAPTER V

MIND IN STARFISHES

STARFISHES in the shore pools are very striking illustrations of *efficiency without thought*, indeed, without brains.

One of the unfamiliar but useful groupings of animals is into the hard-mouthed and the soft-mouthed. The hard-mouthed, such as crabs, beetles, sea-urchins, fishes, parrots, and tigers, have something in the way of jaws for dealing with substantially hard food. The soft-mouthed, such as bivalves, sea-anemones, jelly-fishes, and sea-squirts, have no jaws, and are accustomed to soft food, often in the form of microscopic organisms or particles. Now, the starfish is one of the soft-mouthed animals, and yet it lives chiefly on hard food. Mussels, for instance, it is very fond of—if an animal without brains can be said to be fond of anything. It settles down on the top of the mussel and hunches up its body like a half-open umbrella. With the suctorial tube-feet towards the end of each of its five arms it takes a firm grip of the rock; with the tube-feet nearer the centre it pulls in opposite directions at the two valves of the shell. It pulls and pulls, without haste, without rest, and it is able to exert a pull of over a thousand grams. At the same time it protrudes part of its stomach over the mussel, which it holds directly under its mouth. Gradually the valves begin to gape, and the digestive juice from the stomach begins to ooze into the mussel. The flesh is digested, the fluid passes into the starfish food canal, the empty shell is dropped, the stomach is drawn in, and the starfish passes to another mussel.

The shell of the hedgehog-like sea-urchin is thickly covered with strong spines moving on ball-and-socket joints, and amongst these there are numerous much smaller snapping-spines (pedicellariæ), which are somewhat like pincers with three blades. Some of them are poisonous, and it is plain that a sea-urchin is not very open to attack. Yet the naturalist Prouho has given a circumstantial account of the occasional combat between one of the starfishes, *Asterias glacialis*, and a sea-urchin. Can a brainless animal be credited with courage? In any case, what happens is this: the starfish draws near to the sea-urchin and touches it with one of its arms. At the point touched the big spines bend away, leaving the snapping pincers exposed and stretching out towards the starfish's intruding arm. In a moment the pincers clinch in the assailant's soft, suctorial tube-feet, whereupon the starfish withdraws, and the first "round" is apparently with the sea-urchin. But when the starfish retires, it pulls away with it the clinched pedicellariæ, for they cannot declinch. Soon the starfish returns to the combat, and begins again, laying another arm on the sea-urchin. When it has sufficiently disarmed its distant relative, it protrudes its elastic stomach, exuding digestive juice. This is remarkable behaviour for a brainless animal, for it implies persistence along a definite line of behaviour which is not rewarded till a somewhat remote goal is reached. It should be mentioned, perhaps, that the sea-urchin is as brainless as the starfish. Neither has any nerve centres or ganglia. Most of the starfish's nervous system is quite superficial, not separate from the skin. It consists of a nerve strand running up the ventral median line of each arm, and a pentagon uniting these five strands around the mouth. There is also a tangle of nerve cells and their fibres all over the skin, but there is no concentration into nerve ganglia, and we cannot speak of brains.

Many experiments have been made with starfishes which prove that they can " learn " to do difficult things more and more rapidly. They eliminate fumbling and ineffective movements somewhat in the same way as we do when learning to play tennis or to ride a push-bicycle. A common experiment is to use big-headed pins or staples to close in the starfish and make it difficult for it to move on a flat board. Not that the body is injured in any way; it is simply imprisoned. The pins do not go through the starfish; they simply act as impediments. And with uninjured animals the result is always the same: they show an increasing facility in overcoming the difficulties of the situation. The brainless creature pursues a method of "trial and error," and when the effective way out is discovered by elimination of ineffective movements, then the solution is somehow registered in the organism. Without intelligence a lesson is learned, and the animal shows for a short time that it can profit by its experience.

Some starfishes are in the habit of creeping with the same two arms leading the way, and an interesting point is that these leading arms often take command in the " righting " movements exhibited when a starfish is turned upside down. At first each arm seems to act for itself, and one sees the tube-feet searching about anyhow. But quite suddenly the two leading arms seem to take the reins, as it were, and the independent movements of the other arms cease. Soon the body is swung round into its natural position, and up to a limit the time required becomes shorter as the number of lessons increases. But a condition of the simple kind of co-ordination is the intactness of the nerve pentagon uniting the ends of the five nerve strands around the mouth. Thus, in a primitive sort of way, the nerve pentagon serves as a brain. And yet, anatomically speaking, there is certainly no brain whatsoever.

Professor Jennings, of Baltimore, who has given much attention to starfishes and their ways, made a neat experiment. He turned a starfish upside down, and prevented movement except in two of the arms. He gave this lesson over and over again, ten times a day for a fortnight, and then he left the inhibited arms free. But the starfish would not use them. It had learned its lesson to use two, and two only, and for a week the enregistration of the lesson lasted. Then it faded away. An important step will be made when we understand more clearly how there may be learning and enregistering and efficient adjustment all without brains.

CHAPTER VI

MIND IN CRUSTACEANS

HERMIT-CRABS strike one as active-minded animals, but careful study shows that their behaviour consists to a very large extent of (*a*) reflex actions, like jerking into the shell; (*b*) obligatory movements or tropisms, like moving from light to shade; and (*c*) instincts, like seeking for a shell to shelter the vulnerable tail. It seems at first sight intelligent that they should punctiliously explore empty shells with their appendages when they are about to flit from a smaller to a larger house. But the fact is that they cannot help doing this when they come across an empty shell; they carefully examine it even when they are in no need of a new one. Very striking, however, is the deliberate, yet gentle, way in which some kinds of hermit-crab loosen off a sea-anemone from the rock and hold it on to the back of the borrowed sea-snail shell until it takes grip. They sometimes stroke it coaxingly, and when they flit from the borrowed house they occasionally try to take their partner with them. The partnership must mean much to them in some way, for they will search for the sea-anemone in the aquarium if the naturalist has taken it away; and two hermits will fight over a sea-anemone that they both wish—if we dare say "wish." On the other hand, there are remarkable limitations warning us not to be too generous. Take this story in illustration. A lady naturalist of distinction with an unpronounceable name that begins "Drzw" supplied a number of naked-tail hermits with empty top-shells—just the kind of shell that the hermit would appreciate for the shelter of the sensitive inflamed tail. They were suitable in every way except that the mouth of each shell was closed with a cork. The hermit-crabs spent the whole night trying to draw the corks, but in vain. They continued their efforts next day, but gradually they abandoned the problem as hopeless. After four or five days, when they happened to touch a corked shell, they drew back just as if the shell was inhabited, and this they did, although they were badly in need of a sheltering shell. After six to eight days they had lost all interest in top-shells. A negative association had been established, a taboo formed. But when the experimenter gave them shells of entirely different form, also corked, they tried them eagerly, yet of course in vain. And when they were supplied with top-shells with only paper in the mouth, the hermits would not look at them, though it would have been quite easy to pull out the obstruction. A forceful association had been established. There was a " learning " from experience, though not so profitably as might have been the case with animals of fuller intelligence. In crustaceans, intelligence is hardly more than dawning.

Professor W. E. Agar, of Melbourne, has made some very interesting observations on water-fleas (Daphnia carinata), various water-mites, and the Australian freshwater crayfish. The animal was placed in unfavourable conditions, such as confined space, too shallow water, or excess of carbon dioxide. It had two avenues of escape, one actually leading to freedom, the other ending in a cul-de-sac. The " unpleasant " result of making a wrong choice was sometimes reinforced by the administration of an electric shock, or by other means. The point was to discover whether the animals would profit by experience. The apparatus was often a Y-shaped arrangement, the animal being placed in the stem, and having to make a choice between the left-hand or right-hand branch of the Y when it arrived at the bifurcation.

A dozen experiments with the water-flea, involving altogether over 1,400 trials or lessons, showed no power on the animal's part to learn by experience. The proportion of right to wrong choices did not increase. Twenty principal experiments were made with water-mites, the number of lessons in each experiment varying from 100 to 800, with a total of over 5,000. There seemed to be a well-marked tendency to form motor habits (tending to run for a long series of trials into the same passage), but there was no good evidence of any power of learning. While some showed improvement during the course of the experiment, others showed the reverse.

The experiments with the young crayfishes (Parachæraps) gave very different results. The animals soon learned to avoid the wrong passage and take the right one. " In one experiment, in which entry into the wrong passage, besides failing to bring freedom, resulted in an electric shock, the animal took the wrong (left) turn at its first trial, and then chose the right passage seven consecutive times. The electrodes were then transferred to the right-hand passage. The animal continued to go into this passage for eight more times, receiving a shock each time. In the next twenty-one times it only twice entered the passage, making the correct choice in the other nineteen." Thus, while the lower crustacean, the water-flea, showed no signs of ability to learn a lesson, even after several hundred trials, the higher crustacean, the crayfish, learned the same lesson almost perfectly in half a dozen trials. It seems reasonable to correlate this difference in intelligent educability with the mode of life of the two types. The crayfish searches out its food by means of its sense-organs, susceptible to stimuli from a distance (tele-receptors). Having found booty, it manipulates it with its mouth-appendages. It will defend itself and will probably attack other animals that might serve it as food. But " Daphnia lives a life of far less initiative. It feeds on microscopic organisms, which are collected by a current of water produced by the movements of certain of its appendages." It does not search for its food, and it shows no evidence of awareness of other animals or bodies, except that it quickens its swimming when disturbed. Similarly for the water-mite (Eylais), it discovers its prey (mostly Daphnia) by accidental collisions. Thus the experimentally demonstrated difference in intelligence can be correlated with the degree of psychological development required for the normal life of the three animals that were studied—a not unexpected conclusion, but well worth proving.

CHAPTER VII

THE MIND OF THE INSECT

Among higher animals, such as mammals, intelligent behaviour is as conspicuous as instinctive behaviour ; but among insects there is a dominance of instinct. Therefore it is much more difficult for us to understand a bee's behaviour than a dog's. We ourselves are children of intelligence, with relatively few clean-cut instincts, and we do not feel at home among ants, bees, and wasps, which are children of instinct. And what is an instinct, or, better, what is instinctive behaviour ? The trouble is that the word "instinct" is used in four or five different ways, but naturalists have decided to use it to mean an inborn or hereditary capacity for doing apparently clever things in a routine which does not require to be learned. Unlike intelligence, it is shared equally by all members of the species of the same age and sex ; thus all female spiders of a particular kind make an equally perfect web. There is no reason for regarding instinct as a low stage of intelligence, and there is very little reason for regarding instinctive behaviour as intelligent behaviour that has become automatic. Instinct comes nearest habit or habituation, but habits are formed by the individual. Some naturalists believe that instincts are the hereditary results of habits that have been formed in the course of thousands of generations. But some instinctive actions only occur once in a lifetime. You cannot make a habit of what you only do once! In all likelihood Bergson is right, that instinct and intelligence are on quite different lines of evolution, not to be regarded as two successive stages.

But long before Bergson Sir Ray Lankester drew a clear contrast between what he called the "little brain" and the "big brain" type of animal, which are on lines so different that direct comparison is hardly possible. The "big brain" type finds its finest illustrations in mammals, such as dogs, cats, horses, elephants, monkeys, with relatively few instincts in the strict sense, but highly educable. The "little brain" type has its climax in ants, bees, and wasps, with a rich repertory of ready-made accomplishments, but not strong in educability. We see then that insects belong to the "little brain" type.

Many keen-witted people brush aside with impatience the question, "Do ants think?" How, they say, can ants be so marvellously effective if they do not think? Do not some ants manage to keep stored grain from germinating, while others allow vetch seeds to sprout, so that a desirable fermentation sets in and the hard seed-envelopes are burst? Then they stop the sprouting by exposure to the sun; afterwards they chew the seeds and make biscuits that are stored for the evil day. Not think, forsooth! These little people that grow moulds for food, that cultivate the rice-grass they are fond of, that use their larvæ as animated gum-bottles for binding the leaves of the nest together with glutinous threadlets of silk, that domesticate green-flies, that keep slaves, that wage wars ! Call these achievements instinctive if you like, it is said, but why not call them intelligent ? The answer is manifold. Instinctive behaviour requires no learning or apprenticeship ; it may be improved by practice, but it is characteristically ready made. Thus each particular species of spider makes its web true to pattern the very first time. Instinctive behaviour, as we have said, is shared equally by all members of the same species, of the same age and sex. It has little or none of the inequality that marks intelligent behaviour. And again, the instinctive animal is thirled to the particular, *i.e.*, it is bound up with certain circumstances or situations that are of vital importance ; and a slight disturbance of the conditions puts the whole routine agley. The Procession Caterpillars of the Riviera have the instinct to go straight on in Indian file till they find soft ground into which to burrow, but they will continue circumambulating for days if the Italian urchin makes the head of the first touch the tail of the last. The least gleam of intelligence would break the spell in this and in scores of other cases where the limitations of instinct stand in striking contrast to the relative freedom that marks intelligence, where there is always some understanding of the situation.

We draw away our finger involuntarily from a hot plate ; we close our eyes when the rebounding branch is about to strike our face. These are reflex actions, depending on prearranged linkages between sensory nerve cells (like scouts), shunting nerve cells (like general headquarters), motor nerve-cells (like executive officers) and muscle cells (like the men who do the work). Some of the reflex actions, as in swallowing, form chains, for one pulls the trigger of its successor, and that of a third; and most naturalists regard instinctive behaviour as being on its physiological side like a chain of reflex actions. The female Yucca moth emerges from her cocoon and meets her mate in the evening air; she then flies to a Yucca flower and collects a ball of pollen which she carries on the front of her head; she seeks another blossom and lays some eggs in the seed-box; she deposits the ball of pollen on the tip of the pistil, and continues on her way.

But if there is nothing more than a long chain of reflex acts in these routine performances, then there is no need at all to speak in this connection of the insect's mind. On the other hand, the more we peer into instinctive behaviour actually going on, the less possible it becomes to regard it as altogether and always automatic. In many cases we cannot make sense of it without supposing that it is suffused with awareness and backed by endeavour. Every now and then intelligence seems to take the reins in a manner that suggests a dim awareness all the time.

Father Wasmann inserted into an annex of an ant's nest some cocoons of another species. These were soon detected by a single worker, who ran quickly to headquarters, and in less than a minute a company had turned out to deal with the abnormal situation. Or, again, there is strong experimental evidence that ants learn their geography. They get to know their region by experience, and come to recognise way-posts of scent, illumination, and the shape of objects. When transported to a short distance they sometimes behave in an interesting tentative way, suggestive of intelligence, as if they tried to appraise the relative value of different hints. When an ant has found a treasure, its socialistic disposition leads it to tell all its neighbours about it and to guide them to the spot. Sometimes, however, as Forel records, the way is rather intricate, and the guide hesitates. It tries one way, turns back and tries another ; its companions wait ; it corrects its mistake, and on they go. In this eloquent hesitation and experimentation there is, we think, more than a hint of intelligence. Turner taught an ant to lift and use a little wooden bridge to get access to its nest, which had been artificially insulated. Many naturalists have described ants making a bridge of fragments across a strip of moist tar or some similar very discouraging obstacle. Thus, while our general conclusion is that insects are for the most part children of instinct, we are convinced that intelligence occasionally takes the reins.

CHAPTER VIII

THE MIND OF SPIDERS

He must be like a new-born kitten who thinks of spiders as humdrum or commonplace. Theirs is a rich and romantic life. We must think of them as endowed with an almost incredibly delicate sense of touch, living in a world of tremors and vibrations, as artists in silk, as abounding in adventures, such as gossamer flight, journeying through the air without wings. The females surprise us with their expedients, such as sinking a smooth-lined shaft in the ground and furnishing it with a tight-fitting silk-hinged lid, or, in another direction, making an under-water nest of silk and filling it with dry air brought down from the surface. The trap door nest and the diving-bell are both for the shelter of the eggs. Picture the Queensland spider called the Magnificent, that hangs itself from a twig by a silk rope, and then makes a shorter line with a viscid globule at the end, which she—she again—throws against a passing moth with deadly accuracy of aim. Let us realise the artistic quality of the courtship dances and displays of the males and the quaint miniature tournaments, which are usually as harmless as they are vigorous. Let us admire the courage often shown by the mother-spider in defending the silken bag in which she carries about the eggs. We must grant spiders a life of feeling.

No doubt spiders are very largely, like ants and bees, creatures of routine, but we are not without some good experimental evidence of a half-intelligent emancipation. Thus when Dr. Dahl gave a jumping spider (Evarche) a house-fly that had been steeped in turpentine the creature threw itself instinctively on its victim and jerked itself reflexly back again when the strong odour was sensed. This happened three times in succession, but after that the spider refused to look at a fly for some hours. It would not even interest itself in a dry fly that had *not* been in turpentine. Next day it threw itself once more on a turpentined fly, but only once! It had no more use for flies that day, whether turpentined or *au naturel.* Spiders can " learn " to the extent of establishing useful associations.

No one can fail to admire the web of the Garden Spider.

Considered for its effectiveness or its beauty, it is a masterpiece. If we could make it ourselves, we should be proud all the days of our life. For lack of something better to say, we call it a work of art, yet we know that art means giving significant expression to an idea or an emotion, and the term does not fit the spider's web. The web is a work of *instinctive* art, not of intelligent art. An instinct is an inborn hereditary power of doing apparently clever things, and what is often very striking in instinctive behaviour is the apparent absence of any intelligent appreciation of what is being done.

Searching for some criterion that would indicate intelligence as well as instinct, we find some satisfaction in adaptability. A web spun between two rocks on the seashore is true to the type of its species, but it shows some extra threads running in a direction opposite to that of the prevailing wind, and some others which keep these lines taut. Here is plasticity—a special adaptation which tends to prevent the web being blown away. This strikes the note of intelligence.

There are a number of cases like this, where the web is constructed in a difficult place, and specially adapted to meet the difficulties. In some cases there are actually little weights fastened to the lower foundation-line of a vertical web, and these serve to keep the web taut, and thus more effective in insect-catching. The weights remind us of the stones that we sometimes see hung from the covering of a haystack, or even from the thatched roof of a cottage. Yet the lower foundation-line of a web is often fastened by threads to the ground, so care must be taken to make sure, if one can, that the little weighting stones have not been lifted automatically. For this would not be convincing of intelligence. Similarly, when a horizontal web is spun across a ditch or a stream, and involves the carrying of at least the first thread by the wind, we must not make too much of the indubitable efficiency. For it is only an extension of a method used by many spiders for short distances—namely, allowing a gust of air to pull out the thread so that the free end attaches itself a little way off.

Spiders are very short-sighted, but they have an exquisite sense of touch, and also a keen chemical sense, sometimes olfactory. Like most animals, they establish associations between certain sensory stimuli and certain actions. Thus it has often been noticed that when a spider waits in a nest close by the web, and connected with the web by a special thread of silk, it reacts in different and appropriate ways, according to the visitor whose movements make the web vibrate. It may be a struggling fly, or a destructive wasp, or another spider. To each of these there is an appropriate answer back, depending in part, at least, on associations that have been established on a basis of discriminating individual experience. This brings us near what may be called hints of mind.

CHAPTER IX

HAVE MOLLUSCS A MIND ?

WHAT can be said, for instance, in regard to the mind in snails ? We remember Darwin's pleasant story of the two snails that found themselves in a very inhospitable garden. One of them, with more vigour than the other, went exploring over the wall and found a land of promise. And what did it do but retrace its steps and rejoin its companion? Whereupon both snails went over the wall. There is no doubt that snails and some of their relatives have some topographical memory, somehow enregistering their own movements and the nature of the surface on which they creep. Thus from a short distance on a sea shore rock a limpet can find its way back to its own particular groove, which the margin of its shell precisely fits.

Molluscan mentality does not seem to rise to any great height, except in cuttlefishes, which have by far the finest brain among backboneless animals. The eyes are also highly developed, and there is good reason for concluding that octopuses and the like are able to form a genuine picture of their surroundings. They have a strong local memory; they sometimes build walls of stone around their den; some of them, like the sepias, swim in companies, keeping time very beautifully; they are capable of high excitement and will discharge their black ink till none is left; and they occasionally show an ingenuity which betokens intelligence. Thus, while we may doubt the validity of the observation that a cuttlefish sometimes inserts a stone between the gaping valves of a big bivalve, there is no doubt that Piéron taught an octopus within twenty-four hours how to get at a crab imprisoned in a glass tube with a corked opening. But in a week it had quite forgotten what to do!

In illustration of the caution that should be cultivated in judging of the mental aspect of animal behaviour, we may refer to the reactions of molluscs to shadows. Some eyeless burrowing molluscs, that extend their respiratory siphons out of the sand, are exquisitely sensitive to differences of light and shade. If a plate be held over an aquarium lighted from above so that a shadow falls on the mollusc, there is immediate reaction. The siphons are retracted. The same sort of sensitiveness can be studied in snails in natural conditions if we hold a piece of black pasteboard above the eyes, which are carried at the end of the long horns. A rapid retraction of the horn follows the sudden shadow. But after the mollusc has reacted several times within a short period the stimulus ceases to work; and in some cases, when the experiment is made on successive days, the answer back becomes less and less vigorous. Now it may be that the animal learns by experience, an interpretation the more plausible the higher the development of the chief nerve centres. Thus one authority concludes that "the animal recognises that the repeated shadow is not due to the presence of an enemy or other danger." In most cases, however, especially when the stimulus comes rapidly, a less generous interpretation probably fits the facts better. The animal becomes physiologically fatigued by the frequent repetition of the same stimulus; the sensitive cells may be dulled or inured in some quite simple way without there being any judgment or even feeling involved.

We must be prepared, however, for more complex behaviour, especially in snails and cuttlefishes, where the nerve ganglia are closely concentrated. If the tentacle of a big cellar slug be touched repeatedly with a glass rod, it is retracted over and over again—an ordinary reflex; but after this has been several times repeated the creature turns away. That is to say, it makes an adaptive movement, which might well be effective. But if the tactile provocation continues, the slug may change its tactics: it may turn towards the glass rod or the like and try to curve round it. In natural conditions, this might be an effective way of getting rid of a baulking obstacle or tiresome stimulus. The trial of different reactions raises the behaviour to a higher level.

It is very interesting to see the energetic way in which a big scallop (Pecten) in an aquarium reacts to the close approach of a starfish, its inveterate enemy. It flaps its shell-valves together with great force, and does this repeatedly, so that it makes a rapid retreat by an unusual mode of swimming. This is very effective behaviour, but it is one of the scallop's racially ingrained reactions, requiring no learning nor perception. It can be provoked by squirting a little extract of starfish into the scallop's gaping valves. The better equipped an animal is with inborn reaction capacities that work well in frequently recurrent exigencies, the less likely is it to display novel intelligence. Animals are seldom cleverer than they need to be.

The effective way in which an octopus deals with a vigorous lobster introduced into the tank is admirable, and although the tactics are just those that are practised throughout the creature's predatory life, there is an individual plasticity in the performance that gives evidence of a mind at work. Not less convincing is von Uexküll's observation of the way in which an octopus was impressed—indeed, over-impressed—by being stung by a sea-anemone that masked a hermit-crab. The octopus would have nothing more to do with crustaceans; it gave clear evidence of memory.

CHAPTER X

THE MIND OF THE FISH

FISHES are peculiarly shy in giving us glimpses of their mind. They do not proclaim their emotions like birds, nor dazzle us by their intelligence like the higher mammals. They do not seem to have a good conceit of themselves, and thus they are taken by the careless at their own valuation.

Yet in a really careful study, like Dr. Harry Kyle's "Biology of Fishes" (Sidgwick and Jackson, 1926), we find something like appreciation of the mental life of these primitive animals—primitive, though they were for long ages the crown of creation! One of the difficulties in getting at an accurate view is, as in other cases, that fishes are often not so clever as they seem. They have been living so long that they have gained many automatisms that lead them right without their needing to attend their minds thereunto. Thus there are inborn, engrained, obligatory movements or tropisms that enable them to find conditions of satisfaction as regards light, temperature, pressure, and even food; yet the fishes are not consciously seeking these comfortable situations any more than the moth is desiring the candle. There are also many inborn, hereditarily pre-established linkages between certain nerve-cells and certain muscle-cells, so that reflex actions result without any thinking or learning. Just as we cough away a crumb, or jerk back our finger from a hot plate, so the fish throws off or snaps at the dangling bait, or by complicated movements balances itself most beautifully against the changeful current of the stream.

How clever, they say, it was of those eels to make unhesitatingly for the river, several miles away, when they were emptied out in the middle of a field. "Effective," yes; but "clever," no. They were just obeying what another eel did when it squirmed up and up a pipe until it found itself in the rain-gutter on the roof of an old house—in Ireland.

At a higher level there are instances of instinctive behaviour among fishes, chains of reflex actions suffused with awareness and backed by endeavour—activities that do not require to be learned, in which, however, mind is beginning to stretch out its hands for the reins. The male stickleback's nest-building is largely instinctive—the binding together and fashioning of seaweeds or of parts of fresh-water plants so as to make a fit cradle for the eggs. Even more remarkable are the bubble-nests made by the Growling Gourami and some other fishes. One of the methods is to start with a few threads of filamentous Alga, which are buoyed on the surface with bubbles of air blown from the mouth of the high-spirited male fish. He collects more threads and blows more bubbles until there is a little floating island. Below this the pairing takes place and the eggs float up under the green shelter. Sometimes they are heavier than water and sink, but in such cases the male blows them forcibly into the floating bubble-nest. In some species there is a little secretion mingled with the bubbles, so that they remain together without bursting. When bubbles burst they have to be replaced; if eggs fall out the blowpipe comes into use again; the nest is kept well buoyed. There is considerable variety and individuality, and we think that the behaviour should be interpreted as half-instinctive, half-intelligent, as is often the case among birds. Dr. Kyle does not seem convinced that there is demonstrable utility in the whole business of the bubble-nest, but one would like to observe these fishes in their natural surroundings. Perhaps there is no great difficulty in the grim fact that in an aquarium the parents will devour the young ones when these begin to swim about. In natural conditions the young ones probably scatter quickly, and at this low level one must be prepared for a conflict of instincts. The nest-building or nest-blowing instinct has come to an end ; the reflex of snapping at a rapidly moving object returns in full force. Yet the facts warn us not to expect too much mind among fishes !

Most fishes follow the old-established invertebrate custom of multiplying by "spawning." That is to say, they produce such multitudes of eggs that there is a large margin for prodigious infantile mortality. When a cod liberates two million eggs, or a conger-eel ten million, there is no need for parental care and no possibility of its expression. But when the eggs are few there is need for special protection, and the higher method of parental care and economised reproductivity is illustrated. Similarly when the fertilisation of the eggs is external and more or less fortuitous, there is no likelihood of conjugal affection, which implies courtship and more intimate relations than most fishes exhibit. It follows, then, that parental affection and conjugal affection are often linked, and that they are to be looked for when the number of offspring is small.

There is an interesting Cichlid fish called Tilapia, carefully studied by the Rev. N. Abraham, which deserves a mark of exclamation for quaintness. The mother takes the eggs in her mouth, mistrusting the appetite of the male. She keeps them there till the young ones are hatched, and even until the fry are ten days old. Numerous tiny fishes, as many as sixty, were seen one morning playing round the mother's head. She herself is only three inches long.

When the water was disturbed the fry collected in front of the mouth and the mother opened the door. After some hours she blew and shook them out again. For five days this quaint carefulness was studied. The mother attacked everything strange that came into the water. " And every evening, when darkness came with the night, she withdrew into a corner and put them to sleep in her mouth."

Proceeding cautiously, we notice that fishes can learn, and at several different levels. A salmon that tries many times in vain to surmount a fall may succeed in the end, probably as we ourselves sometimes succeed in a physical achievement, not by cleverness, but by the automatic elimination of useless movements. Again, there may be learning by means of well-defined associations which are gradually strengthened. Thus a trout may learn to be more selective in its feeding, and aquarium fishes sometimes prove themselves apt pupils. They learn to associate feeding time with certain visual signals, and many anglers would say that trout may become intelligently wary.

Some perch living in an aquarium, which was divided by a glass partition, used at first to damage their noses by butting towards minnows on the other side. In about a month, however, even the slow-brained perch had learned by experience that it was no use even looking at the minnows. One would think that a glass partition must be a great puzzle to a fish, especially to one that has any hankerings after higher education. Eventually, however, the perch ignored the minnows so thoroughly that the experimenter went the length of removing the partition. Even then the perch did not venture into the minnows' preserve. The taboo lasted! Dr. Kyle writes: " How long the absent partition remained in their memory is not told, but when one of the minnows accidentally got amongst the perch and passed rapidly by, it promptly disappeared. On another occasion, after the partition was removed, one of the minnows trespassed, but so long as it swam quietly about it was not molested. Then it took fright apparently, made a quick movement, and paid the penalty of its transgression." This is a very interesting case, for the inhibition of the perch's natural reaction to minnow lasted until a rapid close-by movement pulled the trigger irresistibly. There is no doubt that fishes can learn.

In a search for definitely intelligent behaviour we should always look for cases in which there is individual plasticity, when the conditions are slightly altered. Inborn instinctive capacity, requiring no learning, may be more marvellous than intelligence, but its weakness is revealed when there is some little change in circumstance. Then the stereotyped routine fails for lack of adjustment, as when the Procession Caterpillars, changed from Indian file to a circle, persist for days in futile circumambulation. But the distinctive feature in intelligence is some adaptation of old ways to suit new conditions. There must be some evidence of appreciating the situation, some hint of "perceptual inference." It is a pity to mix this up with reason, which means "conceptual inference," or experimenting with general ideas. This is practically, if not wholly, restricted to man.

But take the little Spitter Fish (Toxotes jaculator) from the wonderland of Siam. Near the surface of the pool it fixes its eye on an insect that has alighted on a water-plant; it "measures" the distance, aims, fires a drop out of its mouth, and the insect is gone. Two of them kept in an aquarium developed an expectorating game with the onlookers. "The first case was perhaps accidental; an observer was shot right in the eye. But afterwards they practised on the nose, ears, and lips, and seemed to do so intentionally from a sheer sporting love of the thing. With what certainty and celerity the fish had learned to shoot can be judged from the fact that even when one knew the shot was coming, at three feet away, one had no time to close one's eye." This is strongly suggestive of "mind."

CHAPTER XI

THE MIND OF THE FROG

Superficial observations of animals are very unreliable as a basis for estimates of their intelligence. Some animals, such as pigs, are much cleverer than they look, but many other animals look much cleverer than they are. It is probable that frogs and toads belong to the second group. When we watch a toad climbing up a bank by the roadside we get a suggestion of a shrewd and resolute old man. When we watch a frog focussing a fly we get an impression of extreme concentration. The creature looks as if it were attending its mind thereunto, to use Newton's famous phrase. But there is good reason to believe that the suggestion and the impression are too generous. The over-generosity is, perhaps, due to an illusion which leads us, in spite of ourselves, to make too much of the amphibian's relatively large head, forgetting the almost ludicrously small brain. There is also something in the eye, especially the toad's, which gives us a prejudice in the amphibian's favour. We like Miss Frances Pitt's description of the toad's " gleaming jewel-like eyes. They are a pale metallic brown with reddish lights like flickering fires in their depths."

It was during a period of aridity in the Devonian or Old Red Sandstone Age that certain adventurous scions of a mudfish stock began the first vertebrate invasion of the dry land. How one envies the discoverer of the footprint of Thinopus, the earliest known footprint, a vestige of a pioneer Devonian amphibian. It marked a new beginning of things—the advent of terrestrial vertebrates, the first animals with fingers and toes, the first animals to be able to grasp a thing.

As fossils rarely show more than skeletal parts we cannot be sure about internal structures; but the probability is that the early amphibians had many of the acquisitions which mark those of to-day, such as true lungs, a movable tongue, vocal cords, a drum to the ear, besides nostrils that open into the mouth and are used for the in-breathing and out-breathing of air.

It must surely have meant something in the evolution of mind to acquire a hand that could grasp, that could tuck a worm into the mouth, that could feel a thing in three dimensions. It must surely have meant much to the mind to acquire a voice, even if it never became more to an amphibian than a sex-call. For it was in connection with mating that the silence of nature was first broken by Life. As man's intellectual powers depend greatly on his language—for words, as Hobbes said, are wise men's counters—we must look back with gratitude to the amphibians who invented a voice.

Frogs are well suited, on the whole, for a rather humdrum life, yet they often go very far wrong. The females sometimes lay their eggs in very unsuitable places, such as shallow transient pools, the dampness or an encounter with a male pulling the trigger inappropriately. The pairing or clasping instinct in frogs and toads is so violent and imperious that it often goes wrong. The male may blind and kill his mate with his embrace. A frog may clasp a fish and gouge out its eyes ; a toad may embrace a wizened apple ; for instinctive ways go oft agley.

We should, however, correct the impression conveyed by these limitations by recalling the numerous experiments which frogs and toads have made in connection with parental care. However they arose, these expedients had to be tested and approved by individuals in the course of generations until at length they became pieces of ingrained instinctive behaviour. We are not citing them as clever expedients devised by the individuals now practising them ; but, although they are not thought out now, and although the probability is that they were never thought out at all, it does not follow that there was no mentality involved in testing them and in sifting them out from among other variations in behaviour. It is a very large assumption that the whole sifting was by *automatic* processes of natural selection. In any case, in estimating the mentality of amphibians we must not ignore their methods of securing the survival of their offspring.

Let us recall some of these expedients. The male Nurse frog of the Continent carries the rosary-like string of ova coiled about his hind legs. During the day he hides in a hole ; in the evening he has a meal and also a bath, which renews the moisture around the developing eggs. After three weeks he plunges into the pool and from thirty to fifty tadpoles bite themselves free from the string and swim away! The male of the Surinam toad helps to adjust the eggs (fifty to one hundred) on to the female's back, where they sink into little skin pockets, whence miniature toads eventually emerge. Several female frogs have a pouch on their back in which development proceeds, and in the case of Darwin's frog from Chile the eggs develop inside the male's croaking sacs!

It seems that frogs and toads can learn to distinguish between different people, though the basis of the discrimination is uncertain. It has been shown that they can find their way "home" from a distance of from 200 to 300 yards. But the most satisfactory observations are those made by Professor Asa Schaeffer on various species of American frog. He found that frogs learned after a few trials to avoid disagreeable objects, such as hairy caterpillars, and that the lesson was remembered for at least ten days. Another frog learned in two trials not to have anything to do with chemically treated earthworms. The lesson was perfectly remembered for a short time, and somewhat imperfectly for five days. When a frog got a mild electric shock on seizing an earthworm, it declined earthworm for a whole week, but it did not decline mealworm. Frogs can learn.

Some of the details are of unusual interest. When a hairy *caterpillar* was seized, the next event, to put it as politely as possible, was its active muscular rejection. This experience served to stamp in the fact of unpalatability. On the other hand, a chemically-treated *earthworm* was eaten like a normal earthworm, and the unpalatability was registered although there was not any visible muscular repentance. The lesson "No more earthworms for me" lasted for a considerable time.

If we ask why the frog learned so quickly to refrain from hairy caterpillars and doped earthworms, whereas it is very slow to learn a maze or how to circumvent (by hopping) the obstacle of a transparent thread, the answer is, doubtless, that given by Schaeffer, that the frog in natural conditions is both experienced and plastic in regard to different kinds of food. " Undoubtedly situations frequently arise in a frog's wild life when a disagreeable insect or other food animal is tested and rejected. If the frog did not learn in a few trials to leave the disagreeable object quite alone—if the feeding instinct was as inflexible as it has usually and erroneously been supposed to be—the frog would be condemned to try the disagreeable object at least twenty to one hundred times, or perhaps indefinitely. Aside from the waste of time and energy, which might otherwise be employed in getting food, there is the added danger that the disagreeable object may be swallowed accidentally. It is therefore highly advantageous to frogs to learn rapidly to avoid disagreeable foods."

Some pigeons will not try to retrieve their two eggs which have been taken from the nest and placed in a quite accessible position only 2 inches away. This suggests the rule that when a piece of behaviour has been entirely handed over to instinct, to speak metaphorically, a stereotyping which works almost perfectly in natural conditions, we must not infer stupidity from the fact that an artificial disturbance of the normal routine leads to extraordinary futility. In the case of the frog we are face to face with another rule, that learning from experience or by experience is likely to be most rapid along lines which in natural conditions show considerable plasticity. Thus a frog which is dull in regard to the problem of a maze may be quick to learn when the problem is that of its meals. There may be something in the suggestion that to learn how to find a way out of a maze is *positive* learning, whereas to learn to avoid hairy caterpillars is *negative* learning ; but the probability is that the frog learns rapidly in the second case because in its natural life it is vitally important to retain plasticity in the method of testing food and associating the palatable and the harmful with particular sensations. In regard to earthworms it may be that the frog's reaction is profitably ingrained or instinctive ; but in regard to insects which are so multitudinous in their kinds, the profitable quality for the frog is the power of learning quickly. It is interesting to notice that Professor Schaeffer's definite experiments, proving that frogs can learn quickly to discriminate between harmful and palatable food-objects, tend to increase the probability of the value of warning colours which advertise the noxiousness of certain insects and other food animals. The experiments prove that frogs can profit by *noli me tangere* advertisements.

By a simple device Professor Schaeffer arranged that when a frog made a rapid mouthful of a cockroach it got a slight electric shock. This stopped the eating of cockroaches, but it also stopped all eating for some days. In this case, therefore, the frog got a physiological shock which put it off its food. There was not much *learning* there.

In the case of the earthworm from which the frog got a mild electric shock there was prolonged abstinence from earthworms, but mealworms were eaten. There was the beginning of learning here.

In the case of the hairy caterpillars there was rapid learning, an associative putting two and two together, and there was a retention of the lesson for a considerable time. The frog was forming the habit not to eat hairy caterpillars.

But there was one particularly instructive type of experiment to which we must briefly refer, for it gives us a glimpse of the frog's mind at work. A hairy caterpillar was dropped in front of an experienced frog; it began to crawl away; the frog hopped after it and closely examined it as it crawled; the frog refrained from any action. It was, perhaps, the movement of the caterpillar that pulled the trigger of the frog's interest and led it to hop after. But closer inspection called an association into activity; there was, perhaps, something like a memory of previously-experienced disagreeableness. Examination ceased and the caterpillar was left alone. Now it seems difficult not to conclude that in its careful examination of the caterpillar the frog was in a very literal sense making up its mind.

But the story does not end here. The caterpillar, in which the frog had lost interest, tumbled into a dish of water and wriggled energetically on the surface. This novel wriggling once more arrested the frog's attention, and a re-investigation, preceded by a hop, took place. But ten seconds sufficed to assure the frog that it was the same old hairy caterpillar, and it finally turned away. Not much of a mind, perhaps, as we count mind, but surely a glimmering!

Disbelieving utterly in the materialistic superstition and in every apsychic theory of life, we venture to ask in all seriousness whether the humble pioneers which we know as frogs and toads may have a glimmering not only of intelligence but of self-consciousness. The point of our question will be clear to those who are familiar with the contrast between frog and toad. Every observer of country life knows that the toad does not hurry; he is a leisurely gentleman who will not be hustled even in the Mansion House traffic of the meadow. Once a year he may jump from the avalanche started by the motor car with a shooting party; but it is his rule to walk with dignity. The frog, on the other hand, is quick and nervous, taking great leaps, hopping, not crawling, alert and incalculable. No doubt this is to some extent a question of constitutional gearing—phlegmatic against nervous, slow-going against adventurous, enduring against explosive, preponderantly anabolic against predominantly katabolic—an illustration, in short, of the fundamental biological dichotomy to be seen through the whole of animate nature from the first great split which led to Plants and Animals. But our question is how far the toad has a dim awareness that its safety is more or less assured by the abundance of its skin-secretion—a volatile, irritant and unpalatable poison called "phrynin"—while its second cousin, the frog, with much less of this nauseousness, has to remain nervous and alert.

Let us sum up. Some people think we are joking if we ask: Has the frog a mind? Except in its Spring croaking and pairing the frog lives a very humdrum life; What would it do with a mind? Its body, as body, is sufficient for all its needs. To a large extent, we think, this is true; and yet the cases we have cited strongly suggest that there is, at a low potential as it were, an inner life of association and memory, of feeling and even judgment?

CHAPTER XII

THE MIND OF REPTILES

We read in the Scriptures that the serpent was more subtle than any beast of the field, but it is difficult to get scientific warrant for this generous appreciation. No doubt some snakes are very efficient, but that is not the same as intelligent. Though they cannot put their tail in their mouth and roll along like a hoop, they " can out-climb the monkey, out-swim the fish, out-leap the zebra, out-wrestle the athlete, and crush the tiger." No doubt some of them remember persons; no doubt some pass readily into a kataleptic or death-feigning state; no doubt the egg-eating African Dasypeltis breaks the shells away down in its gullet so that it loses none of the precious contents; no doubt some snakes brood on their eggs with patience and thus point forward to the birds; but there is very little evidence of actual intelligence. It should be noted, however, that this is far from being the view of Dr. Hornaday, the experienced Director of the New York Zoological Park, who believes that the mental aspect of snakes has been unjustly depreciated. He attaches great importance, for instance, to the case of a Reticulated Python, 22 feet long, which had to have its slough peeled off to save its life. At first it writhed and resisted, but as the five keepers worked quietly and spoke soothingly, like dentists, it acquiesced and the peeling process continued for a long hour without resistance or protest. According to Dr. Hornaday, the snake, though fresh from the jungle, appreciated the situation; but this is being very generous. Similarly, there is Layard's often-quoted story of the cobra from Ceylon which had thrust its head through a narrow aperture and swallowed a toad. When it tried to draw back, it could not get its distended head through, so it had to disgorge its booty. When the amphibian sought to get away, the reptile had perforce to seize it a second time, and the same thing happened again. On the third attempt, however, the cobra seized the toad by one leg, withdrew itself and its victim through the aperture, and then swallowed with lasting satisfaction, if not with triumph. Perhaps mind was stirring in that cobra, but to prove intelligent learning it would have been necessary, in a critical experiment, to try a second toad, and a third or fourth in case of coincidence.

Our estimate of snakes will apply also to other reptiles—crocodiles, tortoises, and lizards ; they are very effective in their answers-back, but not very quick in the up-take. We must keep hold of the principle that animals are rarely cleverer than they need to be. The greater the routine-efficiency, the less likelihood is there of intelligence being in evidence.

The tortoise is not an animal that suggests much intelligence, but there is evidence of memory of places. Pet tortoises sometimes recognise their owner or something associated with their owner, such as dress.

Professor Yerkes made careful experiments with turtles in a simple maze, which involved four blind passages, and led eventually to the comfortable darkened nest. During the first four trials the time was reduced from thirty-five minutes to three minutes and thirty seconds. In the fourth trip the animal took only two wrong turns. For the fiftieth trip only thirty-five seconds were needed !

In another labyrinth two inclined planes were introduced, up and down which the turtles had to crawl. This was more difficult and the results showed irregularity.

Thus the forty-fifth trial required seven minutes, whereas the time had been reduced to two minutes and forty-five seconds at the thirty-fifth trial. An interesting detail was that the turtles had to turn about as soon as they reached the foot of the descending plane, and they soon began to save time by making the turn before they got to the foot. Eventually, they threw themselves over the edge as soon as they reached the top of the ascending plane.

The last observation is of peculiar interest, because the short cut appears to have been discovered by an accidental tumble at the summit. There is a gleam of intelligence in the utilisation of a fortuitous occurrence. It is highly probable that some of the remarkable things that *individual* animals do are not devices, but appreciations of the accidental.

Many of the instincts of reptiles are striking. Thus, at the critical moment, the Madagascar crocodile digs up her young ones, which are hatched out of eggs buried deep in sand and decaying vegetation. When the young ones are ready to emerge they pipe instinctively from within the eggs, and the watchful mother instinctively shovels the earth away. The African snake Dasypeltis swallows the eggs of birds in a very careful way, and does not break the shells until they reach the gullet, where they are pressed against the sharp spines of the descending processes of several anterior vertebræ, which actually protrude into the food-canal. Thus the shells are neatly broken and not a drop of the precious contents is lost. The empties are returned out of the weakly-toothed mouth. In the case of the Madagascar crocodile, we have to deal with a racially-enregistered predisposition to certain activities structurally pre-arranged for. In the young ones the trigger is pulled from within—by relative lack of oxygen in the blood ; in the mother the trigger is pulled from without by the sound of the progeny's piping. In the case of the African snake, we have also to deal with a racially-stereotyped line of behaviour, correlated with structural peculiarities in the dentition and still more remarkable structural adaptations in the anterior vertebræ.

Very striking is the persistent way in which the young loggerhead turtles hatched in the sand make for the sea, even against artificial obstacles, the chief stimulus in this case being the more open horizon, which usually means the sea. But in all these cases, wonderful and interesting as they are, there is no convincing evidence of an awakened mind. There is more evidence of this, perhaps, in a simple experimental fact, that crocodiles get greatly excited when they are shown out of hours the board on which their food is chopped. There is no doubt as to association-forming in reptiles, but this is only a beginning of mentality.

CHAPTER XIII

THE MIND OF THE BIRD

WE must judge birds, not by domesticated hens and the like, for these have in many cases become individually dull, largely because they live an over-sheltered life. We must udge the bird by the adventurous highly-educable chick and our total impression must be chiefly based on facts from Wild Nature, from the life of rooks and crows, cranes and parrots.

It is a step towards an active mind to have alert senses, and birds certainly excel in sight and hearing. The rapidity and discrimination which gulls show in picking up fragments of biscuits from the white wake of the steamer may be cited as familiar evidence of their excellence of vision. We get the same impression when we watch a hawk searching the hillside from a considerable height. There is great acuteness of vision and unsurpassed rapidity in adjusting the focus of the eye. To the sense of sight the sense of hearing comes a good second in birds. The breaking of a twig pulls the trigger of flight and of the danger-call; and surely the frequent excellence of the cock-bird's song has its counterpart in a cultivation of the ear. Speaking of danger, we should remember that some young birds have an instinctive or inborn "appreciation" of the specific warning cry of their kind. When danger threatens their chicks the parent partridges utter a particular cluck-clucking note, and the young birds squat flat and remain absolutely motionless. They will do so when two or three hours old; but to other sounds, such as the anxious clucking of a foster-mother hen, they remain quite indifferent. It is not that they know what they are doing when they squat and lie motionless, but their behaviour illustrates the discriminating character of their sense of hearing. It might have been enough to refer to the geese that saved the Capitol, detecting something unusual in the sounds of the night.

Touch cannot be very highly developed in a creature so fully clothed in feathers, but we know how the woodcock feels the earthworms which it cannot see, and the innervation of the snipe's bill is extraordinarily rich. Taste is not greatly developed, for birds are too much given to bolting their food; and of the sense of smell comparatively little is known. It seems to be of some importance in nocturnal birds of prey, but it is by sight, not by smell, that the eagles gather to the carcass. Besides the conventional five senses, which people persist in believing in, there are no doubt others, such as sense of temperature and the sense of balance, and birds have perhaps some others which we do not know of. But all attempts to demonstrate a magnetic sense, for instance, have hitherto failed. The important fact is that in birds there are two widely open gateways of knowledge, the sense of sight and the sense of hearing.

The effectiveness displayed in the ordinary life of a bird depends to a large extent on useful associations established in early life. A moorhen chick, for which Professor Lloyd Morgan used to dig earthworms, soon learned to run to him from some distance whenever he took a spade in hand. This was not from any intelligent appreciation of the spade as a digging instrument, but because an association had been established. The spade was an item in the mental registration of a pleasant experience. The life of wild birds in the open country seems to be full of these associations.

There is no doubt that birds have a rich repertory of inborn capacities for doing apparently clever things. In other words, they have many instinctive predispositions. There are hereditary aptitudes in the way of pecking, scratching, swimming, diving, climbing and flying. The young redshank lies low at the first sound of the parent's danger-signal. Some precocious young birds do this before they are quite free from the egg-shell.

A young coot swims right away when it is tumbled into the water for the first time, and the same is true of many birds. The capacity for executing the requisite swimming movements is laid down as part of the constitution, as a pre-established concatenation of certain nerve cells and certain muscle cells. But it requires an appropriate stimulation to set it agoing, and this may be supplied by some teaching on the parent's part. Thus in the case of the great crested grebe, the mother plays a part in educating the young ones for aquatic life. She takes them on her back and then sinks beneath the water, leaving them gently afloat. Among guillemots and razorbills and other members of the auk family there seems to be some coercion in the early training, and, indeed, the first plunge from the cliff into the sea would try any creature's nerve!

Our first point, then, is that many effective things that birds do are the expressions of innate predispositions of a very definite kind which result especially in effective movements. But this repertory is much more limited in birds than in creatures like bees and wasps, which belong to the "little-brain" line of evolution. Professor Lloyd Morgan found that his chicks, incubated in the laboratory, paid no attention to their mother's cluck when she was brought outside the door. Although thirsty, and willing to drink from a moistened finger-tip, they did not instinctively recognise water even when they walked through a saucerful. Only when they happened to peck their toes when standing in water did they appreciate water as the stuff they wanted and raise their bills up to the sky. And was not the limited character of instinct clearly shown by the way in which they stuffed their crops with "worms" of red worsted? Evidently they were missing their mother's teaching! Limited as they were, however, they learned with prodigious rapidity, thus illustrating the deep difference between the "big brain" type, *relatively* poorly endowed with instinctive capacities, but eminently educable, and the "little brain" type, say, of ants and bees, very richly endowed with instinctive capacities, but far from being quick or glad to learn. Not more than once or twice did the chicks experiment with the red worsted; not more than once or twice did they try the unpalatable caterpillar. Our general position is that while birds have their instincts, they are more characteristically learners, and that even in their instinctive doings there are often flashes of intelligence. Of intelligence co-operating with instinctive predisposition, Professor Morgan gives a good instance. He reared two moorhens in isolation from their kindred, and watched them almost from hour to hour. They swam instinctively, but they would not dive, either in a large bath or in a stream, and diving is swimming with a difference. One of these moorhens, about nine weeks old, was swimming one day in a pool at the bend of a stream in Yorkshire, when a puppy came barking down the bank and made an awkward feint towards the young bird. "In a moment the moorhen dived, disappeared from view and soon partially reappeared, its head just peeping above the water beneath the overhanging bank." This was the first time the bird had dived, and yet its performance was absolutely true to type. There can be little doubt that in this case we have to recognise three factors: (1) the young moorhen had a hereditary capacity for swimming and another for diving; (2) the young moorhen had enjoyed about two months of swimming experience, which may have counted for something; but (3) the bird saw and heard the dog, was emotionally excited, and did to some extent intelligently appreciate a novel and meaningful situation. Intelligence co-operated with instinct and the young moorhen dived appropriately.

The general impression one gets in regard to the cleverness of ordinary birds in such activities as nest-building, capturing booty, and dealing with food is, that on an instinctive basis, varying in definiteness, there is built up a superstructure, partly due to early education and subsequent imitation, and partly due to an intelligent appreciation of the lessons of experience. But careful observation and experiment must furnish more data before we can venture to say in any particular case how much is inborn and how much is acquired, how much is due to the inherited " nature " (the racial legacy of wits or talents) and how much is due to individual " nurture," including in that term, not only direct education on the parent's part, but personal experience as well.

Some young woodpeckers show notable expertness in opening fir cones to get at the seeds. This might be referred to a special instinctive capacity, like that which enables the young coot to swim when it first tumbles into water. Or, again, it might be referred to native quickness of uptake, such as lies at the root of the trained weaver-bird's educability or the parrot's pawkiness. Yet neither interpretation is quite correct. For we have to recognise that the parent woodpeckers bring their young ones first the seeds themselves, then partly opened cones, and finally intact ones. Thus, as Professor L. T. Hobhouse says in his " Mind in Evolution " (1915), " the method of preparing the family dinner is at least as much a tradition as an instinct." It is the outcome of both teaching and learning.

We wish to put on record a recently-observed instance that shows very clearly how intelligence may intervene in instinctive routine. A cock homer pigeon was due to relieve the brooding hen, who was sitting in a dovecot. This had an alighting-board at the entrance, and the door itself was a sliding shutter working in a bevelled rail. As the entrance was only slightly open, the cock-pigeon, obedient to an insistent instinctive urge, got his head and shoulders in and succeeded in shoving the shutter along. But the observer frustrated his successful entrance and put him outside again, adjusting the shutter in the rail in its original position. Whereupon the pigeon repeated the procedure with success, and this was done several times in the course of a few minutes, the bird becoming increasingly expert. This was an exhibition of intelligent learning; but there was more to follow.

After a short time the experiment was varied by inserting in the bevelled rail a small piece of wood about 2 inches long and ½ inch broad. This was placed in the groove in such a way that the door could not be pushed along far enough to allow the pigeon to enter. After some fruitless pushing the pigeon seized the obstructing piece of wood in his beak and threw it on the ground. He then slid the door along and hurried into the dovecot.

But he was not allowed to settle down, and the performance was repeated several times in the course of a few minutes. As the bird was always baulked of his reward he gave up trying and remained passive on the alighting board for almost ten minutes, the observer standing three or four yards away.

The next step was of much interest. The observer went into his house close by, but lost no time in going to a window. He was rewarded by seeing the wideawake pigeon seize the piece of wood and toss it into the air, afterwards effecting entrance as he had done before. The observer removed the pigeon again and returned to the house, where he was witness of precisely the same procedure. In fact the experiment was repeated several times, always with the same result. When the observer remained standing near the dovecot the pigeon did nothing ; when he went into the house the pigeon immediately lifted the jamming piece of wood and slid the door along. After the observations had lasted for about three-quarters of an hour, they were discontinued, partly because nothing new happened, and partly because the cock-pigeon became exceedingly impatient to take up his position on the nest. We have lingered over this new case, because it is a carefully-observed clear instance of behaviour that must be called intelligent, though the prompting of the whole was instinctive. There are four points to be noticed : (*a*) the dexterous sliding of the door along ; (*b*) the quick removal of the piece of wood that kept the door from being opened far enough ; (*c*) the cessation of endeavour when the pigeon perceived that his solution of the problem did not meet with its due reward ; and (*d*) the immediate repetition of the procedure when there seemed to be, in the absence of the observer, a chance of success.

Let us take some other instances where the intelligence factor seems conspicuous. When the Greek eagle lifts the Greek tortoise in its talons and lets it fall from a height so that the carapace is broken and the flesh exposed, it is probably making intelligent use of an expedient. Whether it discovered the expedient by experimenting, as is possible, or by chance, as is much more likely, it uses it intelligently, appreciating the situation. The same expedient is illustrated by herring gulls, which lift sea-urchins and clams in their bills and let them fall on the rocks so that the shells are broken. Rooks, which are notoriously clever birds, do the same with freshwater mussels. There are records of a bird of prey letting food drop upon its beleagured nestlings and of another which makes a habit of letting a stone fall into the midst of a clutch of ostrich's eggs with consequences highly satisfactory to itself.

In the quiet of the wood one sometimes hears the song-thrush breaking snail shells on its stone anvil, and one may easily find the tell-tale evidences of its appetite. Is this habit, which comes so near using a tool, an inborn gift, or has it to be learned? The answer is given by Miss Frances Pitt in her admirable "Wild Creatures of Garden and Hedgerow" (1920). To a young thrush which she had brought up by hand she offered some wood-snails (*Helix nemoralis*), but he took no interest in them until one put out its head and began to move about. The bird then pecked at its horns, but was bewildered when the snail retreated within the shelter of the shell. This happened over and over again, the bird's inquisitiveness increasing day by day. The thrush often picked a snail up by the lip of the shell, but no real progress was made until the sixth day, when the thrush beat a snail on the ground as it would a big earthworm. At last, on the same day, he picked up a shell and hit it repeatedly against a stone. He tried one snail's shell after another, until after fifteen minutes' hard work he managed to break one. After that all was easy. He had cracked his first snail. After long trying he had found out how to deal with a difficult situation. We may say, then, that while a certain predisposition to beat things is doubtless inborn, the use of the anvil is no outcome of a specialised instinct, it is an intelligent acquisition.

There is much evidence that many a bird could be more intelligent if it liked to try. But given an endowment of instinctive aptitudes and a youthful schooling during which it learns with prodigious rapidity, why should a bird trouble its head with perceptual inference? To enjoy is better than to experiment, and singing a finer art than playing with syllogisms. But every now and then we hear a different note, a throb of a restless brain, the note of inquisitiveness and adventure. It implies (1) a fine brain to start with, like that of crow or parrot; (2) a certain measure of success, enabling the animal to look round with some confidence; and (3) the inducement of some probable or certain reward. Speaking of the weaver-bird (*Ploceus baya*), Mr. C. H. Donald says: "His extraordinary intelligence and his natural love for inspecting everything he sees and picking it up in his beak has been taken advantage of to teach him tricks. He is a very apt pupil, and if carefully and kindly taught will within a week select a particular number out of many cards and bring it to his master. He will catch a two-anna piece which has been thrown into a well before it reaches the water and bring it back. Some of his tricks seem absolutely incredible, and yet one and all may be taught in a couple of days each. The first and most important step in his training is to teach him that an open hand means food and that a closed fist does not. Everything hinges on his first mastery of this secret and the rest is simple."

In regard to the weaver-bird, it seems fair to say that it has a fine brain to start with, that it has very plastic movements, that it has served a long racial apprenticeship in the art of nest-weaving, where successful manipulation is of survival-value. But it seems also to have a noteworthy power of concentration, focussed by the reward. Most birds that have been tested for educability show a baffling degree of inattention.

The Hampton Court maze test has been successfully passed by the common sparrow, the cow-bird and the pigeon. In the last case the solution remained in the adult bird's possession for a whole month. Sparrows, cow-birds, and chicks will also learn to discriminate clear-cut markings on cards, and a few birds learn to master simple mechanisms, such as pulling up the food dangling at the end of a string.

To sum up: We must credit birds, in the first place, with a repertory of ready-made efficiencies or instincts, as seen, for instance, in the nest-building and the care of the offspring. These are often subtly influenced and modified by intelligence. In the second place, there is extraordinary educability, so well illustrated by chicks, a power of building up associations, and enregistering the results of experience. In the third place, there is occasionally some flash of indubitable intelligence, such as was exhibited by the pigeon's cleverness in getting into the dovecot. But it may be that even more characteristic of the bird mind is the strong current of feeling—whether it be in the patience of brooding or in the ecstasy of the nightingale's lyric.

We cannot leave the bird's mind without referring to the well-known cleverness of rooks and parrots, and raising the interesting question how far this is due to their social life and their habit of talking a good deal. Both rooks and parrots have finely-developed brains, and it was probably this possession, shared by non-gregarious relatives (such as many crows), that made their sociality possible. But these things often work round in circles. Given fine brains, then sociality and loquacity may follow; but sociality and talking form appropriate evolutionary sieves for sifting out and retaining progressive variations in the direction of nimbler wits. A great law of evolution is that to him that hath more shall be given.

CHAPTER XIV

THE MIND OF THE PIGEON

THANKS to the careful observations of the late Professor C. O. Whitman, of Chicago, we have got nearer the mind of the pigeon—such as it is—than in the case of any other bird, not excluding the parrot. The resulting impression is a strange mixture of admiration and disappointment. Let us illustrate. A number of pouters were feeding on a few grains of oats which had fallen out while the nose-bag was being fixed on a horse standing at bait. "Having finished all the grain at hand, a large pouter rose, and flapping its wings furiously, flew directly at the horse's eyes, causing the animal to toss his head, and in doing so, of course, shake out more corn." This was done repeatedly, whenever the supply on hand was exhausted, and it has the mark of intelligence. Even if it could be proved that the method was discovered by a chance startling of the horse there was a shrewd appreciation of the situation and a profiting by experience.

We saw the same kind of "learning" lately while a train stood long at a small station. A sack of wheat, resting upright against one of the supporting posts of the station shelter, had a small hole in it near the top, from which a few grains had fallen out. But this hole was out of reach and could not be directly pecked at. What a hen did was to jump up and strike the sack forcibly with its beak at a strategic bulging, the result being that a few grains were jerked out of the hole. The device was repeated many times, and there was nothing random in its efficacy. Even if it should be proved that this hen had been through a long education with the various kinds of feeding receptacles which compel poultry to take exercise as they eat, one would still be inclined to allow a spice of intelligence in the stricter sense. The case we gave of the pouter and the horse, observed long ago by Commander R. H. Napier and cited by Romanes, is, perhaps, more convincing, and it commands admiration. But how are we to reconcile this with the stupidity of pigeons which fail to recognise their own eggs when these have been removed a few inches out of place ; which may cast the young bird from the nest along with the empty shells ; which may continue brooding day after day on a nest where there are no eggs at all ? Perhaps it is by pressing this question that we shall get nearer some understanding of the pigeon's mind.

It rather pleases us to know of a pigeon recognising the voice of its mistress after an absence of eighteen months, and we can cap this with the case of a golden eagle. It had been taken thoughtlessly from the eyrie, and therefore it could not be liberated when it came under our charge at the age of about fifteen years. We became good friends with the bird, but had to send it to the " Zoo " in the scarcity of the winter of 1914 when its usual supplies from the zoological laboratory were cut off. We visited the Gardens about a year later and standing outside the cage cried " Peter, Peter ! " as in old days. The bird flew down as he used to do, and we shook hands. Thus the eagle and the dove have their memory ! But the pigeon's remembering the voice of its mistress must be as nothing compared with the visual memory of " homers," which fly so unerringly over the countryside that they have learned to know. Rouse's experiments with pigeons and a maze showed that they not only learned the secret, but that they remembered it after four weeks, although there had been no practice or further instruction in the interval. There are many other evidences of memory in pigeons, and yet we are pulled up again by the apparent discrepancy of an almost ludicrous forgetfulness. To Whitman's experiment of removing the eggs to a distance of 2 inches outside the edge of the nest, three answers were given. The wild passenger-pigeon (now extinct) found out by feeling that something was wrong; "her instinct was keenly attuned and she acted quite promptly"; in a few minutes she flew away, though her eggs were within her reach. "The little ring-dove sits on while you remove the eggs; she soon moves a little restlessly and may put her head down as if to feel for what is not there; she may glance at the eggs near by as if half-consciously recognising them." Then one of two things may happen. After ten to twenty minutes "she leaves the nest with a contented air, as if her duty were done." Or she may stretch her neck towards the eggs and try to roll them back. If she recovers one she is quite well pleased and sinks into her usual placidity, though her other egg is within reach. In the third case, that of the common dovecot pigeon, an attempt is usually made to retrieve both eggs, though satisfaction may be attained with only one. The three grades of "stupidity" are interesting, especially when it is noticed that the wildest bird was the stupidest. This gives us the required ray of light. In the exacting conditions of wild life it is necessary that the routine of inherited instinctive behaviour be rigorously adhered to; the whole business of brooding has been, as it were, handed over to instinct. Under man's care the pigeons are safer and they have also been accustomed, perhaps, to slight disturbances of routine. There is a little latitude in their obedience to the instinctive laws. As Whitman put it, "the door to choice is unlocked." Thus we see that what we are apt to call blank stupidity, in contrast to the free cleverness of getting grain from the horse's nose-bag, means that, along certain lines of behaviour, control has been entirely handed over to that inborn enregistration which we call instinct. How dim the awareness must be when the removed eggs do not suggest any action at all, or when one is as satisfactory as two !

We must not be too patronising in our attitude to creatures that can find their way home from a place previously unknown to them and to which they were transported in a closed basket. It verges on the miraculous ; and we have referred to it in another part of this book. Everyone admits that " homing " attains to a high degree of excellence in homing pigeons, but what is striking on our present line of thought is the contrast between this way-finding efficiency and the fumbling inefficiency of some of the details of everyday behaviour. " Change the position of the nest-box of the ring-dove," Professor Whitman writes, " without otherwise disturbing bird, nest, or contents, and the birds will have great difficulty in recognising their nest, for they know it only as something in a definite position in a fixed environment. If a pair of these birds have a nest in a cage, and the cage be moved from one room to another, or even a few feet from its original position in the same room, the nest ceases to be the same thing to them, and they walk over the eggs or young as if completely devoid of any acquaintance with or interest in them. Return the cage to its original place and the birds know the nest and return to it at once." The solution of the discrepancy between this throwing of the activity out of gear and the fine achievements of homing is to be found in the idea that it has paid to hand over great tracts of behaviour to instinct, that is to say, to inborn pre-arrangements from which a routine performance follows whenever the trigger is pulled. Plasticity of instincts may be seen in the young creature before habits have put their seal on inborn promptings—the familiar contrast between chick and hen. Plasticity of instincts may also be seen in the sheltered life of domestication, if that is associated with the rich stimulation of complex conditions—as in parrots. It may also be exhibited when there are numerous instinctive promptings and when they begin to contradict one another. Then there is hesitation and a selection of alternatives. The door to choice has been unlocked and " through the open door the great educator, experience, comes in and works every wonder of intelligence." What we see and admire in rooks and cranes and parrots is intelligence breaking up stereotyped instincts; what we see in pigeons—and that is their peculiar interest—is rarely more than a slight rocking of the instinctive equilibrium. The inference is plain—that we should look for the mind of the pigeon in circumstances for which there are not predetermined instinctive answers-back.

Romanes gives an instance of the kind of behaviour which seems to deserve to be ranked as intelligence. Many blue pigeons roost in the buildings of the Central Prison at Agra; they feed in the country during the day and return to the town in the evening, where they drink at a tank just outside the prison walls. In this tank there are numerous fresh-water turtles which lie in wait for the pigeons and sometimes succeed in snapping a head off. But the pigeons have learned, on the whole, how to avoid the ambuscade. A pigeon coming in crosses the tank at about 20 feet above the surface and then flies back again, apparently selecting a safe spot previously marked. But even when such a spot has been selected, the bird will not alight at the edge of the water, but on the bank about a yard off. It will then run down quickly, take two or three hurried gulps, and then repeat the process somewhere else. This strikes the note of intelligence.

Pigeons have acute vision and hearing ; they remember people and how these people treated them ; they know all their grown-up neighbours ; they are quick to imitate new ways of feeding and to learn tricks of bluffing one another ; and, above all, they are quick in mastering and tenacious in retaining the lessons of topography. Along certain lines they have a facile intelligence ; along other lines, where control has been normally handed over to instinct, they seem to be unutterably stupid, though we have tried to indicate that they are not so stupid as they seem.

But the mind is far more than intelligence, and we are misunderstanding the psychology of the pigeon if we do not recognise it as a bird of feeling. The emotion of fear bulks largely, and pigeons are very sociable. But most strongly developed is the love of mates, often marked by an intricate courtship ceremonial, often rising to an almost mad physical passion, often passing beyond the physiological fondness to psychological affection. In normal cases the sex-impulses are suppressed during the brooding period when the parents are alternately on duty ; in normal cases the two birds remain faithful to one another throughout the whole breeding season, but the cock is not quite so faithful as the hen.

CHAPTER XV

THE CHARM OF CHICKS

Before chickens become gastronomically interesting they are æsthetically charming. For several weeks after hatching out they are graceful in form, alert of sense, dainty in movement, and astonishingly quick to learn. It is a lesson in pædagogics to watch them from day to day as they feel their way about in an intriguing world. They are engagingly young and unprejudiced; they strike a note of newness; and they are revelations in educability.

Zoologically they are ranked as "præcoces," because they are able to fend for themselves so soon after they are hatched, in such striking contrast to the blind and naked fledglings in the nest of the thrush. Precocious, indeed, and yet in another sense old-fashioned, for as they run about, like miniature ostriches, they have little suggestion of flight, and are rather reminiscent of the ancient pioneer birds which sprinted swiftly along the arid ground and only occasionally took a running leap, half flight, into the shelter of a bush. Chickens take our thoughts back to the ancestral birds of many millions of years ago, which were warm-blooded, feathered bipeds just learning to fly. On the other hand, chickens are modernities, for they are, strictly speaking, much younger than Man.

If an instinct is an inborn ready-made power of doing apparently clever things, then chicks have some instincts, such as aiming at a fly moving on the wall of the hen-run. But the conspicuous fact is that their instincts are so few and far between. When we take account of pecking with precision at accessible objects, jumping neatly from an eminence eight times their own height, scratching the head with the toes, stretching out the leg backwards, and a few similar accomplishments, we come near the end of the chick's instinctive repertory.

It seems undesirable to include swimming, for a true instinct has always a reference to normal circumstances. It is no doubt interesting that if chicks a day or two old are tossed into a pond, they make their way very quickly and effectively to the shore, which is more than experienced hens can do; but it is highly probable that the young creatures are simply running in the water. It is certain that they have considerable inborn powers of muscular co-ordination, as exhibited in jumping, running, and balancing, but we are persuaded that it is a confusion of thought to speak of the chick's "swimming instinct."

The chick is the very opposite of an ant, for its youthful mind is a *tabula rasa*, whereas the ant's is a repertory of ready-made tricks—the most marvellous atom of matter in the world, as Darwin said. The advantage on the ant's side is that apprenticeship can be dispensed with; the advantage on the chick's side is an extraordinary educability. It learns by leaps and bounds. We wonder, however, whether it is not a little extreme in its unprejudiced innocence. Thus some chicks that were hatched in an incubator paid no attention at all when their unseen and previously unheard mother clucked outside the door.

Thorndike and others have made the experiment of putting a self-controlled cat among chickens, and the result was nothing. The chicks showed no fear, but went on eating as if there was nothing about. Up to thirty days there was no hint of fear when they were put into a cage where a mocking-bird was at home.

One of Lloyd Morgan's experiments showed that young chicks did not recognise water by sight, even when they were thirsty. They would swallow a big drop from the experimenter's finger when he touched their bill, but they would walk through or stand in a saucer full of water without recognising what certainly afforded them satisfaction. But when a chick standing in the water happened to pick its toes, then enlightenment followed, and the bill went up to the sky in the familiar fashion. Thereafter water was recognised. Incubated chicks do not recognise their mother's cluck, but those hatched out by the hen are usually quick to learn the significance of the whole of their mother's vocabulary.

A noteworthy point, however, which marks what is learned from what is instinctive, is the diversity among individual chicks. They vary greatly in alertness and docility. As Thorndike says: A loud sound may make one chick run, another crouch, another give the danger signal, another do nothing whatever. Instinctive capacities are usually shared equally by all members of the species (of the same sex); but intelligent capacities vary with the individual.

Apart from the æsthetic charm of young chicks, there is a fascination in watching their alert intelligence. Yet a few weeks pass and they settle down into stolidity. They do not fulfil the promise of their youth. The brains of a hen are proverbially poor, and chanticleer is not much better. The meaning of this relapse is partly that the young creature is always nearer the ancestral type, in this case the alert and independent jungle fowl. But the other part of the answer is to be found in the sheltered domesticated life of poultry. The natural ability is there, but as there is nothing to keep it in exercise, it retrogresses or falls asleep. Which things are a parable.

CHAPTER XVI

THE UNFULFILLED PROMISE OF YOUTH

There are many familiar facts in everyday Natural History that no one has yet pondered over enough, and one of these is the disappointing change that befalls many a promising young creature as it grows up. This is very marked in domesticated animals. As we have just seen, and as every one knows, the engaging chicks, alert, inquisitive and extraordinarily quick to learn, become stolid and stupid hens. Even a cock, albeit with a certain magnanimity in his harem and courage in his combats, is rather incompetent when any crisis occurs. Lambs are playful, joyous, experimental, adventurous, but sheep are stolid, stupid, and not very interesting. Kids show an exuberance of tricks and frolics, but goats, though less respectable than sheep, do not fulfil the promise of their youth. Why is it? What is the inhibition that seems to dull so many young creatures as they grow up?

Calves are delightfully playful. Like lambs, they have their "races," and "tig," and "follow-my-leader," but cows are more than a little bovine—placid, contemplative, ruminating, dull. They get into a hurtful panic before a fly that cannot bite, and they refuse to understand the ways of motor cars or even bicycles. They are diagrammatic victims of ultra-maternity and its correlates, as the domestic bull is a martyr to eroticism. For the wild bull Mr. Ralph Hodgson has spoken, and left the naturalist nothing to say. But what is this nemesis that stupefies creatures which are in their youth so full of promise?

The foal is a singularly attractive juvenile, precociously able to accompany its mother, very alert and inquisitive; but in the majority of cases it settles down into a very humdrum life. The dullness of its adult eyes often reproaches us; we know how many pardonable expressions of individuality are pruned off by the whip. The pathos of the over-drudged work-horse is not lessened when we remember how the cleverness of a naturally fine brain persists in the polo pony, not to speak of the puzzling arithmetical horses of Elberfeld. Why is it that "life-harming heaviness," as Shakespeare called it, settles down on the great majority of horses? Similarly, we might contrast duckling and duck, gosling and goose, even kitten and cat. Has man's hand some stupefying influence? Must it not be of great importance for human education to be able to answer this question? Man means well, on the whole, by the creatures which he has taken under his ægis. Why does he make many of them so dull?

In the case of domesticated animals, three facts stand out clearly: (1) Man gives them an artificial safety, a sheltered life, and food without exertions. The nemesis is dullness, sluggishness, obesity, stupidity. "Behold the life of ease—it drifts." Without sifting (whether in the form of natural selection or otherwise), there cannot be any steady progress; there cannot even be a retention of what has been already gained. (2) Animals are characteristically motor organisms. The cravings of their gastric or "autonomic" system are always pulling the trigger of their neuro-muscular or "proficient" system. They search for food. They accumulate explosives, and these must be exploded. If the creatures are cribbed, cabined, and confined, denied their motor output, they suffer from repression—and from fat. (3) In the wholesome conditions of wild nature animals are forced to live a strenuous life, and they have adequate motor outlets: in domestication they are coddled and forced into relatively sedentary habits. But there is more. The wild animal has many responsibilities; most domesticated animals have few or none, or are allowed them only along more or less artificial lines. And it is a very suggestive fact that when a domesticated animal is granted a considerable share of responsibility, especially in co-operation with man, it retains a notable degree of intelligence. This is plainly seen in dog and horse, as contrasted with cat and cow, to take mammals somewhat alike in cerebral endowment. For it would be unfair to contrast dog with sheep, or horse with rabbit.

Does it not seem as if there were food for reflection here? If our methods of education involve sheltering children too much, if motor activities (well provided for in some sections of the community) are restricted, and if there are few responsibilities or only very artificial ones (such as learning lessons), is not stupefying almost inevitable? And is this not in process all around us?

We are not forgetting the sex factor. It is plain (1) that some domesticated animals, like ordinary horses, are undersexed, which must be stupefying; (2) that others, like poultry, have the normal punctuation of sex-activity removed, which must be fatiguing; and (3) that others, like breeding rams, are exaggeratedly sexual, which must be dangerous. But this is another story. Our question is why the promising young creature should often become so dull.

We wish that the only instances of the non-fulfilment of promise were to be found among domesticated animals, for then we could say that the artificial conditions were to blame. But do not wild creatures give indications of the same perplexing regression to mediocrity? The young foxes, the young hares, the young water-shrews, the young monkeys, and so on through a long list, are they not more experimental, more alert, more adventurous, more educable than their seniors? Is it simply that youth is the time when new variations have elbow-room to express themselves in the play-period and under the protection of parents, and that most of these idiosyncrasies are gradually pruned off because they are hazardous? Is it that the conditions of life for most higher animals are along somewhat restricted and constant lines, and that it is unreasonable for us to expect such creatures to be any cleverer than they need to be? They have become in the course of ages well adapted to their everyday routine, and why should they experiment? There is not, except in monkeys, much hint of the restless, scientific brain.

We might think that this answer was quite satisfactory did we not know of animals like the otter. This engaging type, which eugenists should make their totem, remains young till it dies, playful up to the gates of death, versatile, resourceful, and full of the joy of life. What is the secret of this persistent youthfulness? Is it not that the otter has discovered the value of *change*—change of haunt, change of food, change of habit; that it is a persistent rover; and that it makes up for a youthful innocence—free from too many instincts—by a remarkable educability and thoroughness of parental instruction. Is there nothing for educationists here?

CHAPTER XVII

MIND IN COMMON MAMMALS

How are we to avoid thinking too generously or too stingily of animals like dogs, horses, and elephants? Mind is not a quality that we can test for, as we might for an acid or an alkali. The only scientific plan, apart from experiment, is to try to describe what we observe in as simple terms as possible. If we can describe the animal's doings without any word like judgment or inference or idea or purpose, then there is not much mental aspect in that particular action. From other facts, however, we may know that the animal is very affectionate or very trustworthy, and these qualities would also indicate mind. For mind is a general term for the inner life, and includes feeling and purpose as well as judgment. But each activity must be judged on its own merits, and we must try to be neither too generous nor too stingy. The animal has no general ideas, yet it is not an automatic machine. It can sometimes reason, but it has no Reason, for Reason means working with general ideas or concepts.

We must always allow a good deal for the animal's power of forming associations; that is to say, connecting a particular sound or sight with a particular action or prospect. Speaking from behind a screen, so as to exclude visual hints, Mr. Dixie Taylor said to his bull-terrier, Jasper: "Go to the next room and bring me a paper lying on the floor." Jasper did this at once, and was only at fault when there were several objects in a row, for then he did not always bring the right one. On the street he was told to go and put his paw on an automobile, which was standing about a hundred yards away. This was at once done without mistake. But this was the outcome of prolonged training during which the dog had learned to associate certain sounds with certain pieces of behaviour. This power of association-learning is doubtless of much importance in Wild Nature, for some young animals, such as otters, spend a good deal of time in mastering, with their mother's help, what might be called the alphabet of woodcraft; that one sound spells danger, for instance, while another promises booty.

There was a setter that used to answer vocally with a sound like " Don," when asked its name, and a sound like " Hunger," when asked what ailed it ; and so on through eight words, one for each year of his life. It sounded very impressive till a visit from a psychologist revealed the fact that the ingenious owners had always put the dog through its catechism *in the same order*. When the first question put was : " What ails you ? " or " What do you want ? " he answered " Don " instead of " Hunger " or " Cake."

Sometimes the learning is much more subtle, and yet we hesitate to call it intelligent. Thus Professor Yerkes soon taught his educable Dancing Mice to discriminate between alternative pathways which were differently lighted or coloured. If the mouse chose the one path, it found a clear passage direct to its nest ; if it chose the other, it was punished by a mild electric shock and had to take a roundabout way home. The safe path was sometimes to the right, sometimes to the left ; so as to exclude the off-chance that position gave the mice a clue. In a short time the mice learned to choose aright without mistake, and the interest of this is that it suggests how mammals in Wild Nature may readily learn to discriminate between nuances of illumination or colour.

In some cases it is difficult to say what exactly is learned, and how. Thus rats, mice, and various other animals will learn to find their way to the centre of a labyrinth or Hampton Court maze. In the course of time they make fewer and fewer wrong turnings, and eventually none. The power lasts for some days without further experience. They do not find their way by sight or scent ; it is difficult to suppose that they form a mental picture of the maze, or that they master its secret as a boy might ; there is probably some enregistration of the profitable sequence of muscular movements.

So much, then, to suggest that we must not take every piece of behaviour at its face value ; but let us turn to instances that may be regarded as indicative of genuine intelligence—meaning by intelligence some exercise of judgment, some putting two and two together. Consider, for instance, cases like the following : a Polar bear scooping the water in its great pool so that the floating buns came within its reach as it stood on land ; a dog adjusting its swimming across a tidal river according to the ebb or flow ; the mares in a great flood bringing their foals to the top of a hillock in a field, and holding them up in their midst. A dog, entrusted with a basket of eggs, poked it through the foot of a stile, ran back a few yards, took the stile at a bound, picked up the basket, and went on its way, doubtless well pleased with itself. "Yes," said the narrator, "he knew the eggs would break if he attempted to leap with the basket." But this generous interpretation is at once unverifiable and unnecessary. The dog might have a perception of the fit thing to do, without analysing it in detail as man might. Great deftness is sometimes shown in getting out of puzzle-boxes where the latches and catches have to be opened in a certain order, but a higher note is struck, we think, when the Arctic fox discharges the trap ever so cautiously and experimentally, thus securing the bait without receiving any hurt.

To sum up : there is, first of all, evidence that common mammals have a groundwork of instinctive capacities, such as beavers show in cutting down a tree, or squirrels in storing nuts, or harvest-mice in making a nest. There are inborn powers of doing effective things without any apprenticeship or " learning." In the second place, there is no doubt as to their power of forming associations and of being educated, whether by their parents or by man. The elephant at the Belle Vue Gardens, Manchester, used to take a penny from the benevolent visitor, put it into the slot of an automatic machine, and get its biscuit. If it received only a halfpenny it would fling it back impatiently. On the face of it, this looked very clever ; but every stage in the performance was the outcome of careful training. The elephant had its trunk carefully guided to the machine, and it required two or three months of tuition before it learned to discriminate between the penny which worked and the halfpenny which did not. On the other hand, in the third place, there is no doubt that mammals sometimes show a spice of judgment, a capacity for perceptual inference. This may mingle with the instinctive behaviour and with association-learning ; and though we may not be able to disentangle it from the results of education, it perhaps finds its finest expression in co-operation with man, sharing his responsibilities. We see this when we watch the elephant helping the woodman, or the horse doing shunting work at a railway station, or a collie dog driving the sheep in a difficult place. In all these cases we see judgment.

CHAPTER XVIII

THE MIND OF MONKEYS AND APES

There is great variety of attainment at different levels in the Simian tribe, and in a general study like this we cannot hope to reach more than an average impression. There is a long gamut between the bushy-tailed, almost squirrel-like marmosets and the big-brained chimpanzee.

To begin at the beginning, it is certain that monkeys have a first-class sensory equipment, especially as regards sight, hearing and touch. The axes of the two eyes are directed forwards as in ourselves, and a large section of the field of vision is common to both eyes. In other words, monkeys have a more complete stereoscopic vision than the rest of the mammals enjoy. They look more and smell less. They can distinguish different colours as such; that is to say, apart from different degrees of brightness in the coloured objects. They are quick to discriminate differences in the shapes of things, *e.g.*, boxes similar in size but different in shape, for if the prize is always put in a box of the same shape they soon learn (by association) to select the profitable one. They learn to discriminate cards with short words or with signs printed on them, coming down when the "Yes" card is shown, remaining on their perch when the card says "No." Bred to a forest life where alertness is a life-or-death quality, they are quick to respond to a sudden movement or to pick out some new feature in their surroundings. And what is true of vision holds also for hearing.

Another quality which separates monkeys very markedly from ordinary mammals is their manipulative expertness, the co-ordination of hand and eye. This great gift follows from the fact that among monkeys the fore-limb has been emancipated. It has ceased to be indispensable as an organ of support; it has become a climbing, grasping, lifting, handling organ. The forelimb has become a free hand, and every one who knows monkeys at all is aware of the zest with which they use this tool. They enjoy pulling things to pieces—a kind of dissection—or screwing the handle off a brush and screwing it on again.

Professor Thorndike hits the nail on the head when he lays stress on the intensity of activity in monkeys—activity both of body and mind. They are pent-up reservoirs of energy, which almost any influence will tap. Watch a cat or a dog, Professor Thorndike says, it does comparatively few things, and is content for long periods to do nothing. It will be intensely active in response to some stimulus, such as food or a friend or a fight, but if nothing appeals to its special make-up, which is very utilitarian in its interests, it will do nothing. "Watch a monkey and you cannot enumerate the things he does, cannot discover the stimuli to which he reacts, cannot conceive the *raison d'être* of his pursuits. Everything appeals to him. He likes to be active for the sake of activity."

This applies to mental activity as well, and the quality is one of extraordinary interest, for it shows the experimenting mood at a higher turn of the spiral than in any other creature, save Man. It points forward to the scientific spirit. We cannot indeed believe in the sudden beginning of any quality, and we recall the experimenting of playing mammals, such as kids and kittens, or of inquisitive adults like Kipling's mongoose, Riki-Tiki-Tavi, which made it his business in life to find out about things. But in monkeys the habit of restless experimenting rises to a higher pitch.

They appear to be curious about the world. The famous psychologist whom we have quoted tells of a monkey which happened to hit a projecting wire so that it vibrated. He went on repeating the performance hundreds of times during the next few days. Of course, he got nothing out of it, save fun, but it was grist to his mental mill. "The fact of mental life is to monkeys its own reward." The monkey's brain is "tender all over, functioning throughout, set off in action by anything and everything."

Correlated with the quality of restless inquisitiveness and delight in activity for its own sake there is the quality of quickness. We mean not merely the locomotor agility that marks most monkeys, but quickness of perception and plan. It is the sort of quality that life among the branches will engender, where it is so often a case of neck or nothing. It is the quality which we describe as "being on the spot," though the phrase has slipped a bit from its original moorings. Speaking of his Bonnet monkey, an Indian macaque, second cousin to the kind that lives on the Rock of Gibraltar, Professor S. J. Holmes writes: "For keenness of perception, rapidity of action, facility in forming good practical judgments about ways and means of escaping pursuit and of attaining various other ends, Lizzie had few rivals in the animal world. . . . Her perceptions and decisions were so much more rapid than my own that she would frequently transfer her attention, decide upon a line of action, and carry it into effect before I was aware of what she was about. Until I came to guard against her nimble and unexpected manœuvres, she succeeded in getting possession of many apples and peanuts which I had not intended to give her, except upon the successful performance of some task."

We wish to say once more that quite fundamental to any understanding of animal behaviour is the distinction so clearly drawn by Sir Ray Lankester between the "little brain" type, rich in inborn or instinctive capacities, but relatively slow to learn, and the "big brain" type, with a relatively poor endowment of specialised instincts, but with great educability. The "little brain" type finds its climax in ants and bees; the "big brain" type in horses and dogs, elephants and monkeys. And of all animals, monkeys are the quickest to learn, if we use the word "learn" to mean the formation of useful associations between this and that, between a given sense-presentation and a particular piece of behaviour.

The front of the cage in which Professor Holmes kept Lizzie was made of vertical bars which allowed her to reach out with her arm. On a board with an upright nail as handle there was placed an apple—out of Lizzie's reach. She reached immediately for the nail, pulled the board in and got the apple. "There was no employment of the method of trial and error; there was direct appropriate action following the perception of her relation to board, nail, and apple." Of course, her ancestors may have been adepts at drawing a fruit-laden branch within their reach, but the simple experiment was very instructive. All the more instructive because, in many other cases, the experiments indicate a gradual sifting out of useless movements and an eventual retention of the one that pays. When Lizzie was given a vaseline bottle containing a peanut and closed with a cork, she at once pulled the cork out with her teeth, obeying the instinct to bite at new objects, but she never learned to turn the bottle upside down and let the nut drop out. She often got the nut, and after some education she got it more quickly than she did at first, but there was no indication that she ever perceived the fit and proper way of getting what she wanted. " In the course of her intent efforts her mind seemed so absorbed with the object of desire that it was never focussed on the means of attaining that object. There was no deliberation, and no discrimination between the important and the unimportant elements in her behaviour. The gradually increasing facility of her performances depended on the apparently unconscious elimination of useless movements." This may be called learning, but it is learning at a very low level ; it is far from learning by ideas ; it is hardly even learning by experiment ; it is not more than learning by experience ; it is not more than fumbling at learning !

A higher note is struck in the behaviour of some more highly endowed monkeys. In many experiments, chiefly in the way of getting into boxes difficult to open, there is evidence (1) of attentive persistent experiment, (2) of the rapid elimination of ineffective movements, and (3) of remembering the solution when it was discovered. Kinnaman taught two macaques the Hampton Court maze, a feat which probably means a memory of movements, and we get an interesting glimpse in his observation that they began to smack their lips audibly when they reached the latter part of their course, and began to feel, dare one say, " We are right this time."

In getting into " puzzle-boxes " and into " combination-boxes " (where the barriers must be overcome in a definite order) monkeys learn by the trial and error method much more quickly than cats and dogs do, and a very suggestive fact, emphasised by Professor Thorndike, is " a process of sudden acquisition by a rapid, often apparently instantaneous abandonment of the unsuccessful movements and selection of the appropriate one, which rivals in suddenness the selections made by human beings in similar performances." A higher note still was sounded by one of Thorndike's monkeys which opened a puzzle-box at once, eight months after his previous experience with it. For here was some sort of registration of a solution.

We watched, the other day, two chimpanzees busily engaged in washing the two shelves of their cupboard and "wringing" the wet cloth in the approved fashion. It was like a caricature of a washerwoman, and some one said, "What mimics they are." Now, we do not know whether that was or was not the case with these chimpanzees, but the majority of the experiments that have been made do not lead us to attach to imitation so much importance as is usually given to it by the popular interpreter. There are instances where a monkey that had given up a puzzle in despair returned to it when it had seen its neighbour succeed, but most of the experiments suggest that the creature has to find out for itself. Even with such a simple problem as drawing food near with a stick, it often seems of little use to show the monkey how it is done. Placing a bit of food outside his monkey's cage, Professor Holmes "poked it about with a stick so as to give her a suggestion of how the stick might be employed to move the food within reach, but although the act was repeated many times, Lizzie never showed the least inclination to use the stick to her advantage." Perhaps the idea of a "tool" is beyond the Bonnet monkey, yet here again we must be cautious, for Professor L. T. Hobhouse had a monkey of the same macaque genus which learned in the course of time to use a crooked stick with great effect.

One of the cleverest monkeys as yet studied was a performing chimpanzee, called Peter, which has been generously described by Dr. Lightner Wilmer. Peter could skate and cycle, thread needles and untie knots, smoke a cigarette and string beads, screw in nails and unlock locks. But what Peter was thinking about all the time it was hard to guess, and there is very little evidence to suggest that his rapid power of putting two and two together ever rose above a sort of concrete mental experimenting, which Dr. Romanes used to call perceptual inference. Without supposing that there are hard and fast boundary lines, we cannot avoid the general conclusion that, while monkeys are often intelligent, they seldom, if ever, show even hints of reason, *i.e.*, of working or playing with general ideas. That seems to be Man's prerogative.

Many recent observations of great value have been made on chimpanzees, especially by Professor Köhler. A banana was hung from the roof of the chimpanzees' cage, and they tried to reach it by climbing and swinging, but all in vain. One climbed on to the shoulders of another, but the fruit was still out of reach. Suddenly it occurred to one of them to pile one box on the top of another, and when he erected a four-storey structure, there were bananas to be had that day. That was an intelligent invention ; it meant very literally putting two and two together.

But it is an interesting fact that the individual chimpanzees varied notably in the degree of their understanding. For after one of them had successfully built up a pile of three boxes, she put the fourth one on the top with the open end up. Thus, she was not much nearer than if there had been only three boxes, but she did not understand enough to see what was wrong, so she got inside the topmost box and fell asleep !

Professor Köhler studied his chimpanzees at Teneriffe, where the climate suited them, and he made a point of keeping several together, for, as he says, a solitary chimpanzee is not a chimpanzee at all. They rewarded him by being apt pupils, and they illustrated the soundness of the well-known heuristic method, which encourages learners to discover things for themselves.

An instructive experiment was to place the fruit on the ground outside the cage and beyond an arm's length. Then the apes were supplied with lengths of bamboo rod, but none long enough to reach the fruit. The chimpanzees tried these rods, and one of them got the length of pushing a short rod along the ground at the far end of a long rod, so that the fruit was touched. But as the short rod was not continuous with the long one, the fruit could not be retrieved. In the course of a forenoon's trying, however, one clever chimpanzee discovered how to fix a short length into the hollow end of a longer rod, thus making two sticks into one ; and with this it was possible to get possession of the fruit.

An interesting elaboration of this achievement was seen when one of the merry crew whittled with his teeth at the end of a short piece of wood so as to make it small enough to fit into the hollow end of a longer piece. There is no word for this but sheer intelligence—an adaptation of old means to an entirely new end. There was an appreciation of the situation.

Very suggestive in trying to estimate the mental life of apes is their approach to what we venture to call an argument from analogy. Thus Mr. Hornaday, of the Bronx Park Zoological Gardens, in New York, tells how an orang discovered the use of a lever—not the principle of the lever, but the *use* of a lever, with which, indeed, he did much damage. But the point is that the orang proceeded to make more levers of other dimensions, his crowning achievement being the use of his trapeze bar as a lever to force apart the iron bars of his cage, so that he could put his head out and look round the corner to see what his neighbour was doing.

Or, again, when Miss Cunningham's young gorilla was refused a seat on her lap because he was dusty and she had a light gown on, he went and fetched a newspaper which he spread over her skirt, probably extending to this situation the previously observed use of a newspaper in lining a drawer or the like.

Similarly interesting was the way in which Professor Köhler's chimpanzees, having enjoyed the fun of looking into a hand-mirror, proceeded to discover other mirrors of their own, such as brightly polished pieces of metal. Although they could not rid themselves of the fallacy that there was another ape on the other side of the looking-glass, whom they continually tried to catch, there was something striking in their discovery of the analogues of a hand-mirror. Eventually they found out that they could see an ape in a puddle of water, and at this they would sit gazing for a long time ; perhaps not far from the dawn of a clear self-consciousness.

Whenever we study the minds of animals and are filled with admiration at their achievements, we should correct this by noting that they are in many ways narrowly limited. Even the clever chimpanzees are baulked by a practical problem that a young child could quickly solve. Why is this ? Their brains are not so finely fashioned, that is the general reason. But we should also notice that they are handicapped by not having true language, though they have many sounds. They seem also to have a very poor equipment of mental images ; they cannot experiment with pictures in their head ; they can rarely solve a problem unless the materials for the solution are within their present visual range.

To sum up, the higher apes stand apart from most mammals in their restless inquisitiveness and delight in experimenting. This is true of monkeys in general. In the second place, besides forming associations and acquiring dexterities, the higher apes illustrate a sort of argument by analogy. "If this, then that," they seem to say to themselves, as is illustrated by passing from the use of a small lever to the use of a large one. In the third place, when we think of chimpanzees making two sticks into one to retrieve the fruit, or piling box upon box to reach the roof, we cannot but credit them with perceptual inference or genuine intelligence. And apart from the mental background of their clever doings, we must keep in mind their life of feeling, which includes not only affection and anger, but such subtle emotions as jealousy and kin-sympathy.

CHAPTER XIX

THE EVOLUTION OF VISION

If we are to reach a clearer view of the behaviour of animals, we must take account of the senses, and we must think of these as having in animals a *rôle* somewhat different from that which they have in ourselves. In man we regard the sense-organs rightly as gateways of knowledge, or of the raw materials of knowledge. By our senses we get tidings of the outer world. They are the outposts that give us information, so that we are able to form accurate perceptions of things. But this *rôle* came late in evolution, when the central nervous system had attained to a considerable degree of differentiation and integration; that is to say, of intricacy and unity. The original use of sensory structures was to serve as triggers by means of which muscles were made to move. Their primary significance was not to convey information, but to excite immediate action.

The use of the word "receptor" is convenient as a general term for a sensory cell or sense-organ, whether its use be to bring in tidings or to activate muscles, and it is a noteworthy fact that sensory nerve-cells tend to be excited by one kind of stimulus and by that alone. Thus in the course of evolution there have come to be many different kinds of specialised scouts, each of them very alert to one particular kind of change in the surroundings, which may include the body itself as well as the outside world.

We cannot do more in this book than illustrate the different senses, but we must recognise that there are far more than the conventional five—smell, taste, touch, hearing and sight. We cannot do with less than nine:

1. Light-sense, rising to vision.
2. Touch-sense.
3. Static sense of balance.
4. Hearing.
5. Sense of movements and pose.
6. Temperature-sense.
7. Smell.
8. Taste.
9. Pain.

The Sense of Sight

When one thinks of the human eye or the eagle's eye, and of the vision that both enjoy, it is difficult at first to silence the feeling that these structures and functions are much too wonderful to have been *evolved*. But this is a fallacious impression due to unacquaintance with the graduated series of stages that lead up to the end-results. In regard to human inventions, the final approximations to perfection would often seem magical if one did not know something about the long series of antecedent tentatives. So it is with what may be called Nature's many inventions. The most evolved eyes are miracles of adaptiveness, but the first light-sense organs are mere pigment spots, and the stages are many and gradual that lead from these to the compound eyes of the butterfly along one line of evolution, to the single-lens eyes of cuttle fishes on another, and to the eyes of backboned animals on a third.

Two other general points should be noted: (1) that the stages in the evolution of the optical instrument must be correlated with the gradual improvements of the brain, to which it sends tidings; and (2) that the eye had many functions before it became an image-forming or a picture-making organ. Just as the ear was for millions of years a balancing or equilibrating organ before it became a hearing ear, so the eye was for ages a light-and-shade organ, or a movement-detecting organ, or something else, before it could be said that its possessors were able to form a picture of their surroundings. That power came very late.

The electro-magnetic vibrations that we call light have many direct effects on living creatures. Thus they bring about photo-synthesis in green plants; they evoke pigment formation in many animals ; and they may have a tonic influence on growth and health. But by light sense is meant a special photo-chemic susceptibility of certain receptor nerve cells to light rays in general, or to certain light rays in particular, with the result that the explosive thrill evoked by the absorbed rays is passed on to other parts of the organism which react in some definite way, notably by movement. The living matter of a simple unicellular animal or Protozoon may be sensitive to light without there being any appreciable differentiation of structure that could be dignified even with the name of " eye-spot." The function comes before the organ ! But one of the first progressive steps was the accumulation of a little splash of pigment, which may have various uses ; for instance, in screening off rays to which the receptor cell or protoplasm is not attuned, or in surrounding the sensitive spot so that the light enters only from straight in front. A second step was the formation of something in the way of a lens which focusses the rays of light. In the simplest cases the lens is not even cellular, so primitively do things begin ! A third step was the fashioning of the " light organ " into something like a little cup, or camera, with the receptor cells on the posterior concave surface and the lens in front. In some of the sea-worms, for instance, we start with diagrammatically simple " cup-eyes," like prentice-work, and pass gradually to very elaborate " cup-eyes," the grading of the series being in itself a quite convincing " evidence of evolution."

With the development of a minute optic skin-cup, so readily brought about by inequalities of growth, there must be associated (*a*) the beginning of the perception of the direction from which the light comes, (*b*) the first dim awareness of moving objects whose shadows flit across the sensitive wall of the tiny camera, and (*c*) the first experiences in the visual detection of obstacles. But long before animals showed directed movements, definitely oriented in relation to the light-stimuli, there were vaguer reactions. Thus many animals, such as tube-inhabiting worms, sea urchins, rock barnacles, gnat larvæ, burrowing bivalves with their siphons projecting out of the sand, and the long-horned snails, answer back by reflex retraction to the shadow of one's hand held ever so gently above them. Many do this although they have no eyes in the ordinary sense of the term. It has already been noted that the shadow-reflex is never exhibited more than a few times within a short period ; the creatures soon cease to answer back.

Much less frequent than reaction to a shadow is reaction to a sudden increase of light ; but there are instances of animals that move towards the more illumined part of an aquarium lighted from above, though a reverse movement into the shade is commoner. Our point is simply that long before there was any " seeing " there was exquisite sensitiveness to light and shade. This discrimination is of obvious importance to animals that live in darkness, or are active only at night, as also to others which cannot be active except when illumined. Whether it is light or darkness that paralyses, it is advantageous to become rapidly aware of the change. Of great interest, in insects especially, is the relation between the intensity of the illumination and the tone of the muscles ; but this is a very difficult question.

When a simple animal moves from an illumined to a shaded part of an aquarium lighted from above, or conversely, it is illustrating the light and shade reflex ; but a higher level of reaction is seen when an animal moves towards or away from the source from which the light comes. This "phototactic" movement usually implies something in the way of a genuine eye, yet it is sometimes exhibited by creatures that have not risen to anything more than an eye-spot. In certain cases there is no movement from one place to another, but merely an adjustment of the body so that both sides are either equally illumined or equally in the shade. But it was a great step when the eye began to be used like a compass, enabling the animal to steer, either automatically or tentatively, towards an illumined object. In other words, it was a great step when sight became directive. It is very instructive to contrast the circumambulating circuitous track of an animal moving in total darkness with the straight course it pursues when there is an illumined object to serve as a guiding star.

The next great step in eye evolution was the formation of an image, the visual perception of form. This implied the differentiation of a lens and a retina, and not too simple a retina. Towards the seeing of shapes there were doubtless many steps, such as the perception of moving objects without discrimination of their precise form, and the recognition of obstacles in the path without perception of their precise contour. Of much importance must have been the evolution of some method of "accommodation"; that is to say, some way of adjusting the focus of the eye for objects at different distances, or for the variously distant parts of the same object. This may be effected by altering the distance of the lens from the retina, as is illustrated by Alciopid marine worms, which have very fine eyes; by the sea snails, called Heteropods; by the cuttlefishes or squids, by most of the true fishes, and by the Amphibians. In reptiles, birds and mammals the method is quite different, for accommodation is effected by altering the curvature of the lens.

After a certain stage was reached, probably among the worms, the evolution of eyes proceeded along three distinct lines. There was the line which finds its climax in birds and mammals. But quite different in detail and in development is a type of eye found among molluscs, and reaching its climax in the extraordinarily effective eyes of octopuses and their relatives. Entirely different again is the compound eye of insects and higher crustaceans, where there are hundreds of lenses and hundreds of percipient retinules, the image formed being a mosaic built up of numerous minute contributions. This type of eye seems better adapted to the detection of movements than to the perception of form.

The story of the evolution of vision should take account of the movements of the eyes, the binocular apparatus, the discrimination of colour, and the general improvement in picture forming. The last depends mainly on the size of the instrument, the number of sensitive receptors in the retina, and the number of nerve-fibres passing from the receptors to the brain. Nor can we forget the evolution of the brain behind the eye, for it is the brain, with its mind, that changes vital photography into intelligent scrutiny, and sublimes sight into vision. The eye sees what it has acquired the power of seeing, as we all prove every day, both pleasurably and painfully.

CHAPTER XX

ARE MANY ANIMALS COLOUR BLIND?

When scientific attention began to be directed to the senses of animals, there was a not unnatural inclination to read the man into the beast. If a fish has an ear, shall it not hear? If a bee has an eye, will it not recognise the bee-keeper? If a butterfly visits a gay flower, must it not be appreciative of colour? But as knowledge grew and as experimentation began (practically with Lubbock), it became clear that an animal's possession of sense-organs analogous to ours does not necessarily imply that the creature sees or hears, and so on, as we do. Many an animal with a well-developed ear was found to be stone deaf, and Plateau showed that certain insects continued their visits to particular flowers after the brightly-coloured petals had been removed or concealed. Thus the pendulum has swung into a position of wholesome scepticism; every animal must be experimentally tested. In the meantime, however, somewhat exaggerated conclusions have become current, as this, for instance, that "all backboneless animals are colour blind."

This can be disproved by experiment by those who have the requisite time and skill, but before passing to the existing evidence we wish to suggest two or three general considerations. In the first place we should, as a rule, distrust assertions about the ways of "all backboneless animals," for only a few have been carefully tested. In the second place "colour blind" has a variable meaning for man, according to the number and the nature of the colours that can be distinguished. Thus many people can only discriminate between red, green and violet; but this is not the only form of human colour-blindness. It is highly improbable that an absolute statement, like the one we are objecting to, could be true for the whole sub-kingdom of, say, 250,000 different species of backboneless animals. A vast number of these are deaf, but we should have the same *a priori* objection to predicating deafness of them all. In the third place, the relations of insects to coloured flowers and to flowers of diverse colours, the frequent contrasts of colour between the sexes, and the activities in which males seem to show off their colours to their desired mates, conspire towards the *a priori* conclusion that colour as colour counts for a good deal among animals.

The importance of the words "colour as colour" will be obvious; for it is necessary to try to discriminate between the particular colour as colour and its brilliance as a reflector of light in general and of ultra-violet rays in particular. In many cases it may be the pattern that impresses itself on the eye of the impressionable animal, and the pattern may be marked out by different intensities of surface-reflection. These intensities may be perceived though the colours as such are not distinguished. On the other hand, we cannot forget the fact that many brightly-coloured animals, some of them with eyes, live in deep water beyond, even miles beyond, the limit of light-penetration. Unless the so-called phosphorescent light of other deep-water animals makes these colours visible, it is not evident that it would be of any advantage to any inhabitant of these depths not to be colour-blind!

The early experiments of hive-bees made by Sir John Lubbock (Lord Avebury) were excellent of their kind. He placed similar baits of honey on slips of glass resting on pieces of paper of different colours. The colours were blue, green, orange, red, white and yellow ; and one piece of glass had no paper at all. " Out of a hundred rounds the bees took blue as one of the first three in seventy-four cases, and one of the last four only in twenty-six cases ; while, on the contrary, they selected the plain as one of the first three only in twenty-five cases, and one of the last four in seventy-five cases." Lord Avebury concluded that bees discriminate colours as such, *e.g.*, blue from red.

The next important step was due to Hess, who showed that many animals—among molluscs, crustaceans, and worms—distinguish different intensities of light, but do not distinguish colour as such. When a number of different animals were placed in a vivarium with one-half of the roof light blue and the other half red, it came to pass in a short time that some kinds were all in the blue and others all in the red half. But when great care was taken to get the intensity (apart from the wavelengths) of the light identical in the two halves, so that a completely colour-blind man saw no difference, then the animals which had been called " blue-lovers " and " red-shy " belied their description by occurring indiscriminately all over the vivarium. They were colour-blind, and this has been shown to be the case with numerous animals whose apparent discrimination of colours resolves itself into a discrimination of differences in the intensity of the illumination.

But let us now take one of the recent experiments of Frisch on hive-bees. He trained the bees to feed out of watchglass-like vessels that rested on squares of coloured, say blue, paper. An association was established. He then prepared a draught board with many squares, varying in colour from dark to light grey, and irregularly disposed. Amongst these he placed one blue square, and it was on this, and on this alone, that the trained visitor bees settled down, though there was no honey at all. Since some of the greyish squares had the same intensity of illumination as the blue square, a discrimination of colour as colour was proved.

Although the discrimination of blue and of yellow seems to have been proved up to the hilt for bees, it should be noted that they fail to distinguish red and black (a common defect), while, on the other hand, they surpass man in being able to discriminate, as ants also do, the ultra-violet rays which we cannot see at all. Some flies, butterflies and moths are certainly able to discriminate colour as colour, especially the shorter wavelengths.

Some kinds of crabs are in the habit of masking themselves with seaweed, and in a red-walled aquarium they will deck themselves with red paper and reject white. Yet they make no distinction between yellow and green, and this is one of the cases where the discrimination seems to depend on the brightness rather than on the colour.

Definite colour sense has been proved, however, for the Æsop prawn and some of its relatives. It is necessary, therefore, to correct the exaggerated statement that "all backboneless animals are colour blind." There is definite colour sense among insects and crustaceans, and also among cuttle fishes.

Careful experiments have proved that many true fishes, living in shallow water, are able to discriminate colours, as one would expect in the case of those that change their own hues very rapidly in correspondence with those of their surroundings. In some flat fishes and some dogfishes, in tench and sticklebacks, and in some other cases, there is convincing evidence of colour sense. The minnow can actually distinguish red, yellow, green, blue, violet and ultra-violet. Among amphibians the common frog is so sensitive to colour that it alters its breathing according to the colour that plays upon it; and colour-sense has been proved for sundry toads and newts.

The retina of the vertebrate eye contains microscopic rods and cones, the rods having to do with the perception of light and shade and form, the cones having to do with colour. In nocturnal creatures, such as bats and owls, the rods predominate greatly, and there is probably little colour-sense in any animal that always walks in darkness. Moreover, in many birds and in some reptiles there are red or yellow droplets of oil in the cones, and in these cases there is relative colour blindness for blue rays. But this is certainly not universal; thus some cage birds are much excited by a blue dress. The probability is that the differentiation of the colour sense has waxed and waned among animals according to their struggle for existence. One would expect much in a flower-visiting honey bird and little in a nightjar, much in a bull (we are thinking of a red rag!) and little in a hedgehog. So far as we know, dogs have very little colour-sense, and cats are quite colour blind.

CHAPTER XXI

THE HEARING EAR

APART from certain insects, there seems to be no sense of hearing among backboneless animals, and even among backboned animals the hearing ear does not count for much below the level of birds and mammals. Yet many of the invertebrates have earlike organs, and a humble vertebrate like a fish has a highly evolved ear, though hearing is not important at this level, and is sometimes apparently absent. The explanation is to be found in the fact that before ears evolved the function of hearing they had another function, that of balancing, or equilibration, which is still retained by the semi-circular canals of the ear, even in ourselves. We have learned that before the eye was an image-forming organ, it was of use to distinguish light and shade and to detect the movements of objects ; so before the ear became sensitive to sound waves, it was of use in the automatic adjustment of balance and poise.

When we say that no invertebrates can hear, except some insects, we must be careful to distinguish the perception of sound waves as such from the detection of other vibrations which a resounding body may produce. Many animals, such as earthworms, have tactile cells which are exquisitely sensitive to mechanical tremors, though they are entirely indifferent to waves of sound. Unless the so-called ear has some sort of structure that can vibrate sympathetically under the influence of sound waves, we cannot think of crediting its possessor with any sense of hearing.

An earthworm in a flower pot placed on the top of a piano jerks itself into its hole when a note is sounded. The somewhat shrimp-like crustaceans, called Mysids, flex their tails when one taps on the window of the aquarium with a glass rod. But neither of these simple experiments proves the presence of a sense of hearing. There are scores of such cases, but they only prove sensitiveness to vibrations.

Even for fishes, in which the inner ear is highly evolved (though there is no drum), most of the experiments prove no more than sensitiveness to vibrations in the framework of the aquarium. This holds for goldfishes, dogfishes and American minnows. But it would be a mistake to conclude that all fishes are deaf. For the common North American bull-head, or fresh-water catfish, is able to establish an association between a whistle and a meal. After some training, the fish learns to pop out of its hole whenever the whistle sounds. In all such cases care must be taken to eliminate not only mechanical vibrations, but the appearance of the food or of the experimenter. It is known that fishes may learn to come to the side of the pond when the keeper appears ringing a bell, but a critical modification of the experiment showed that the association established was with the appearance of the man, not with the sound of his bell.

Since many insects, like crickets and cicadas, the males in particular, make characteristic sounds, it is natural to suppose that there must be a sense of hearing. But this commonsense argument is not by itself convincing. It is supported, however, by the structure of many of the so-called "ears," for these typically show a drum-like membrane which vibrates and thus excites the more deeply situated sensory or receptor cells. These may be in contact with the membrane, as in cicadas and locusts, or separated from it by an air space, as in green grasshoppers. The analogy with our own organ of hearing is close, and it is difficult to believe that the organs in question are not hearing ears.

That this is a correct conclusion is proved by observation and by experiment. There is an Alpine moth, Endrosa aurita, the males of which are somehow able to produce a tiny crackling sound as they fly. The sluggish females, climbing on tussocks of grass, respond to the signal by vibrating their body and wings, and the tremulous movements are exhibited even when the males are not seen but only heard. It seems as if the male's signal appealed to the female's sense of hearing, and the female's signal to the male's sense of sight. This seems to be a satisfactory case of a hearing ear.

Very convincing is the experiment of making the male cricket signal through the telephone to the females in a distant room. The cricket's sound, which is produced by rubbing the edge of one wing cover against the file of the other, has considerable carrying power, and the females crowd to the telephone to listen !

There is no doubt that frogs and toads can hear, for the females will draw towards the croaking males. Sometimes, when there is no responsive movement of the animal as a whole, there is an interesting visible change in the breathing. It has been noticed that frogs may be excited by sounds which bear some resemblance to croaking, while to other much more striking sounds they remain quite indifferent. In all probability the ear is affected by these striking sounds, but the brain—or the mind, should one say ?—is not interested. It is an important fact that a physiological stimulus often fails to evoke any response because it has no biological significance to the animal. The sounds that interest frogs are those that have come to be associated with sex, namely, the croaking, and anything suggestive of croaking. To much louder noises they may remain quite indifferent, and this is quite natural.

Among reptiles there is not much that could be called listening, and there is a corresponding lack of sound production. Some mother crocodiles hear the slender piping sounds made by their unhatched young ones within the eggs buried in the mould. This shows how a latent faculty may be activated when there is real need for it. It would never do to leave the young crocodiles to be hatched in the soil, so when the mother hears the signal she proceeds to scrape the earth and vegetation away. Male crocodiles call loudly at the breeding season, and it is difficult to believe that the invitation falls on deaf ears. Yet we are not aware that it has been proved that one rattlesnake hears its neighbour's hiss. In snakes there is no external ear-opening, nor drum, nor ear-passage, nor Eustachian tubes, yet the snake charmers are confident that snakes listen to their music. And it may be so. Scientific demonstration of hearing is forthcoming for common lizards, which open their eyes at the sound of an electric bell, and learn to associate certain sounds with food. When the signal sounds they change their breathing movements, or raise their head, or lick their lips, or go off in search of the meal.

Aristotle's observational acuteness, almost as striking as his reflective genius, led him to notice more than 2,000 years ago that the internal ear of mammals includes a minute coiled structure which he compared to a spiral shell. This is called the cochlea, and it has a very interesting evolutionary history. It is just indicated, and no more, in the frog; it is a slightly curved short tube in the crocodile and in the New Zealand lizard; it is more marked in birds; it comes to its own and is spirally coiled in all mammals, except the two primitive oviparous types, the duck-mole and spiny ant-eater. In the internal cavity of all vertebrate ears there are patches of hair cells which quiver under the oscillations of the internal fluid of the ear and pass on their thrills by the fibres of the auditory nerve to the brain, where they are sensed as sounds. But in mammals there is a very important accession to this equipment of the ear, namely, the organ of Corti, which is situated in the cochlea. It consists of an archway formed in man by about ten thousand elastic rods which support rows of sensitive hair-cells connected with the endings of the auditory nerve fibres. The organ of Corti is an instrument for analysing or separating the mixed sound-waves that fall upon the ear, and it gives mammals a more precise power of listening than even birds possess. For in many mammals the hearing ear is life-saving.

CHAPTER XXII

THE SENSE OF BALANCE

No one can tell, but it seems very unlikely that we shall soon cease to puzzle over the connection between the mental and the nervous aspects of our behaviour. We know in ourselves the inner life of thinking and feeling, and we infer that the higher animals have something analogous. They certainly look as if they had ; and if you deny that your dog has a subjective or conscious life, you will find it very difficult to prove it for your neighbour. But we are not only sure of the reality of our conscious life—we know that it *counts*. If we deny the practical reality of " purpose," we have lost the clue that makes sense of our life. As Hegel wisely said : " ideas have hands and feet." But while this is true, we do not need to go far to find that a great many effective activities go on in our body that do not, to all appearance, require the mind at all. They take place, as we say, automatically; and the progress of physiology is showing us that even man is much more automatic than was suspected.

It is so characteristic of man to stand erect that he commends those whom he admires as being "straight" and "upright." The erect posture is maintained by the co-operation of many muscles, and these muscles are commanded by appropriate nerves to slacken or to become taut as the situation may require. But how are the nerves instructed, so to speak? Certainly not by intelligence or by conscious attention. As Sir Charles S. Sherrington says:

"Even in absence of those portions of the brain to which consciousness is adjunct, the lower nerve-centres successfully bring about and maintain all this co-operation of muscles which results in the erect posture."

It has been shown by Professor Magnus and Dr. de Kleijn, of Utrecht, that this comes about as a beautifully automatic response to movements in the head and neck. What is true for the body as a whole is true also of special parts; thus the posture of the eyeball is automatically adjusted to compensate for movements of the head.

In connection with the cavity or labyrinth of man's inner ear, and firmly embedded in the bony framework, there is a minute fluid-filled vesicle, in which there is a tiny crystalline stone attached to the delicate processes of a patch of well-innervated cells. There is, of course, one for each side. If the head be tilted to one side the resulting slip of the two minute stones on their respective nerve-patches makes the stimulation unequal. And from that slip there results exactly the right unsymmetrical action of the muscles to give the unsymmetrical pose of limbs and neck required for stability.

There is a second pair of tiny "gravity-bags," as Sir Charles Sherrington calls them, in which the stones hang rather than press; these have to do with posturing the head on the neck, and with the adjustment of the eyeball by means of its muscles. "Whichever way the head turns, slopes, or is tilted, these adjust the eyeball's posture compensatingly, so that the retina still looks out upon its world from an approximately normal posture, retaining its old verticals and horizontals." For instance, if we turn our head to the right, the eyeball's visual axis *untwists* from the right.

When a cat loses its footing on the roof of a barn and tumbles back downwards towards the ground, it has not fallen far before it has righted itself in the air, so that it lands on its springy feet, which is at any rate better than landing on its back. Now we know in detail how the cat moves its hind-legs and tail and fore-legs during its quick fall so that it regains the normal posture; and we also know the mathematical formula that puss illustrates! But what Professor Magnus and his collaborators have proved by their investigations of the last fifteen years is that the cat's regaining of right-side-upness is quite automatic. It does not require the higher brain at all; it depends on non-mental adjustments comparable to those which enable us to maintain our erect posture in walking and running, or which help us to recover ourselves when we have slipped on a piece of orange peel.

But it would be a mistake to suppose that all the careful adjustments which an Alpine climber makes in a ticklish corner are non-mental! You just ask him. He often puts in several seconds of hard thinking. He could not get on without his automatisms, but neither could he get on without his mind. Automatisms extend higher up than used to be thought, and we are reminded of Spinoza's warning that no one can yet say what the body, as body, may not be able to do. But this is quite consistent with the reality of a very vigorous inner life of thought.

From humble animals, like worms, upwards, it has been part of Nature's tactics, so to speak, to enregister profitable capacities of action in the framework of the body, so that the " mind " is left more free for fresh experiments and initiatives. Chains of sensory nerve-cells, associative nerve-cells, motor nerve-cells, and muscle-cells are welded in the course of ages ; the concatenations become part of the normal inheritance ; they form the basis of reflexes, tropisms, and automatisms. They form the physiological side of instinctive behaviour. But the result of all forms of automatisation is to leave mental activity less burdened, to give it more freedom to experiment, should clamant needs arise. Just as the busy man cultivates habituations so that he can direct his mind to something else, so the more reflexes there are in the body, the more chance of reflection by the mind. Automatisms like those that secure right-side-upness save the mind from drudgery.

CHAPTER XXIII

THE SENSE OF SMELL AMONG ANIMALS

SOME of us are predominantly eye-minded ; our world is a picture gallery. Some of us are ear-minded ; our world is an orchestra and a loud-speaker. " Seeing is believing," say the former ; " We believe in the spoken word," say the others. But if we could get an answer from a dog, he would tell us that he was predominantly nose-minded, and that his world was largely compounded of whiffs and scents. He knows where his master went on his bicycle, although he was shut up for half an hour after the start ; he stops on the road at the spot where his master lifted the bicycle across the footpath and hid it behind a wall ! Faint traces of smell have for a dog a significance which is almost beyond our understanding.

We have seen a student in a thick wood make straight for a malodorous stink-horn fungus, but such a high degree of sensitiveness is rare in civilised man—not that the retrogression of smell is an effect of civilisation, for it is marked even in monkeys. As vision became more stereoscopic and the hand was emancipated from serving as a fore-foot, the sense of smell lost part of its survival value. In most mammals, however, it is still very important, except in whales and dolphins, in which it has degenerated. Its value is often increased by the habit of sniffing, which brings more floating particles into contact with the smelling-patches in the nostril. How early the importance of scent is demonstrated, for it is by smell that very young puppies find their way to their mother's milk !

It is by sight, not by smell, that the vultures gather to the carcass, and the majority of birds seem to have very little sense of smell. Yet it must be smell that guides the ravens to dig down to some animal that has been smothered in the snow. In pigeons the sense is certainly keen, and the same is true of certain nocturnal birds of prey. On the whole, however, one must say that the perfection of the sense of sight in birds has allowed the sense of smell to remain ill-developed.

Reptiles far excel birds in their olfactory sense. A snake will nose out the track of a mouse or of a mate. When a big snake is killed in the forest its body should not be *dragged* home, unless a visit from its mate is desired. Alligators have a keen scent for man ; lizards and tortoises often sniff at their food.

Among amphibians it has been shown that newts sometimes search for food by smell, and these creatures are interesting in being able to change in a moment from smelling molecules suspended in water to smelling molecules suspended in dry air when they are on land. A substance cannot be smelt unless it gives off molecules, but it must also include particular groups of atoms called osmophores, of which there are many different kinds.

Some fishes depend mainly on their eyes when they are searching for food, but there is no doubt that some can smell. Dogfishes become excited when the scent of food in a bag begins to diffuse through the water, and it has been proved up to the hilt, in this and several other cases, that the excitement begins by affecting some of the cells that line the nostrils. In the sense of taste, which many fishes have in a high degree, the material that is tasted must come into contact with the tasting cells ; in the sense of smell, it is enough if particles or gaseous molecules enter the nostrils and stimulate the olfactory cells.

It may be said of the hive-bee, even more than of the dog, that it lives in a smell-world. On the last eight joints of its feelers it has hundreds of olfactory cells, and it is able not only to find fragrant flowers, but to distinguish particular odours, both from flowers and from its fellows. The rapidity with which the queen's absence from the hive is detected is probably due to a particular regal fragrance. There is a scent-producing gland between the fifth and sixth ring of the posterior body, and when a worker-bee finds a treasure of nectar it sprays the blossom with its own perfume. This helps other workers to rediscover the source of supply. In the case of the queen the body perfume not only makes the workers aware of her presence, it serves as an attraction and a guide to the drones when she issues from the hive on her nuptial flight. It is rather striking that, except as regards the bee's own body perfume, the olfactory gamut of hive-bees is almost the same as man's. Indeed, when an animal has the sense of smell well developed, it is sensitive to most, if not all, the scents that man can detect ; but there are great differences in the degree of sensitiveness to different intensities of the odour. Man and ant are both sensitive to the odour of formic acid, but man cannot, of course, perceive the minute traces which an ant leaves on the ground to serve as transitory guide posts. Similarly, a dog is sensitive to minimal traces of odours which man does not perceive until they become very strong.

As an exception to what we have just said, we must notice the smell specialists. That is to say, there are a few animals that are attuned with extraordinary sensitiveness to one particular odour, and are dull to all others. Some male moths, such as Oak Egger and Peacock, are very remarkable in this way ; for they congregate from considerable distances into the open-windowed room where a female is imprisoned in a box. It is said that a Kentish Glory male will settle on the clothes of a collector who is carrying a female in his pocket. These specialists are not in the least embarrassed by other scents, such as clouds of tobacco smoke.

It is not surprising that the sense of smell should be very common among animals and that it should often be extraordinarily keen. For it has so many uses. It serves to warn the animal of the approach of enemies ; it guides many a creature to its booty ; it aids in the discovery of profitable food and in the rejection of the injurious ; it facilitates the finding of mates ; it enables kin to recognise kin ; it often supplies the clue by which a forager finds its way home. Man will be the poorer if he loses much more of it.

CHAPTER XXIV

THE FEELINGS OF ANIMALS

WHEN we read a really successful revelation of childhood like Aksakoff's famous " Recollections," we recognise what a large *rôle* in early years is played by feeling. We refer to this work of genius rather than to our own reminiscences, for it is given to few of us to revive our youth without reading into it an intellectuality which was conspicuous by its absence. Very early, no doubt, there begins the building up of general ideas and an occasional puzzled playing with them ; but for four or five years the child is finding its way about in the world with association linkages and perceptual inferences like those of intelligent animals, and with a stream of feelings all the time. Stream of feelings, we say, for joys and sorrows succeed one another rapidly—like " April showers that pass with varying shadows o'er the grass."

The simile is re-quoted from Miss Frances Pitt's fascinating book on "Animal Mind" (1926), which differs from all analogous books that we have seen in giving something like fair play to the *rôle* of feeling in animal life. For animals are in many ways like young children, and *vice versâ*; the stream of feeling is always there, whereas judgment is fitful. Miss Pitt, whose knowledge of wild animals is very intimate, has done good service in insisting on the feelings which so often sway them—feelings of anger and even rage, of fun and fear, of affection and joy, and so forth. Let us think for a little of animals as creatures of feeling.

Everyone allows that animals react effectively to stimuli from the outer world. Whether we watch bees or dogs, we can be in no manner of doubt as to their sensations. But when the worker bee dances on the honeycomb on her return to the hive with a bag full of nectar, has she joy; or when the dog loses his master has he grief? We cannot demonstrate the inner life of animals; we can only argue from the analogy of ourselves, and this is plainly precarious. Yet, as Darwin showed so well in his book on "The Expression of the Emotions," we may argue plausibly from features, gestures, tones and other external signs to the hidden life of feeling within.

The plus and minus feelings of pleasure and pain, joy and sorrow, satisfaction and dissatisfaction, content and anxiety, affection and anger, and so on, are correlated in higher animals with changes in heart and pulse, breathing movements, and voice, and with changes in facial expression, the look in the eyes, the state of the skin, the tone of the muscles, and so forth; and one of the valuable results of Darwin's work was to show the general similarity between "expression" in man and "expression" in the higher animals. It is this that gives confidence to the argument from analogy, though our confidence becomes weaker the further removed the animal in question is from the human type. In regard to the lower vertebrates and the invertebrates, it is necessary to be very cautious. Moreover, since the organism is a unity, and man's feelings are influenced by his whole being, notably by his general ideas, we must be careful not to suppose that a particular feeling in a mammal or a bird is more than the analogue of the corresponding feeling in man, though for convenience we use the same term in both cases.

Among higher animals it is not difficult to convince ourselves of the reality of a byplay of external and internal bodily movements, comparable to a byplay which we are familiar with in ourselves in correlation with certain feelings. We must either dismiss the byplay in animals as an insoluble puzzle, which seems unnecessarily sceptical, or we must regard it as expressive or indicative of an inner life or feeling. But if we adopt the latter—the common-sense—view, we must be cautious in our pronouncements as to particular feelings that are present. Some of the identifications appear to us to be unnecessarily generous. Thus some lovers of dogs speak of "a sense of humour" in their faithful friends, and others of "shame"; many are quite sure of "sympathy," and others of "offended dignity." We do not doubt the reality of "expressions" that may be interpreted in these terms, but we are inclined to think that the interpretations err on the side of generosity.

On the other hand, it seems impossible to deny such an emotion as anger, often arising to passionate fury. It may be excited by a hostile intrusion on territory or home, on offspring or mate. It may be inflamed by an interference with or opposition to sex conquest. It may be so passionate that timidity and discretion are thrown to the winds. It is familiar in the dog-fight, in the cat-and-dog encounter, in the rivalry of robins, in the doubly fatal combat of two stags, in the fierceness of shrews, in the bantam hen's defence of her chickens. Unless there is something magical there is no denying the reality of rage among animals.

But we feel much less convinced in regard to revenge. There is no doubt that many animals resent affront and seek retaliation. They take dislikes to people and to other animals, and form associations that last. The old story of the elephant who remembered for many a day the tailor who stuck a needle into its trunk may be anecdotal, but there are modern confirmations. There are interesting records of retaliation on the part of the raven, gander, peafowl, sow and elephant ; but revenge is a big word to apply to bird or beast. For revenge means a clearly-defined purpose of retaliation, and a keeping of this purpose not far from the focus of consciousness. It means not only nursing one's wrath to keep it warm, but planning how to get even with the enemy. Animals do not rise to these heights.

The amiable tendency of many observers of animal behaviour is to be too generous, making the animal a homunculus, a " brer rabbit " ; and this is apt to become extravagant. But the tendency of others is to be too parsimonious, reducing the animal to the level of an automatic machine, with no psychical life at all, or with one that does not count any more than the foam bells count in the river's flow. We plead for a *via media* which credits the higher animals with a stream of simple feelings, as in young children, and with feelings that count—through the ductless glands and otherwise—in giving increased power as well as zest to life, or in reducing efficiency, of course, if they are of the negative nature of grief and fear. No doubt there is a physiological side to parental care and to courtship, but our old-fashioned thesis is simply that we must take account of feelings as well, and of feelings that count. *Nemo physiologus nisi psychologus ;* bad Latin, but good sense.

By simple feelings we mean pleasure and pain, joy and sorrow, gladness and sadness, affection and anger, confidence and anxiety, sympathy and aggressiveness. We should like to see the issue clearer in regard to these fundamental feelings before we say much about "revenge," "shame," "vanity," "a sense of humour," or the "æsthetic emotion." In the present state of comparative psychology there is a danger that if we pull the bow too tight we may miss the target altogether. From exaggeration there is always a rebound, which may bring us back to the other extreme of "behaviourism," according to which the psychical side is negligible—a view that seems to us a travesty of the ways of animals, whether wild or tame. If animals have not feelings, and feelings that count, then we are confronted with the puzzle of man as an emotional Melchisedek "without any pedigree."

CHAPTER XXV

ANIMAL COURTSHIP AND MATING

We must not think of the courting animal as thinking out programme, or meditating on its music, or planning an attractive ceremonial, as might be true of human kind. It is rather that the animal is full of passion and desire and lets itself go, in an abandonment of self-expression, along diverse lines which are prescribed by its inborn instinctive equipment. And these lines, whether of song or dance, of display or tournament—it may be of luminescence or fragrance—are the lines which, in the course of millennia, have been sifted out as those that proved most effective in awakening interest and admiration, sex-excitement, and the sympathetic resonance of passion in the desired mate. No doubt there are individual variations, as in the songs of particular nightingales, but the main lines are prescribed by the hereditary endowment. Little improvements are always being added, especially when the males are in the majority, which, unless polyandry supervenes, is generally a good thing for the race, since it leads to a higher valuation of the females. In 999 cases out of 1,000, it is, of course, the male who does most of the wooing, but there are quaint exceptions that give us pause. Such are the grey phalaropes, which breed in the Far North and pass our shores or linger on them in autumn. For in this attractive bird, the female does the courting and the male the brooding.

Naturalists, like other fallible men, are often apt to take over simple views of familiar occurrences, and some are quite satisfied with saying that the significance of animal courtship is to attract the attention and awaken the passion of the desired mate. But the courting ceremonial is often so extraordinarily elaborate and prolonged—often like a ritual—that we feel bound to agree with Professor Julian Huxley that it has in these cases a deeper significance. It forges psychical bonds which keep the mates loyal partners and parents when the storm of passion is past. Controlled courtship may raise fondness into love, and this unconscious end is its higher evolutionary significance.

We miss part of the meaning of courtship if we do not appreciate the elaborateness to which it may attain. Thus Professor Julian Huxley's study of the Great Crested Grebe has shown that for this bird the courtship includes waggling and swaying, bending and shaking, a "cat-attitude" of display, a "ghost-dive," and an offering of water-weed gifts! The ceremonies establish emotional bonds. Even in one of the most familiar of birds, namely, the lapwing or peewit, there is intricacy of courting behaviour—the extraordinary äerial dance of the males, with its nose-dives and somersaults, the prayerful cries, the "wing-music," the posing and the show-off, and the excited formation of suggestive "scrapes" in the ground. The male frigate bird has an incredible, inflatable scarlet throat-pouch, and here is Mr. Beebe's description of his behaviour: "Another emotion obsessed him; he bent his head back until it sank between his shoulders, the red balloon projecting straight upward, and the long angular wings spread flat over the surrounding bushes. The entire body rolled from side to side, as if in agony, while the apparently dying bird gave vent to a remarkably sweet series of notes, as liquid as the distant cry of a loon, as resonant as that of an owl. In our human, inadequate, verbal vocality, I can only record it as kew-kew-kew-kew-kew-kew. In a higher tone the female answered him from the sky, oo-oo-oo-oo-oo-oo."

When we pass from birds to mammals we have to admit that they come a rather poor second. For there may be no courtship at all, and when it has been evolved, it is on the side of vigour, rather than of art. It is true that there are sometimes passionate sex-calls, of which we have knowledge in the cacophonous caterwauling of the cats on the roof, but these seem a sad bathos after the lyrics of the birds. There are weird howlings among monkeys, and powerful bellowings among deer, but they are not very artistic. Fondling and kissing are well-known, especially in the wiser mammals, such as elephants. Occasionally there is a display of agility, as in the antics of the March hare. In some cases the males have special decorations which are shown off at the courting time, as when the elephant seal inflates the big hood above his snout. It may also be that the fierce combats between rival males, well-known in stags, antelopes, and sea-lions, may sometimes serve to excite the females if they stand by as spectators. But the victorious bully does not seem to give them much choice. On the whole we must confess that there is not much to boast of in the courtship of mammals.

One must not expect too much from cold-blooded animals, but a few of them have courting activities. The male crocodile curvets and capers in a most undignified way, roaring and bellowing at the same time, and perfuming the water with a copious secretion of musk from the skin-glands of his lower jaw and tail. Mr. W. P. Pycraft, whose "Courtship of Animals" (1913) is a treasure-house and a biological education, once had the good fortune to see a painted terrapin flogging his desired mate's head with the whip-like ends of his long finger-nails. Some lizards show off their graceful frills and coloured collars, and one of their attractions is to open the mouth very wide to show the vividly-coloured interior. This looks like wooing with a yawn! Some of the male newts go in for amorous writhings and fondlings, as well as display; and we cannot listen to the croaking of the frogs in spring without being reminded that the first use of the voice was as a courting-call.

In most fishes the sexes can hardly be said even to come into contact, but there are cases where the rival males fight, where the male caresses the female, or swims around her excitedly, sometimes flushed with gorgeous colour, as in the gemmeous dragonet. But there are a few fishes that strike a subtler note. The male stickleback is dazzling when he puts on his wedding robes ; he challenges rivals and they fight fiercely. A remarkable feature is that the females swim about in troops outside the battle-ground, and now and then the victorious polygamous male selects a temporary mate from the company and induces her to visit the nest that he has built. But the females are not passive. " The female that heads the troop swims forward with rapid darts, followed by the others, suddenly stops, and assumes a vertical position with her head towards the bottom." The others follow suit and take up a similar position. Then the leading female suddenly deals a blow that scatters the crowd, which forms again in a few minutes. What can this mean ?

In the lower reaches of the animal kingdom there is often some sort of courtship, if we use the word, as we must, somewhat elastically, to include signals between the sexes and all outward display of sex-desire. In most cases this cruder courtship is so far away from our understanding that we get an impression of " queerness." Nature is sometimes *farouche*. The apparently apathetic snail shoots a beautifully-formed arrow of lime at its neighbour—the *spiculum amoris* or Cupid's dart. Luminescent signals pass from the female Italian glowworm, sitting in the grass, to the even more luminous male who dances in the air, and the lady attracts a levee. The male deathwatch knocks his head against the wainscot what is taken by the superstitious as a presage of death is really knocking at the door of his desired mate. The grasshoppers trill merrily, the cicadas "sing" to the breaking-point to their voiceless wives (dull of hearing though they may be), the crickets chirp, and there are other forms of instrumental music drawn into the service of "Love" (please notice the inverted commas!). The male spider often fights with his rivals, lustily and skilfully, but not to much hurting; he dances round the capriciously-tempered female, showing off his good points of colour and agility; he sometimes courts from a safe distance by vibrating a silken thread that leads to the spinster's web.

There is a moral to this story, for is it not one of the encouraging facts of organic evolution that fair flowers arise from earth-covered roots, more useful than beautiful? In the lower levels of animal life there is no wooing at all; imperceptibly there is an evolution of sensory appeals, and the lusty may become the fond; gradually there appear indubitable expressions of emotion and hints of psychical as well as physical tendernesses; the leaves of fondness become the flower of love, whence, may be, the fruits of the spirit. In any case, as Socrates said in speaking of the "religious and human love" of the halcyon, "there is comfort in this both for men and women, in their relations with each other."

But, changing the point of view, let us think for a little of the different modes of mating among animals. In the lower reaches of the animal kingdom, among jellyfishes and sea-urchins, for instance, sex has not yet attained to its dual aspect. One ripe Palolo-worm breaks off its posterior body bursting with eggs, and another one breaks off its posterior body bursting with sperms. This happens on the same night among the Samoan coral-reefs, in the last quarter of the moon in October or November every year, under the influence of internal and external periodicities which we only dimly understand. But this is clear : that the two sexes of Palolo-worm are not aware of one another.

There is very little possibility of saying " Lo, here," and " Lo, there," when we study organic evolution. Everything comes about gradually, like a dawn. One sea-urchin, ripe with eggs, does not seem to be aware of another, ripe with sperms ; and yet it has been noticed that spawning is infectious. When one begins, others follow ; but this may be partly due to the similarity of the external stimuli and to the fact that many of the animals are about the same age. In many fishes, most of which must always be thought of as rather primitive animals, far more primitive than, say, spiders or snails, there is a simultaneous liberation of the egg-cells by the female and of the sperm-cells by the male, but there seems very little hint of sex-awareness. Gradually, however, we detect the dawn of interest ; the male salmon follows the female closely, and the down-sinking eggs pass through a zone of water which is momentarily full of millions of sperms. From this simple state of affairs there is a gradual ascent to other fishes where there is more than the beginning of courtship, as in the pipe-fishes and the beautiful dragonets.

At various levels among animals, as among insects, fishes, amphibians, and reptiles, there is promiscuous pairing after very short acquaintance or none at all. Two sex-ripe creatures meet one another and pair ; and then each goes its own way. Even so high-strung a creature as the common hare seems to be a roving lover, in contrast to his enemy Reynard the Fox, who appears to be strictly monogamous. The engaging gregarious birds known as ruffs are said to be very promiscuous, and the same is reported of those aberrant mammals—the bats. There is some subtlety in the sticklebacks' behaviour, for the male builds a nest and assiduously guards both eggs and offspring, but he brings a succession of females on successive days to his preserve, and the same female may visit several males. Yet this is a long way in advance of what we see in jelly-fishes, where the note of sex-awareness does not seem to be sounded at all. In some of the higher instances of chance pairing, as in hares, it seems to us that the psychological aspect is beginning to assert itself. There is a fiery dawn of passion.

Many animals show loyal monogamy for the breeding season ; but after that is over, the males and females separate, and begin afresh, it may be with other mates, the following year. This is the way with many cats, including the lion. It may be that this is sometimes connected with the mode of life, for many hunting animals get on best when they hunt alone. On the other hand, the wolves, that hunt in a pack in winter, live as seasonally monogamous pairs in the spring and early summer. When there is habitual gregariousness, as in prairie-dogs and marmots, there are seasonal couples no doubt, but it is difficult to be sure whether there is genuine monogamy or not. But the Oryx antelopes and the white whales are credited with seasonal faithfulness, and there are many other instances.

The highest level is reached in those birds and beasts that live together in pairs, year in and year out. Thus, cranes and geese, storks and swans seem to mate for life, or till one of the two dies. This is the more interesting since the reproductive period in birds is very sharply punctuated. It looks as if the psychical loyalty of love began to replace the more physiological linkage of fondness; and in any case the fact is that the best examples of faithful and lifelong monogamy are to be found among the high-strung birds.

It is believed that rhinoceroses illustrate lifelong monogamy, and the same is said to be true for the orangs. Some of the monkeys and half-monkeys are also monogamous. It should be noticed again that this praiseworthy constancy will be easier when the mode of life does not prompt the individuals to separate for bread-winning purposes when the breeding season is over. In some cases, no doubt, it is never over; but this cannot be used as an explanation of monogamy, since it is in birds, with their circumscribed breeding season, that monogamy finds its highest expression. There is no doubt that one of the monogamous pair sometimes dies when its mate is killed, and whether this should be called "dying of grief" or not, it certainly testifies to an intensity of attachment. That widow and widower birds often find consolation we should not dream of denying.

The case of the gorilla is particularly interesting, for these apes sometimes live in companies of ten to thirty, each company consisting of several family parties, a father, a mother, and a number of children. According to Reichenow there is strict monogamy, but the superannuated males go off by themselves and live as "solitaries."

As everyone knows there are numerous instances of polygamy and a few instances of polyandry among birds and beasts—arrangements which are sometimes at least associated with, and partly explained by, a marked numerical disproportion between the adults of the two sexes. But what we are immediately concerned with is merely the proposition that genuine and constant monogamy finds many an illustration in the Animal Kingdom.

CHAPTER XXVI

ANIMAL DANCERS

Many touches of nature make the whole world kin, but similarities require careful handling. Thus much of what we call play among ourselves has got far away from the play of animals, which is in the main the instinctive anticipation of forms of activity that will be of vital moment in adult life. Man emerged as a new synthesis, though his compounding may have taken ages, and all his inheritances were transformed. Words became language, intelligence became reason, play became a game, fondness became love, kindly behaviour became good conduct. To forget this human transmutation of the animal is to give the facts a false simplicity; it is like a materialism; we have called it a "biologism." It is bad science to read the man into the beast, that is anthropomorphism; but it is worse science to read the beast into the man, that is theromorphism.

Just as the voice was first of use as a sex-call, and gradually had its *rôle* extended to serve as a means of communication between parent and offspring, offspring and parent, kin and kin, and but slowly rose to be a means of expressing ideas; so it has been with the dance. It began as part of the courting excitement; it gradually became more ceremonious; even among animals it sometimes lost its linkage with love-making; in man at length, yet not always, it rose to the level of a fine art. Every one knows that the dance sometimes forms part of religious ritual.

When we inquire into the early chapters in the evolution of the animal dance, it seems reasonable to begin with those cases in which it is hardly differentiated from amongst other motor expressions of courting excitement. Thus in the well-known courtship of the blackcock there is a subtle combination of (*a*) actual fighting between rival males, (*b*) make-believe fighting, (*c*) display strutting, and (*d*) dancing. We do not know that the jousting of the blackcock ever amounts to drawing blood, as often happens with the capercaillies, but we think we are right in calling part of the rivalry that we have watched " actual fighting." The females are merely onlookers.

Just as the fascinating ruffs have specialised the originally serious combats of males into a play, in which no damage is done, so the dance may be specialised—just like song—into a regularised artistic display. It approaches art for art's sake. Thus it is said of the cock-of-the-rock, Rupicola, that one male at a time mounts on a rock and dances before a gallery of both males and females on the surrounding branches. After he has had his innings he gives place to another gay dancer, and at every change the hens give a cry ! It need not be supposed that the females keep the successive terpsichoreans in mind, and give their reward to the most graceful ; but the other extreme is to be avoided of supposing that the artistic display is no more than a method of working off and infectiously working up the excitement of the courting season. Motion and emotion, eurhythmics and *joie-de-vivre* are closely inter-linked—there is no doubt of that ; but each type among the dancing birds has its own elaborate form of artistic self-expression. What right have we to deny to birds the beginnings of æsthetic emotion ? It would be an arrogant mpertinence.

Some very vivid descriptions of bird-dances are given by Mr. W. H. Hudson in his " Naturalist in La Plata," a book one never tires of. Thus he tells us of the Ypecaha rails that a dozen or twenty rush screaming to an appointed place of assembly—a stretch of smooth, level ground, just above the water, and hedged in with dense beds of rushes. There they dart rapidly from side to side ; they spread and vibrate their wings ; they raise their open beaks ecstatically to the sky. The unearthly shrieks of the dancing rails throw light on the shouts that are associated with human reels. The whole business is rather fatiguing and comes to an end in three or four minutes.

The same sort of half-violent dance is exhibited by the long-toed jacanas, which fly from the feeding grounds to a clear spot, where they dance in a close cluster. There may be a dozen on the floor at once, and a feature of the performance is the display of the usually concealed beauty of the silky, greenish-golden wing-quills. " Some hold the wings up vertically and motionless ; others half-open and vibrating rapidly ; while still others wave them up and down with a slow, measured motion like beautiful flags grouped loosely together." These jacanas and the large rails already mentioned afford good examples of the type of dance in which both sexes share. In the case of the cock-of-the-rock the males are the only performers.

Another type is illustrated by the spur-winged lapwing of La Plata, a near relative of our familiar peewit. The peculiarity here is that the dance requires three birds. Two birds seem to betray the fact that a dance is indicated, and a third, often leaving his own mate, hurries to join them—sure of a welcome. The three of them form a line, and trot rapidly, keeping good time, to the accompaniment of drumming notes. " The march ceases ; the leader elevates his wings and stands erect and motionless, still uttering loud notes ; while the other two, with puffed-out plumage and standing exactly abreast, stoop forward and downward until the tips of their beaks touch the ground, their voices sinking meanwhile to a murmur." Then the visitor lapwing goes home, and later on he and his spouse will also have a "square dance."

An interesting and beautiful feature of the dance of this spur-winged lapwing is its extension beyond the courting season. Just as some birds keep up their honeymoon music, and sing at other times, so these South American lapwings dance all the year round. Indeed, they are so fond of it that they sometimes have several dances in the course of the day, and also on moonlight nights. This illustrates the point we were trying to make, that an activity may lose its primary linkage and come to be appreciated for its own sake. So it has been, obviously, with the human dance.

It is naturally difficult to draw a line between display and dance. Thus while there seems no doubt that some male spiders dance round about their desired mate at a respectful and safe radius, what word is one to apply to the somewhat solemn approach the Fiddler crab makes to the female, brandishing his huge and brilliant great claw, which is sometimes larger than the whole of the rest of his body?

Very interesting are Köhler's observations on a kind of tentative dancing among chimpanzees. Sometimes it takes the form of rhythmic circling, sometimes it turns into a spinning-top play "which appeared to express a climax of friendly amicable *joie-de-vivre*." Sometimes the danseuse spinning round would stretch out her arms horizontally as she revolved. There was a striking suggestion of the primitive ring dancing of some indigenous tribes and the chimps would occasionally allow the professor or some other trusted human friend to join in their merry game!

CHAPTER XXVII

ANIMAL MEMORY

WHEN a sea anemone is offered a fragment of flesh the tentacles grip the gift and transfer it to the mouth. They will do this over and over again, and if they are then given little pieces of blotting-paper just touched with beef-juice they take these as well. But they soon "learn" to distinguish between the faked food and the real—the shadow and the substance—and they throw off the blotting-paper into the water. After a short pause the offer of another blotter insult is rejected at once; after a long pause it is accepted as at first. Here we have the beginning of remembering and of forgetting. In a simple creature without more than scattered nerve-cells there is a registration of experience, so that subsequent behaviour is definitely affected.

At an even lower structural level, in the Venus fly-trap of the Carolina swamps, stimulation with faked fly, accepted at first, is soon detected, and after a few deceptions no reaction follows. The trap refuses to work. Here there is, without any nerve-cells at all, a registration of experience which inhibits the usual response to a touch. But the fly-trap's memory is very short, and after a brief interval it allows itself to be cheated again. What a long gamut from the short memory of sea anemone and fly-trap to what we see in horse and dog! but is not the gist of the matter the same all through—the engraining of an experience and the reviving of it so that subsequent behaviour is appreciably affected? The essentials are the retention of an impression and its recall. It need hardly be said that the lower reaches of memory in the animal kingdom are mainly preoccupied with the practical problems of everyday life—what is good to eat, what spells danger, what promises satisfaction.

In thinking of animals, and of lower animals especially, we must be careful not to mix up individual recollections with instinctive promptings, which are racially enregistered. A tortoise may remember a person, retaining for a long time an association it had formed between certain visual impressions and certain pleasant experiences ; but that is quite different from the hereditary impulse that practically compels a newly-hatched Loggerhead turtle to make towards the openest part of the horizon, which almost always means that the young turtle reaches its unknown goal—its only possible home—the sea.

To test the universally known and possibly authentic story of the tailor and the elephant, a scientifically-disposed gentleman of leisure gave " My Lord " a sandwich with much cayenne pepper. After six weeks he revisited the elephant, who received his courtesies without resentment. But just as the experimenter had made up his mind that the story of the tailor was untrue, he was deluged from head to foot with dirty water from the elephant's trunk. That was elephant memory ; but it must not be hastily assumed that an ant in returning from the nest to a previously discovered treasure of sugar is remembering the way back. It may be nosing out a trail of very minute olfactory stimuli. Many, though not all, of the cases of " homing " among insects seem to be illustrations of very delicate sensory acuteness and not of topographical memory. On the other hand, when a rat that has become familiar with a maze of the Hampton Court pattern scampers along the difficult path after an interval of some weeks, it is exhibiting memory, though we do not understand very clearly what the precise content of its memory of the maze may be.

When the lips of a water-snail are touched with a piece of suitable food the mouth exhibits three or four tentative munching movements. If the head of the mollusc is touched with a glass rod whenever its lips are touched with food an association is gradually established between the touch of the glass rod and the proximity or anticipation of food. So firm is this association that by-and-by the touch of the glass rod evokes the munching movements although no food is presented. For a short time this established association is retained. In this experimental case the association was a useless one, but we believe that similar associations of a useful kind are often established in the early life of animals. Experience rivets non-intelligent, though vitally important, associations between a certain sensory signal—a touch, a sound, an odour, a change of light, and so on—and some important action, such as opening the mouth, snapping, crouching, standing stock-still, or moving very rapidly. The inheritance of an animal includes neuromuscular pre-arrangements for certain useful reflex actions; but associations between these reflexes and certain secondary signals in the outside world are learned, and they last. This is a humble kind of memory; the enregistration of the results of experience takes the form of what are technically called "conditioned reflexes." The tendency of the "behaviourist" school of comparative psychologists has been to reduce much of what used to be called memory to the level of interlinked reflexes. With part of this physiology of behaviour, which leaves mind out, we must agree; but when we see a dog set off by itself and journey some distance to a field where it was disappointed of a rabbit yesterday, it seems common sense and good science to say that the dog is *remembering*. And similarly, when a mammal —such as a monkey, elephant, dog, or horse—suddenly recognises an old master who appears unexpectedly there is no word for it but memory.

When a starfish is turned upside down repeatedly throughout a week it rights itself each day with increasing rapidity. This is a simple case of habituation, and since the starfish has no brains we are not warranted in going beyond vague surmise as to the mental aspect of its behaviour. In virtue of frequent repetition one link in a chain follows another with increasing facility—a habitual sequence is established. In the simplest cases we cannot infer anything more than what might be called bodily memory, but it seems to be very different when we study the collie dog learning its business under the schooling of another dog and of the shepherd behind both. In the process of learning there is retention and recall of experiences ; and the more "meaning" there is in the sequences the more mental memory there is likely to be. Later on, of course, as in man's games and musical performances, the mental factor recedes and automatisation increases. With wearisome reiteration, under the stimulus of rewards and punishments, an animal learns to go through a series of more or less unmeaning tricks. This is probably almost wholly at the level of bodily habituation. And there is not much interest in a parrot that merely repeats a rigmarole. But when a monkey solves a puzzle-box which can only be opened by a particular sequence of actions, and when it retains the solution for several weeks without practice, then we have to do with a higher level of behaviour, where mind and mental memory cannot be left out of account.

When the country doctor used to drive a gig, the horse often became habituated to stop at the doors of chronic patients ; but there was more than that in the way the horse remembered on pitch-dark nights the detailed difficulties of certain parts of the road. A horse in a stable will sometimes demonstrate by neighing its recognition of a particular footstep on the street outside ; and we have known a dog recognise from a long way off at night the particular toot of its master's motor car. Of the recognition of people, even of their voices only, after long absence, there is ample proof among dogs and horses and various other creatures. As we have said, some of the simpler cases of "homing" in ants and bees depend on a sensory familiarity with details of the region, which are recognised and utilised and re-utilised. Some of the simpler cases of homing among cats and other mammals seem to depend on a "kinæsthetic" memory—that is to say, on a registration of muscular movements—and an ability to recall these. But the more difficult cases of homing remain unsolved problems. The culmination of insolubility is in connection with the return of migratory birds to their birthplace. But "homing" demands separate discussion.

We have used the term "memory" widely for a long inclined plane of retentions and revivals ; but we recognise that there is a good case for reserving the term for a mental process only. If this is the view taken another term must be found for memory-like phenomena among lower animals where the mental aspect is hardly to be discerned though registration and revival are clearly in evidence.

CHAPTER XXVIII

CAN ANIMALS COUNT?

MANY sportsmen believe that rooks and some other birds notice when four men with guns and evil intent arrive and only three depart, one having cleverly hidden himself. But the rooks do not notice anything wrong when five come and four go. The inference is that rooks can count up to four. But this experiment would need to be repeated many times in similar conditions, for it is in some cases probable that the very alert birds detect the man concealing himself.

In connection with apes we have referred to Dr. Romanes's chimpanzee Sally, which seemed to be able to give the number of straws asked for up to five. More than that, however, for Dr. Romanes told us once that when Sally was in a hurry to get many straws to secure her reward, she sometimes bent a straw so that its two ends stuck out between her finger and thumb, thus making one straw count for two. When the reward was refused in such a case, Sally would straighten out the bent straw and pick up another. If Sally's behaviour was rightly interpreted, the case is important, but it is necessary to be cautious. Thus the alert ape is known to be very quick to take advantage of conscious or unconscious signs of approval on the part of the observer or the gallery. If the clever creature, having gathered three straws sees that the audience is satisfied, then it gathers no more.

An old and simple experiment with horses hints at some appreciation of quantity, if not of number. The horse was offered on a table a choice between one lump of sugar and two or three lumps, and it always preferred the more than one. Yet it showed no preference for three lumps as contrasted with two. Of course, the sides at which the sweet alternatives were placed were continaully changed, to avoid any right and left association. The same kind of experiment made with hens yielded somewhat surprising results. Certain kinds of hen had no hesitation in preferring a 10-grain heap to a 6-grain heap, or even in preferring 3 grains to 2, 4 to 3, 5 to 4, and 6 to 5. But it is possible that the choice was based on a volumetric rather than on a numerical estimate ! So when a brooding bird is troubled over the theft of three eggs out of six, it is perhaps not more than dimly aware of a quantitative disturbance in the picture or in the tactile sensations.

It would take too long to discuss with fairness the difficult case of " the thinking horses of Elberfeld " that used to stamp out correct answers to arithmetical questions written on the board. It was wonderful, but when they came to extracting cube roots they proved too much ! The probability is that the horses took advantage of conscious or unconscious signs on the part of the teaching staff. We think, then, that there is not much reason at present for believing that animals can count more than a very little. For counting requires counters, either words or symbols or tallies.

CHAPTER XXIX

CAN ANIMALS TELL THE TIME?

In the Luxembourg Gardens in Paris, sparrows and other small birds used to have the habit of congregating punctually shortly before an early forenoon hour when a benevolent visitor was wont to give them a big meal of crumbs. They seemed to have an accurate sense of time, for they did not wait for his appearance nor for the clock to strike. They congregated beforehand so as to be ready for the feast, and their punctuality was often an occasion for remark. Had they gathered when they saw him, it would have been a simple case of association: "There's a figure that spells crumbs." But the puzzle was the punctual gathering before there was any hint of hospitality.

One of the suggestions made in regard to the sparrow puzzle was that the birds began to feel the pangs of hunger about the same time every morning, and no one would wish to exclude the idea of constitutional rhythms. The body soon forms a habit, and even in plants there is occasionally some punctuality in the opening and closing of the flowers. When the course of life from day to day is very regularly punctuated, there is some enregistration of this in the body. Thus, the little green Convoluta worms of the Roscoff sands come to the surface when the tide ebbs and disappear again with the first splash of the flow. And they will continue appearing and disappearing for a week at the proper time in a tideless aquarium on shore. Similarly, there are regularly-living men who always know the lunch hour by their internal sensations; they have a gastric clock. There are others who wake in the morning or in the middle of the night with extraordinary punctuality, because the regular routine of bodily functions starts the alarum clock without fail. It must be allowed that some of the cases where animals seem to know the time are due to constitutional rhythms, to the promptings of internal periodicities of very regular recurrence.

But without discarding the rhythm-theory for the sparrows, we must look for the chief explanation in another direction, which was suggested by the fact that when " summer time " began, the birds still congregated punctually as if they could read the clock. They gathered at a quarter to ten *by the clock* as usual, though this was really an hour earlier. This seemed almost magical, yet the explanation is probably simple. The work of the Gardens, such as sweeping leaves and adjusting seats, went on regularly day after day, and the probability is that the birds established an association between what was going on and the approaching visit of their hospitable friend. When the change was made to " summer time " the routine of the garden was at precisely the same stage as before. It is difficult to prove such a theory without experiment, but various carefully-observed cases point to the view that animals may seem to tell the time when they are simply observing certain signs of the times which have come to have a profitable associative value. A combination of the rhythm-theory and the association-theory may be in many cases quite legitimate.

Some well-observed and well-criticised cases show that clever animals, such as dogs and horses, alter their routine behaviour on Sunday morning. A dog that has been proud to run to the railway to retrieve the newspaper thrown out every morning from the passing train, and has learned to do this perfectly without control and even without suggestion, will take no steps on Sunday morning, when there is no paper. It has been known to disobey flatly when told to go. In such a case it is unnecessary to suppose that the dog has a sense of the normal "train-time," or a feeling that a week has passed and that Sunday has come round once more. It is almost certain that animals live in an unending "NOW." The dog has built up an association-complex of things going on, and this serves it as the signal of "train-time." On Sunday morning the household-routine or the farm-routine is interrupted, and the signal, if one may say so, is not sounded. Just as a dog's mouth may water when a whistle sounds, because an association has been experimentally built up between the whistle and food, so it is in a measure with the newspaper dog, though we must admit that the stimulus and the reaction are much more complex. Instead of the whistle, there are intricate routine circumstances, and instead of the flow of saliva there is very effective behaviour. Yet all this is only a half-truth; for, in the case of a highly-evolved animal like a dog, educated in responsible partnership with man, there is an active memory and an intelligent grasp of the situation. None the less, we do not believe that the dog has any sense of time. Perhaps the nearest approach to that is to be seen in some alert hunting animals, like the fox, which have been known to wait the reappearance of their prey which has been hidden from view for a short time, for instance, by a stream-tunnel running under the road.

There is a certain kind of sea-urchin at Suez which spawns regularly at the full moon, as Professor Munro Fox has shown, but no one as yet understands how the periodicity has been established or what pulls the trigger with such precision. Much more striking, however, is the regularity with which the various Palolo worms crawl backwards out of the holes in the coral reefs and break off their body close behind the head! The body is full of eggs and sperms which are shed in the water; the head creeps back into the reef and gradually grows another body, to be set adrift precisely a year afterwards. In the Japanese Palolo worm, this extraordinary spawning takes place every year on the night before either the new or the full moon in the middle or latter half of December. It invariably occurs at midnight, just after the flood-tide, and by 2.15 the water, which was like vermicelli soup with crowds of wriggling, bursting, headless worms a couple of hours before, is once more clear. Animals cannot tell the time, but they are often wonderfully timed.

CHAPTER XXX

FINDING THE WAY HOME

Some progress is being made in regard to the old puzzle of "homing." Thus it seems possible to distinguish (*a*) the somewhat laborious "learning" of the topography of a given region from (*b*) the ability to return home from a distant and previously unknown place to which the animal was artificially transported. Most of the successful homing illustrated by ants and bees is the outcome of prolonged apprenticeship, in which advantage is taken of landmarks, differences in illumination and surface-relief, smell-traces and the like. But this interpretation does not apply to the homing of terns taken in closed baskets on board ship over unknown waters to a point 800 miles away.

The case of homing pigeons is somewhat intermediate between the two, for there is a graduated series of lessons on the one hand, and yet there are often remarkable successes when the birds are taken to new country. Let us dwell on this case for a little, for it is peculiarly interesting in many ways. Thus the achievements are exhibited by a domesticated variety of a bird which is not migratory in its wild state. And while there is careful apprenticeship, usually in the same geographical direction, there are often sudden leaps to unexpected success. Thus, during a psychological congress at Geneva, Thauzies liberated sixty-six pigeons, trained in distant parts of France and accustomed to " home " from various directions. Two reached their home at Versailles and two reached their home at Guéret (Creuse) on the day of liberation at Geneva, which they had never before visited; most of the others were home the next day; all but one reached their lofts within the week. Another feature is the diversity of endowment, for successful homing among pigeons is the outcome of careful selective breeding, and even among those of good pedigree there seem to be marked individual differences. Only a small percentage are great successes.

It is an achievement to " home " 634 miles in eighteen and a quarter hours; to fly from Barcelona to Brussels (700 miles) twice in three weeks; to return from a ship 125 miles out at sea; to fly from a new home in Thurso to an old home in Lancashire, in one or two days; to cover 1,010 miles in thirty-five and a half hours, which doubtless included a stoppage for the night; and other good instances will be found in Dr. Landsborough Thomson's "Bird Migration" (1926). Yet we are not in a position to estimate these successes aright unless we also know all the mistakes the same birds may have made.

Acuteness of vision certainly counts for much, for homing pigeons do not fly by night, and they are usually nonplussed by clouds and fog. But after we allow a great deal for picking up previously observed landmarks, there is the difficulty of interpreting the successful flight of, say, 150 miles over new territory before any of the previously experienced landmarks have come within sight. In some cases the return is delayed for several days, which suggests that the birds may make tentative flights in various directions over the unknown area. We say "in various directions," yet the general belief is that the main direction is usually right, and this main direction is in most cases that along which the birds have been trained. But how they pick out the enregistered direction it is hard to say, unless they take their bearings from the sun. Neither here nor in the case of migratory birds is there any warrant at present for speaking of a "magnetic sense"; and to credit the homers with a special "sense of direction" means little more than giving a name to a puzzle.

We have questioned several men who can retrace their steps in intricate novel surroundings, or who can find their way without a compass through the mist, but they have never been able to give any account of how they do it. Some have referred to a "kinæsthetic" sense; that is to say, to a subconscious registration of the movements taken; but none have shown any personal conviction that this is the correct line of interpretation. Yet success has usually been most striking when the problem was to retrace their steps. Well-criticised experiments with homing mammals, such as cats, dogs, horses, and sheep, are much to be desired.

Experiments with rats that quickly master a labyrinth of the Hampton Court maze type point to an enregistration of tactile and muscular sensations. Since blind rats readily learn the trick, guidance by sight may be excluded as an explanation. When a fresh labyrinth is used, the rats show no hesitation, so the hypothesis of smell-traces may be eliminated. Very significant, however, is the fact that a change in the length of several of the passages, whether lengthening or shortening, produces hesitation and confusion ; and Professor Watson's blind white rats, that had mastered the maze, were quite flabbergasted when the whole thing was turned round horizontally through 90 degrees or 180 degrees ! This eliminates the generous view that the rats keep a pictorial memory of the maze in their heads. It seems more and more probable that the word " kinæsthetic " sums up a considerable part of these orientation and homing phenomena. For migratory animals there is perhaps a generalised hereditary memory.

When we pass from birds to bees we find notable differences in behaviour, for it has been made clear, we think, that bees cannot " home " except from situations of which they have had previous visual experience. They build up very rapidly a visual memory of their surroundings for an average distance of perhaps a mile around the hive. Professor Emil Yung put twenty marked bees in a box, and took them rather over two miles into the country in the neighbourhood of Geneva. When they were liberated, seventeen returned to the hive. But when these were taken soon afterwards for rather over a mile on the lake, they flew about in all directions when they were liberated, and none reached home. They saw no land-marks on the water.

Many facts corroborate the theory that bees *learn* to find their way home. Thus an inexperienced young bee that has not begun its out-of-door industry is unable to find the way back to the hive even from a short distance. When a bee *first* emerges normally it takes an "orientation-flight," moving in varying orbits around the hive, keeping its head consistently homewards. It probably builds up a picture of the environment, and without its "orientation-flight" it cannot find its way home. It is interesting that bees have to repeat their orientation lesson after the long rest of the winter, or even after they have been kept indoors for many days by persistent bad weather. Another interesting fact is that a bee taken from the hive in a box, and then liberated at a spot a mile away, usually ascends high in the air and swings round in a circle, taking reconnaissances, as it were. Having quickly reconnoitred, it makes a bee line for the hive!

When a bee has become familiar with its region, the homing is probably for the most part a habituation. We might compare the insect to an absent-minded or very tired man walking home along the familiar streets. There is reason to believe that the busy bee's brain soon becomes clouded with fatigue. In any case, the habituation makes it easier to understand why the bee is puzzled when the hive is shifted a few yards, and why it fumbles when the entrance to the hive is shifted even a few inches. This ineffectiveness is misjudged unless we keep in mind the fact that the whole of this homing behaviour has been, so to speak, relegated to the level of habituation. It works well as long as circumstances remain quite the same.

The idea we wish to suggest is the distinction between (*a*) the laboriously acquired success in homing, as in ants, bees, and wasps, and (*b*) the natural endowment, perfected no doubt with practice, that we see in many a wild bird and beast, and also as the basis of the homing pigeon's educability.

CHAPTER XXXI

DO ANIMALS SLEEP AND DO THEY DREAM ?

DREAMING is an activity of the mind when most of the body is asleep. Thus before we can answer the question : " Do animals dream ? " we must ask another : " Do animals sleep ? " And what is sleep ? Do fishes sleep, do bees sleep, do trees sleep ? The whole subject is full of difficulties and pitfalls ; there is far from being unanimity among physiologists as to the cause of the state in which we pass about a third of our life. Sleep is part of an established rhythm, a state of partial fatigue in the higher nerve-centres, during which recuperation occurs, probably associated with the removal of inhibiting waste-products or toxins. During sleep the subtle products of wear-and-tear, fatigue and worry are washed out of our brain by the blood, and we awaken refreshed. But the spinal cord must be a very light sleeper, and the " breathing centre " in our medulla does not seem to need any rest at all—luckily for us.

And just as parts of the nervous system remain always awake, so is it obviously with many parts of the body, such as heart, kidneys, and digestive tract. Even the muscles of the slumbering babe, lying ever so quietly, are far from being inactive ; the engines are still going, though not in gear. It must be admitted, however, that there is in sleep a great reduction of activity ; and another commonplace fact is that the sleepy nerve-cells are no longer ready to answer the door. Moreover, by such automatic devices as shutting the eyes, there is an obviously great reduction of the number of knocks.

If sleep means drawing down the bodily blinds, ceasing to be able to answer the door as usual, and losing the power of moving about without first awakening, then many of the higher animals are known to sleep. The horse can sleep standing on its legs, the bat can sleep hung up by its toes, the whale can sleep on the surface of the sea. A dog that cannot get a sleep will die in four or five days. It can live without food much longer than without sleep.

On the other hand, it is said that guinea-pigs do not need to sleep at all ; they may stop eating for about eleven per cent. of the twenty-four hours, but they do not fall asleep. This is probably a very significant fact : the less intellectual the animal, the less it needs in the way of sleep. " Eight hours for a woman, seven for a man, six for a fool." There is much to be said for the view that sleep is a tax on having a really fine fore-brain. Against this theory is the fact that hens sleep, but only for three hours or so. And, as we have already said, we must judge the intellectual abilities of the domestic fowl not by the stolid adult hen which man has depressed into an egg-laying machine, but by the alert, venturesome, and eminently educable chick.

In any case, we doubt whether there is any convincing evidence of sleep in any creatures below the level of birds.

That reptiles and fishes *rest* is certain, but do they sleep? A snake may curl itself up into a sleeping attitude, a lizard may show not a quiver as it basks in the sunshine, a fish may be seen in motionless poise in the pond, but there is no hint of a drowsy awakening when one touches them. Very much the reverse!

If the need for sleep is a tax that the mind makes the body pay, one would not expect any hard and fast line dividing the sleepers from the non-sleepers. Therefore, just as we can interpret the ever-wakeful, very unintelligent guinea-pig, so we can make an exception prove the rule in the case of the basking shark which may be caught napping on the surface of the sea. For the gristly fishes have finely-developed fore-brains compared with those found in ordinary bony fishes. No doubt a number of bony fishes are known to yawn, but that may simply mean that they are not getting enough of oxygen, not that they are really sleepy. It is hardly necessary to say that a hibernating mammal, a hypnotised guinea-fowl, a frog in cold-coma is not asleep. The most that one could say in such cases is that the animal is in a "hypnoid state."

All this clearing of the decks was necessary in order to get the second part of our question into an answerable form. Dreaming is a more or less unregulated mental activity that goes on when most of the body is asleep, and since only the highest animals sleep in the true sense, it is only amongst them that we need look for instances of dreaming. The cat purrs in its sleep; the dog growls and wags his tail. They certainly have their dreams. No one who has watched dogs carefully can doubt that they go a-hunting in their sleep. A horse, perhaps the most intelligent mammal below the level of apes, has been known to neigh in its sleep and to stamp with its hoofs.

Some human dreams are evoked by stimuli from outside which get across the threshold without awakening us. Similarly, it has been shown that the resinous odour of a wood artificially brought to the nostrils of a sound-asleep dog may be sufficient to send it off a-hunting in dreamland. When the dog is awakened, it is not keen to rush out into the open ; it has forgotten its dream. But there is also strong evidence of dreaming in dogs when the observer at least could not detect any external stimulus ; and so it is with some of our own dreams.

Our general conclusion, which we share with Professor Hempelmann (*Tierpsychologie*, 1926), but have no wish to be dogmatic about, is that the cleverer mammals at least have true sleep closely analogous to that of man, and have also genuine dreams. Prove this dreaming we cannot, but sleeping apes, dogs, cats, horses, and the like utter sounds and make movements the like of which in man's case would be held as indicative of dreams. As Professor Hempelmann says, we come perhaps nearer the higher animals in our dreaming than in our wide-awake mental life. In any case, we have here an interesting brain-stretching problem : how far is sleep a tax on having keen wits, and how far do dreams indicate that the mind does not always become so sleepy as the body ?

CHAPTER XXXII

HAVE ANIMALS LANGUAGE?

THE strict answer to this question should be "No"; but certain saving-clauses are necessary. To some extent it is a question of definition. True language means the expression of a judgment by means of socially imitated sounds. A child does not *speak* until it makes its first little sentence. Many animals, such as apes, dogs, parrots and rooks have *words* which express definite emotions, like anger, fear, and love; or indicate certain things or circumstances like food and danger. But no animal makes a sentence, and though a dog may manage to express its approbation or the reverse, it does not say so in so many words. Parrots and starlings imitate sounds made by their fellows, and this is a distinct step towards language, yet these clever birds never utter a sentence or express a judgment of their own. The appropriate utterance of sentences which they have learned is sometimes quite fortuitous, but it usually happens because of a recurrence of similar situations. On rare occasions it may be intelligent. But the sentence-uttering itself is, of course, purely imitative. That dogs and horses and many other animals learn to associate a sound or word uttered by man with a certain thing, person or action is admitted by all, but it does not come near language.

A careful study of the question of language has been made in the case of the chimpanzee, especially by Professor Yerkes and Mrs. Learned. Chimpanzees have the same vocal instruments as we have; that is to say, there is a close resemblance in the larynx and in the vocal cords; they have "a good voice" and a considerable gamut of sounds;

but, so far as is known, they never show any approach to making a sentence or expressing a judgment, which is man's prerogative.

A parrot imitates sounds, and is in this respect far ahead of the chimpanzee, but we do not think that even a parrot can be said to make a sentence expressive of its own judgment. If chimpanzees had the parrot's power of imitating sounds, or if chimpanzees could imitate what they hear as well as they can imitate what they see, then in all probability they would rise to language.

It is interesting to know the kind of experiment that is made by experts in order to test an animal's capacity for speech. Professor R. M. Yerkes tried four methods of speech instruction with one of his chimpanzees called Chim, but none gave positive results. The first method was to arrange for the mechanical delivery of pieces of banana on the table of Chim's observation room, and to utter the sound "Ba, ba!" as the signal for the appearance of the fruit. For about a fortnight this kind of lesson was given once or twice a day, and Chim was much interested and very appreciative. But he never made any attempt to reproduce the sound. The second method was to hang in Chim's cage an apparatus loaded with pieces of banana, which were delivered to him in succession whenever the experimenter said "Co, co!" But Chim did not get beyond "certain slight and unconvincing intimations of attempts to make sounds when facing the apparatus."

Another educational apparatus consisted of a board on which was a small box hinged on one side and provided with a spring which, when released, would raise the box and uncover a banana. As the box had a wire mesh cover, this method had the advantage that the pupil could see the banana. Professor Yerkes took the contraption into the cage, secured Chim's attention, and made the sound "Na, na!" distinctly and emphatically a few times, thereupon releasing the spring and uncovering the banana. Sometimes he would begin to eat the banana to intensify Chim's eagerness! This was done over and over again, but Chim never learned to say "Na, na." The only kind of lesson in this direction that gave any positive result was that the chimpanzee learned, as a dog will learn, to "speak for food." But there was no *imitation* of the sound. It should be noted, however, that Chim became more and more interested in what people said, and learned to answer back to certain sounds in an appropriate way. "Occasionally he seemed to try to talk when persons were talking in his presence."

Chimpanzees are not usually credited with the power of uttering many different sounds, but Mrs. Blanche W. Learned, a musician, has been at pains to record in musical notation all the sounds that were made by Chim and Panzee and some other chimpanzees. They have a much larger vocabulary than was supposed, and the vocalisations fall into four principal groups, according as they were made while waiting for food, while eating, when in company with persons, and when two chimpanzees were together. There were seventeen words beginning with gutturals, such as *gak*, a food-word; *gho*, in greeting a friend; *ga-ha*, said to a mechanic with blackened clothing and face; *kah-kah*, in penitence; *ky-ah*, in distress; and *kah-hah*, *kak-ha-ha* in laughter.

Four words began with an aspirate, such as *ho-oh* in alarm, and an energetic *who-ah* when dinner was announced. Five began with nasals and labials, such as *ngak*, an intensive variant of the food-word *gak*, and *M*, a sound emitted with lips closed. Five began with vowels, such as *ah-oh-ah*, a half-scream of apprehension, and *Ae*, a double-toned expression of joy or of anger. We have given these illustrations because they illustrate the carefulness of modern methods in inquiring into these problems of animal behaviour which used to be treated in such an easy-going way. They also show that chimpanzees have a considerable repertory of vocalisations which might be utilised as the basis of a language if the animals could be induced to imitate sounds persistently. But Professor Yerkes' experiments showed that this was just what they would not do. The net result, in Mrs. Learned's words, is this : "Although the young chimpanzee uses significant sounds in considerable number and variety, it does not, in the ordinary and proper meaning of the term, speak." No one, of course, wishes particularly to teach chimpanzees to speak ; the interest of the experiments is purely scientific. But enough is known to lead one to doubt the philosopher's remark that animals would speak if they had anything to say. That cannot be the reason for their relative reticence.

If we turn from the question of language to ask whether animals are ever able to communicate with one another, the answer should be "Yes." Vocal signals often pass from mate to mate, from parent to offspring, from offspring to parent, from kin to kin ; and a sound is often a word, and a word is enough for the wise. Among animals, like dogs, that live very largely in a world of smells, a particular odour often serves to convey information. Spiders that live very largely in a world of vibrations can speak to one another in the tremor of a silken thread. A hive-bee that has found a treasure of nectar tells her fellow-workers of her discovery by indulging in a particular kind of dance on the honeycomb. The bystander bees become excited when they see the dancer's ecstasy, and they nose around her to catch the scent of the particular kind of flower she had been visiting, for this gives them their odoriferous clue when they sally forth on the search. There are indeed many ways in which animals communicate with one another—both with and without words.

CHAPTER XXXIII

DO ANIMALS EVER LAUGH?

Of laughter, as of tears, there are many different kinds. Just as there are tears of joy, so there is a laughter of rage, a laughter of bitter disappointment, and a laughter of malicious "Schadenfreude." Just as there are many different kinds of laughter, so, naturally, there have been many different theories, most of which suffer from the defect of being too narrow in their reference—applying only to certain kinds of laughter—and in being too sophisticated—starting with a highly-evolved type instead of with the simplest and crudest. Not that the primitive forms of laughter will explain its highest expressions, for laughter has been extraordinarily humanised. But the simple forms will reveal the raw material of laughter and throw light on its relapses.

A careful and sagacious review of some of the more outstanding theories of laughter by Professor Gopalaswami, of

Mysore, furnishes good illustrations of the speculative ingenuity displayed in finding human survival-value and social significance in an emotional output which certainly occurs in monkeys and apes. According to Professor W. MacDougall, of Harvard, laughter is a safety-valve, relieving us from the sympathetic pain involved in contemplating some mal-adjustment or disharmony. "Laughter is the antidote to sympathy," as is suggested by Byron's lines:—

> "And if I laugh at any mortal thing
> It is that I may not weep."

It is interesting to notice that whereas Hobbes thought that we laugh because we are lacking in sympathy and have a "sudden glory" in discovering "some eminency in ourselves by comparison with the infirmities of others," MacDougall thinks that we laugh because we are apt to sympathise too much! Laughter is a self-preservative "instinct" (that much-abused word!) which saves us from our tendency to over-sympathy.

Gopalaswami criticises MacDougall's theory and proposes another of his own, which is also desperately ingenious. Man has a number of defensive impulses, such as getting into a rage, or taking to flight, or making an appeal, or playing some "ostrich" trick, such as becoming overwhelmed with confusion or even fainting. Now laughter has evolved out of this defence group of impulses, and more particularly out of appeal, which it has come largely to replace. Laughter has proved itself a shield, and many a fight has been obviated by a timely joke. But it is more than a shield; it disarms opposition, it makes the enemy relax, it even attacks him without provoking further irritation. By clever laughter a man may not only defend himself, but turn the tables on his opponent. Of course, this is not suddenly thought out as a policy; what Gopalaswami means is that this sort of advantage has given "the laughter instinct" survival-value in the course of social evolution.

There are other clever theories of laughter which disclose its social *rôle* without throwing much light on its primary nature and origin. They all suffer, as we have said, from over-emphasising one particular use, whereas laughter has come to have many uses; and they tend to be over-sophisticated, beginning far too high up on the evolutionary tree. Thus Bergson has laid stress on the importance of laughter as a factor in social discipline. We laugh the clumsy and the cranky out of court. But this is only another instance of the many secondary functions that man has found for an almost ineradicable peculiarity. Let us try another tack.

Herbert Spencer regarded laughter as the overflow expression of surplus nervous energy or high spirits, but this theory, though getting near the primary significance of the peculiar internal activity, has too broad a point. Primitive dancing, or rolling on the ground, or leaping in the air, or gambolling might also be described as overflow expressions of surplus energy, but the characteristic feature in laughter is, we think, *a momentary loss of control*. A surprise, a wave of emotion, an unexpected failure, an incongruity, or some other analogous stimulus is followed by a paralysis or inhibition of the normal controls of vocalisation and respiratory movements and facial musculature. We venture to think that laughter is primarily nearer to hysteria (which has been observed in dogs) than to, let us say, a relief from "sympathetic pain." That laughter has been subsequently brought to heel, refined, moralised, and socialised we do not for a moment doubt, but our theory is that laughter is primarily a localised loss of control under the stimulus of strong emotion, or sudden surprise, or irresistible stimulus, such as tickling.

As Darwin expounded in his too-rarely-read book on "The Expression of the Emotions," laughter involves, on the physiological side, (1) a deep inspiration followed by short, interrupted, spasmodic contractions of the chest and diaphragm; (2) opening of the mouth, drawing the corners backwards and a little upwards, raising the upper lip and showing the teeth; (3) movements of the head, quivering of the lower jaw, contraction of the orbicular muscles; and (4) the reiteration of the characteristic laughing sounds, which vary notably in their quality in different people.

Bacon drew a careful picture: "Laughing causeth a dilatation of the mouth and lips; a continued expulsion of the breath, with a loud noise, which maketh the interjection of laughing; shaking of the breasts and sides; running of the eyes with water, if it be violent and continued."

Emotion is well known to be frequently linked to internal and external movements of the body, and it is highly probable that the production of hormones has something to do with laughter. We do not doubt the validity of Spencer's view, modernised by Crile, that laughter gives relief to overflowing and overmastering excitement. It is more economical and practicable to laugh than to roll on the ground as some unsophisticated savages do. But we are emphasising a neglected factor—the sweeping away of the usual controls and inhibitions. We may mention a few suggestive facts. Several monkeys titter immoderately; some idiots laugh profusely and violently; some wild peoples go into paroxysms of laughter; the nervous unjustified laugh is familiar; children often pass through a phase during which they abandon themselves to unwarranted laughter; the activity often passes far beyond the limits of giving relief, and may become positively painful to those who laugh; many people laugh till they cry. Many other familiar facts support our view that the essential feature is a breaking down of controls, and this is also suggested by the great variety of the stimuli that provoke laughter. The crudest is tickling, and not much better is the laughter of the gods which Homer describes as "the exuberance of their celestial joy after their daily banquet." Laughter may be excited apart from the ludicrous, apart from mirth, apart from exultation over others, apart from over-sympathy, and apart from anyone save oneself. But the stimulus must be strong enough to break down, though it may not be for more than a few seconds, the normal inhibitions and controls concerned with voice, breathing, mouth and face. With his usual shrewdness Darwin regarded a smile not as a first stage in the evolution of a laugh, but as the outcome of laughter-control. In all likelihood our descendants will laugh less than we do, and smile more.

This saving-clause we must emphasise, that modern civilised laughter does not necessarily imply any lack of control, for, as we have admitted, the laughing activity—Leigh Hunt's "happy convulsion"—has been humanised, moralised, and socialised. If in its earliest stages laughter may sometimes have verged on the pathological, it has become a flower—always, however, with the possibility of relapsing into a weed. This is no laughing matter.

This is a long-winded, but we hope not unprofitable excursus, provoked by a friend who insists that his fox-terrier often laughs. Personally, we think this dog's so-called laughter is a hysterical giggling, like the laughter of fools, long ago compared to the crackling of thorns. But when we have mentioned apes, monkeys, horses, dogs, parrots, and geese, we think we have come near the end of animals that laugh.

CHAPTER XXXIV

SINGING MICE

Many years ago we used to live for part of the year in one of the cottages of a now famous golfing village; and one of our abundant amenities was a singing mouse. In the quiet of the evening, when the room was pleasantly warm, it used to begin its little song from some hiding-place near the fire. It would sometimes continue for ten minutes or so, and then came a longer or shorter interval of silence, after which it would begin again. We were never sure when it would or would not perform, so we could not with any confidence invite friends to hear the music. It is not easy to define music, but there came from the mouse a succession of distinct notes, an undeniably sweet cadence, and more than a hint of a trill. As one of our golfing visitors said one evening, when the mouse took advantage of an unusual pause in his narrative: " I did not know that you kept a canary."

Singing mice are not very uncommon, and they have been the subject of many semi-scientific papers and of still more discussions, not always harmonious. For the phenomenon of singing mice is one of those in regard to which facts are are few and opinions are many ; and there is a type of man who would fight for a " view," yet has no particular desire to make a precise observation. We have a " view " ourselves, but we shall state it without enthusiasm and accept its puncture with nonchalance.

There is no doubt as to the pleasant little song, which varies considerably in value and vigour. There is no doubt that some mice make a habit of it, and may continue for a long time. So it is not a " swan song." The singing may occur at any time of the day or night. Its utterance has been observed in wide-awake mice, which hold their snout high ; so it is not of the nature of a sublimated snore. It is not a male's serenading, for it occurs in both sexes ; moreover, it is an individual peculiarity, present in but a small percentage of the total population of mice. There is not the least warrant for regarding the songsters as a special variety ; and the enthusiasts who crack up singing mice as unique will have to bow before the fact that the phenomenon, whatever its significance may be, has been observed in some other kinds of rodents, such as rats and field voles, and also in unrelated mammals, such as shrews.

We may also dismiss entirely the suggestion that " singing mice " mimic the cage-birds in the house, for they often " sing " when there is neither a model nor any competitive incentive. It is not a social activity, for solitary mice will sing ; yet there are well-authenticated cases of a number of mice singing together, with the noteworthy peculiarity that they do not sing in time ! The effect of the chorus is said to be very funny. There is an old story that the inhabitants of Central China keep " singing mice " in cages instead of canaries, but it is difficult to verify anything that is said about the ways of either mice or men in that remote country.

What is unsatisfactory in our statements so far is that they are so markedly negative. We have stated explicitly what the song of mice is not, but what is it? At its best the song consists of a rapid succession of pleasant notes, quite different from the ordinary shrill squeak of the mouse; it can be easily heard across a room; it may continue for a quarter of an hour at a time; it is uttered both in inspiration and expiration; there may be eight distinct sounds in a second; it may be heard when the mouse is feeding or cleaning itself, when it is running or sitting at rest, when it is handled or when it is undisturbed. There is often a suggestion of a wheeze about it, and there is, to our judgment, more than a suggestion that it is quite involuntary.

One of the early observers describes the pose of a singing mouse in a circumstantial way. He suddenly opened the door of a cupboard which the songster used to frequent, and saw for about a minute the movements of the mouse's throat. The snout was held up in the air like that of a dog when it is howling, and the song emitted was like that of a wren. He notes that there were no birds in the house! Although the mouse was silent when held in the observer's hand, it resumed its song whenever it was set free; and this points to involuntariness.

Another observer, who had a mouse not averse to performing in broad daylight, speaks of the elevation of the snout and the throbbing of the throat like that of a bird when singing. "The song was something between that of a wren and that of a shrew mouse, and rather pleasing than otherwise." He tells us that he suspected some disease of the lungs or throat, but the mouse never seemed ill at ease, and it often sang in a happy way when it came out of its dormitory to wash its face. The mouse was not at all short-lived, and it had numerous progeny, none of which inherited their parent's powers.

We read again of a winter visitor to Mentone who was favoured in the evenings by a singing mouse. It used to sing for hours, sitting on the edge of the table, or on a flower-vase, or in a wood-basket near the fire. "The song was not unlike that of the canary in many of its trills, and it sang quite as beautifully as any canary (*sic!*), but it had more variety, and some of its notes were much lower, more like those of a bullfinch." This is one of the more enthusiastic records—*our* singing mouse never rose to these heights—and it goes on to say that there was sometimes a sort of double song—an air with an accompaniment.

Dr. George J. Romanes kept several singing mice for four to eight weeks, and noted that the singing was evoked by two very different sets of circumstances. When the mice were alarmed they sang vigorously; but they did the same when well content, like a purring cat. He refers to an interesting case where a London house suddenly became the home of numerous singing mice, whether by an invasion or by a hereditary transmission, no one can tell.

The "singing mouse" has, of course, been post-mortemed; and in many cases, at least, there are *indications of inflammatory conditions in the respiratory system.* We do not suppose that there is a special *Bacillus lyricus*, but slightly pathological variations are not uncommon among animals, and we think the observations point to some slight wheezing abnormality, to which the regularity of the breathing movements might give a rhythmic quality. The great pathologist, Virchow, had a strong conviction that many new departures bordered on the pathological, and perhaps the singing mouse is a case in point. Since it does not seem to be a serious abnormality, it might become the initiation of song among mammals.

CHAPTER XXXV

VAGARIES OF ANIMAL BEHAVIOUR

In the life of most animals there is an unbroken reasonableness of behaviour, yet there are many instances of the occurrence of something queer and puzzling. Thus a ewe sometimes steals its neighbour's lamb, with the frequent result that its own dies at birth. A pheasant may lay her eggs in a partridge's nest. A fish, after prolonged parental care, may swallow its own offspring. A female spider often turns with sudden ferocity upon her suitor and kills him. A pigeon has been known to make love to a ginger-beer bottle.

Among the many vagaries, of which we have just given a few examples, one of the most puzzling is the occasional killing of the young by the mother. It is a contradiction in terms and demands some explanation. In some cases, perhaps, when the mother is in captivity and not too well treated, the simple explanation may be that she goes off her head. But the phenomenon also occurs in Wild Nature, where the occurrence of insanity is extremely improbable. What can be the meaning of the strange behaviour ?

In her " Animal Mind " (1927)—a fascinating contribution to comparative psychology—Miss Frances Pitt makes a novel suggestion that the mother animal kills her young ones to ensure their safety. This accomplished field-naturalist has studied the destruction of the young in the meadow-vole, the badger, the hedgehog, the dormouse, the ferret, and the rabbit, and she notes that it occurred from twelve to twenty-four hours or more after the birth, so that it cannot be ascribed to the mother's excited worry. The delay also disposes of the suggestion that the devouring of the young is an extension of the common habit of eating the after-birth or placenta. The mother meadow-vole was seen to kill her quite vigorous young ones, so that in this case at least there could be no question of their simply dying.

Miss Pitt makes two suggestions, the first of which seems to us to be sound, while the second appears incredible. The first is that some unnatural disturbance makes the mother lose her bearings. She is seized with overwhelming terror —" a generalised fear." But, secondly, " in her poor little distraught head was there a great desire to save and keep her babies ? . . . I believe she killed them because she so wanted to make them safe." Now, we believe that the latter part of this theory is far too generous and subtle. We must start, we think, with an instinctive maternal routine, an orderly succession of activities, usually effective. But if this suffers some disturbance or interruption from without, everything may go wrong. The nursing instinct has been perturbed ; a killing instinct or appetite takes its place. We do not think that there is warrant for believing that ordinary mammals realise their newborn offspring to be offspring ; we do not believe in animals having " generalised fear " ; and we cannot accept the theory that the vole killed her young ones " because she so wanted to make them safe."

There is no doubt at all that we make puzzles for ourselves by the imperfection of our scientific methods. Thus we can hardly get free from the habit of reading into the animal either the man or the automatic machine. Both of these errors are common, and both make pseudo-puzzles.

There is a courageously fine sentence in Miss Pitt's book, which tells us that " the Red Indian's conception of animals as ' little brothers ' is nearer the scientific idea of the universe than that of those who are wont to speak patronisingly of ' poor dumb beasts ' and the ' lower animals.' " But in this connection there is a useful story told by P. G. Hamerton in his " Chapters on Animals." It concerns a cow which lost her calf and would not be comforted. The circuit had been broken and everything went wrong. Indeed, the cow would not stand to be milked and was like to die. So they took the skin of the dead calf and stuffed it with hay, and stood it on its legs and placed it before the bereaved mother. The smell of the skin served as a " liberating stimulus," and we are not in the least inclined to deny the possibility of an associated emotional tonic. In any case, as the cow licked the faked calf, the glands began to work, and the crisis passed. But as she continued to lick the simulacrum of the calf she made a hole in the skin and got at the stuffing of hay. This she proceeded to eat, to the great delight of the farmer ; for it meant his cow's recovery. Now, we make a pseudo-puzzle of this incident if we insist on reading the man into the beast. The cow is far from being a stupid animal, but it is not troubled by any desire or need for a consistently unified experience. In Hamerton's case the cow was no more puzzled by the calf becoming hay than she might have been by the hay having previously become calf. She had no clear mental realisation of either !

Whatever be the nature and origin of instinctive behaviour, it means a ready-made capacity for doing apparently clever things, without any need for apprenticeship or learning. This is not to deny that practice may make an instinct perfect. Now, it is obviously advantageous for many ways of living to have a rich repertory of instincts ; but the drawback is that the creature is bound to be nonplussed when there is any big disturbance of the normal circumstances. This is the most frequent cause of animal vagaries. But it is not the only cause ; for another is sheer originality—some new adventure of life.

CHAPTER XXXVI

VAGARIES OF THE CUCKOO

As a particular instance of vagaries let us take the cuckoo. It bristles with peculiarities, but they are not all equally puzzling. Thus, there are far more males than females, and polyandry is a not unnatural consequence. But it is quite possible that the numerical disproportion is due to a differential death-rate among the nestlings, the females being more delicate—more susceptible to aberrations incident on the foster-parentage. Then, again, the spacing out of the egg-laying over an unusually long period is not more than a special case of the *time-variations* that are of frequent occurrence among birds. One version of what happens is that the cuckoo lays an egg on five to seven alternate days, each directly or indirectly deposited in a separate nest, and that, after a short interval, there is another spaced-out laying of four or five. But this is not so far away after all from what occurs in birds with two successive broods. It is plain that irregular spacing out of the egg-laying would make brooding in one nest very difficult.

As to the main fact of shirking nest-building and brooding, we must think again of the frequent occurrence of *time-variations*. As Professor F. H. Herrick points out, the behaviour-cycle of a typical summer visitor is arrival, mating, nest-building, egg-laying, brooding, care of nestlings, education of the young, and departure. One term in the series may be weakened or dropped out; another may be exaggerated and prolonged. Thus a bird may build supernumerary nests at the beginning of the breeding season, or a second nest after the first brood has been reared. It may stop nesting altogether and drop its eggs on the ground or into the nest of another bird. It may migrate too soon, leaving its young ones to perish, or it may have an extra brood too late in the year. A lack of attunement between egg-laying and nest-building is casual among birds; it has become more than casual in cuckoos. "Parasitism" meets the difficulty due to a failure to adjust nest-building and egg-laying, and it is significant that the American black-billed cuckoo, which normally nests and broods, may behave in an irregular way if disturbed in its nest activities. It has been known to shift its eggs to a new nest of its own, and to lay in the nest of another bird. We believe that the European cuckoo illustrates a nervous variation which finds various expressions in its life and habits, but we accept Professor Herrick's suggestion that the *strangeness* of the whole business is lessened if we recognise among other birds the not infrequent occurrence of time-variations in a seasonal routine.

A careful investigator, the Rev. F. C. R. Jourdain, has pointed out that " we have in the bird world every stage between complete breeding parasitism " (a horrible term, certainly not a good translation of " Brut-Parasitismus "), " as exemplified in the cuckoos, cow-birds, honey-guides, etc., and its most elementary form as shown by the habitual use of some old nest of another species for breeding (surely brooding ?) purposes, as in the case of falcons." Thus a falcon may use the nest of a raven, and a pied wagtail may build inside the nest of some other species, or a kestrel may lay an egg amidst a raven's clutch. And among the South American cow-birds (Molothrus) there are some that brood, though frequently annexing the nests of their neighbours, and others that have quite given up both nest-building and incubation.

From the very fine collection of cuckoos' eggs in the Aberdeen University museum, each egg beside those of the foster-parent, one gets the following impressions : some of the eggs are almost indistinguishable, except in fine shell-texture, from those of the foster-parent, showing what is badly called mimicry ; others show a strong general resemblance ; and a third series are as different as different could be, standing out very conspicuously in the clutch.

The question arises whether the resemblance in colour and markings between the cuckoo's egg and the foster-parent's has survival-value ; and in this connection Mr. Jourdain rightly insists that estimates of the number of resemblances and differences are valueless, unless the eggs are taken from the same district. He gives a good case suggestive of there being real significance in the resemblance. In the thickly wooded districts of Southern Finland the normal fosterer is the redstart, which lays pale-blue eggs. In a Helsingfors collection of forty to fifty locally taken cuckoos' eggs all but about four were of the blue type. One would require to be sure that the collection was a fair sample and in no way " picked," but Mr. Jourdain's conclusion is that practically the only type of cuckoo's egg which had survived the ordeal of natural selection was the blue egg. In other words, the dominant type of cuckoo for a region with redstarts as the normal fosterers would be a bird that could habitually produce blue eggs. It is generally agreed that a cuckoo lays eggs of a particular type throughout her life or throughout one season. That there can be any voluntary change from one type of egg to another is out of the question, yet there may be wagtail-, robin-, hedge-sparrow-, meadow-pipit-, and other cuckoos, which " may keep to one particular kind of territory and so remain untainted by interbreeding with other strains."

But what is the selecting agency that eliminates unlike cuckoos' eggs and favours like ones ? A plausible case can be stated in support of the view, an old-standing surmise, that the foster-parents hold the sieve. They sometimes detect the intruded egg, especially when it is conspicuously unlike their own, and deal with it accordingly. This presupposes that they have a good eye for colour, and this probably varies with the individual as well as with the species. In the first place, there is abundant evidence of the occasional ejection of an intruded egg. In the second place, " records of rejection on the part of the rarer fosterers far outweigh all recorded cases in which selection has been exercised by the common ones." This is a good argument : when the egg has been inserted into the nest of the normal fosterers, there are few cases of rejection, as evidenced by finding the broken shell outside the nest, or by the desertion of the nest, or by some similar sign. Yet it cannot be said that the proportion of rejections is necessarily correlated with the closeness of the resemblance between cuckoo's egg and foster-parent's egg. One has to allow for a varying standard of discrimination on the part of the foster-parents. Some of the specimens before us suggest that certain foster-parents must have been extraordinarily unobservant. But the collector may have collected while the bird was still wondering ! An interesting point is that the great majority of the non-parasitic cuckoos lay white eggs.

It is perhaps worthy of notice that the variability in the coloration of cuckoos' eggs is not an ordinary case of organic variation, since the egg-shell is a non-living product of the wall of the oviduct. A change of colour in a cuckoo's egg is not the same kind of variation as one sees in a white blackbird, or in a copper beech, or in a red-eyed fly, or in a tailless kitten, or in a musical genius. In the cuckoo the actual variation is in the constitution of the mother bird which slightly changes the chemical routine of pigment formation ; and that constitutional variation may be traced back, perhaps, to a slight change in the egg-cell (but not in the egg-shell) whence the parent developed. In the same way many of the minor differences between molluscan shells of the same species are not variations like those which distinguish one ruff from another, one brother from another. A feather is for a time a living growing structure, but a shell has never any life in it.

We are afraid that there is not much to be said in support of the idea that when the cuckoo lays her egg on the ground and is about to take it into her mouth for transport, she says to herself: "Now that will suit a robin," or "This is the very thing for a hedge-sparrow." We do not know why she should not have as good an eye for colour as the foster-parent, but Mr. Chance's fine observations indicate that, in many cases, when it is practicable, the cuckoo *lays* in the foster nest. Then, obviously, she will not see the egg until it is too late to think about it. Unless, indeed, she may shift it in her bill from an incongruous to a procryptic clutch.

We have lingered over the behaviour of the cuckoo because it seems to us to indicate very clearly that we have much to learn yet in regard to animal vagaries and their mental aspect.

CHAPTER XXXVII

HAVE ANIMALS A SENSE OF PROPERTY?

WALT WHITMAN says that animals are free from man's "mania for owning things"; but there is good reason for a careful scrutiny of most of the general conclusions that draw a hard and fast line between man and beast. No doubt man stands apart from animals in his language, reason and morality; but even of these great gifts there are hints in the Animal Kingdom. And while there is no reason to suppose that any animal hugs a possession to itself, with a well-defined feeling: "This is my very own," there are adumbrations of the property-sense among animals.

One of the roots of the property-sense is in the egoistic impulse to keep hold of food that has been captured. Everyone is familiar with the danger of interfering with a dog's bone. To do that is to interrupt the pleasurable satisfaction of an appetite. But the dog passes a little beyond this when it hides the bone for another day; and this habit of storing for a short time is illustrated by various wild carnivores, like the leopard, and by some birds, such as owls and shrikes.

Woodpeckers fix acorns in little holes in trees and return to them after many days; gannets sometimes store fish in good weather and fall back on their maladorous reserves when the storm is prolonged. Squirrels store nuts, but often forget their cache; beavers store sticks and marmots store hay. But while there is frequent concealment, there is not usually much in the way of guarding or fighting for the property. That note is struck, however, among the scarabees, for there are often fierce combats when an intruding beetle tries to steal the little ball of dung which a diligent pair are rolling along the ground to their underground nest. There is also vigorous fighting among ants and among social bees when attempts are made to plunder the communal store. Our point is that one of the roots of the human property-sense may be found in the natural impulse of animals to keep hold of food and to defend stores.

Among higher animals there are, we believe, subjective emotional bonds behind the objective parental care. At lower levels all that we dare say is that there are strong instinctive impulses that prompt parents to defend their young ones, or it may be their eggs. Behind this it is difficult to penetrate. It may be that the parental bond is sometimes hitched on to the conjugal, for one must remember that many male animals share in the brooding, and that some make themselves responsible for it all. In other cases it may be that the self-preservative instinct is extended from the body of the animal to what is borne by the body—of the mother at least. Some of the simplest expressions of parental care are found among leeches, in which the two sexes are combined. The skate-sucking marine leech, Pontobdella, attaches its velvety eggs in empty mollusc shells, and mounts guard over them for more than a hundred days. This almost sounds the property note! The brook-leech carries its young ones attached by their suckers to the underside of its body, and in such cases it should be borne in mind that the effectiveness of the parental care may be increased if there is, on the part of the offspring, some constitutional attraction which prompts attachment to the parent's body rather than to anything else. We venture to suggest, then, that another of the roots of the property-sense may be found in the common habit of concealing, carrying, guarding and defending the eggs or the offspring.

Our theory may become more plausible when account is taken of the cases where the parent fights vigorously in order to keep hold of its progeny. Some female spiders resist very strenuously any attempt to deprive them of the silken cocoon in which they carry about their eggs and even their newly-hatched young ones. The male lumpsucker guards with remarkable persistence the mass of eggs which the female deposits in a shore pool near the low-water mark. He defends them for weeks, and occasionally loses his life in the discharge of his self-appointed task.

It is also useful to think of cases where the parental care is vicarious; thus the worker-ants, not usually themselves maternal, make strenuous efforts to save the cocoons from disturbance. They carry them away just as if they were treasures, just as if they were property. A further shunting from the original parental significance may be detected, we think, in the custom some ants have of tending green flies or aphids, which they treat as if they were domesticated cattle. And is not the property-note also sounded in the custom other ants have of keeping slaves?

Another root of the property-sense may be found in the nest, which is often defended with ferocity. No doubt the claim that many animals make on behalf of their nests, as their very own, not to be intruded on, is in certain cases, as in sticklebacks, linked to conjugal activities; and in thousands of cases it is bound up with parental emotion; but there is an approximation towards property when the same site is used in successive years, and when the shelter is resorted to outside the breeding season. When there are permanent products, such as a great ant-hill, or a termitary, or a bee-hive, the property-note is sounded still more clearly. Very interesting also is the claim that many birds, such as warblers, make to a "territory," the centre of their breeding activities, in defence of which they will fight passionately—both males and females. The same marking out of a claim is also illustrated by various mammals, from kangaroos to monkeys. A "preserve" is a property.

Our thesis is that in the defence of food and stores, eggs and offspring, nests and territory, there are the adumbrations, or, in a sense, the raw materials of the property-sense in man. While there is not any possibility of working out a direct affiliation, it is no small gain if we can indicate some of the threads which man has woven into a pattern peculiarly his own. The property-sense, which is just hinted at among animals, has been raised by man to a high power—probably, in most cases, far too high.

CHAPTER XXXVIII

CLEANLINESS OF ANIMALS

Everyone is familiar with the care that a cat takes of its fur ; the thoroughness of the toilet is admirable. The same fastidiousness is well illustrated by ducks, which deal untiringly with feather after feather, as if they enjoyed being finicky. So it is with hundreds of wild animals, and perhaps time would sometimes hang heavily on their hands if they had not to devote so much to the care of their person. This cleanliness, or " propriety," in the wide sense, is a deeply-rooted instinct, based partly on the healthfulness of which it is a condition, partly on the advantage of keeping the senses keen, and partly on the safety that often rewards the absence of betraying odours. No doubt animal cleanliness has often a standard different from man's, for the struggle for existence has forced many creatures into haunts, habits, and diets that are repugnant to human taste. Yet an animal may be beautifully clean though it lives in putrefaction, and devouring far-gone carrion is *de rigueur* for some animals, just as eating warm flesh is for others. Many animals have ectoparasites, but very few have dirty skins.

Fastidiousness in regard to food is very common, and often leads to the rejection of what has been fouled. Hares will not feed on plants which rabbits have soiled. A cat may kill a shrew, but it will not make a meal of it because of the unpalatable glands along the flanks. Many animals, from spiders to toads, from heron to ibis, from terrapins to lions, will eat only what they have just killed. Some dainty deer reject a slice of bread from which we have taken a bite. Savigny tells us that Egyptians are afraid of water from which the sacred ibis will not drink.

In many cases the daintiness is expressed in the way the animal eats its food. Thus Macgillivray pictures the squirrel "holding the hazel-nut between its paws and dexterously unshelling the kernel, from which it even removes the outer pellicle before munching it." This is outstanding, but many another mammal comes a good second. Even an elephant often subjects its hay to discriminating criticism. It is said that cuckoos press the contents out of the food-canal of their caterpillars before they swallow them. How carefully, though quickly, even a hungry golden eagle plucks its grouse. We have seen gulls washing soiled fish before swallowing them, and there are hundreds of instances of this kind of carefulness.

Everyone has admired the way in which a cat cleans up after a satisfactory meal, wiping its lips and its paws ; and this is common among beasts of prey. Hawks and eagles are similarly careful in regard to their bills and talons and the front of the head. We have often watched a golden eagle picking its soiled toes most sedulously. And the toilet after a meal passes insensibly into the general care of the whole surface of the body. We admit that there are a few puzzling exceptions—the hedgehog has a difficult problem—but the general rule among animals is a clean skin.

Brehm has given a detailed description of the elaborate nocturnal toilet of the graceful jerboa, and this has been corroborated by others. Many hours may be devoted to the duty, and the creature has certainly a very high standard of well-groomedness. As the cat again reminds us, the salivary secretion often counts for much, and some birds and mammals have special toilet combs. Most of the hoofed animals are fond of a bath, and Alfred Russel Wallace tells us that birds of paradise bathe twice a day. Everyone knows how the elephant delights to douche itself, and how the sparrows enjoy their sand-bath. It is difficult to think of a more beautiful homely sight than the swans bathing and preening, which usually occurs after a meal or after a sleep. There is extraordinary zest in the bathing of the black-headed gulls and deliberate dignity in the pelican's preening. The instinct of cleanliness is as varied as it is strong.

" It's an ill bird that fouls its own nest," and it is interesting to watch the careful way in which the nestlings are kept clean. Mr. W. P. Pycraft tells us, in his fine " History of Birds," that " the excrement of the nestling is enclosed within a capsule so that it may be picked up in the beak of the parents, and carried away to a distance from the nest before being dropped." As the fouling of the nest would attract fatal pests and would otherwise hinder healthy development, it is not surprising to find that some nestlings, as in the case of kingfishers, have an early-working instinct that assists the parental care in securing the sanitation of the cradle. We confess that we do not know what to make of the exceptional behaviour illustrated by the elegant hoopoe. For this bird "seeks its food among filth and takes no sort of trouble to secure the cleanliness of its nest; and the young similarly lack this instinct. Consequently the nursery of this bird, by the time the young are ready to leave, has become indescribably filthy." Where there is great crowding, as on bird cliffs tenanted by thousands of guillemots, razor birds, and other auks, cleanliness seems conspicuous by its absence, but there is probably more of it than one would think. The disamenities increase when there is anything like storing of fish, as happens with solan geese. Luckily the sense of smell is not well developed in the majority of birds, and many show none at all. But the big fact is that the typical nest is kept very clean; and besides the advantage of sanitation there is in some cases probably the further reward that the position of the nest is not advertised. The importance of this is not lessened by the fact that the nests of some birds, such as rooks and magpies, are very conspicuous, for in these cases the birds are well able to look after both their nests and them selves.

Similarly, while many of the larger beasts of prey seem to be indifferent to the accumulation of bones and the like about their dens, there are others, like the resourceful otter, taking no chances, that are scrupulous in removing from their retreat all traces of either meals or habitation. In many mammals, as in cats, the instinct of cleanliness takes the form of burying both the natural traces of their bodily activities and the crumbs that fall from their table.

The cleanliness instinct which expresses itself in relation to food and person, nest and home, is also displayed in parental care, for there are many mammals and birds that pay great attention to the tidiness of their offspring. The popular belief that the she-bear licks her cubs into shape has a sound basis, for it is difficult to exaggerate the amount of licking and grooming that they receive. This is true of many mammals, and everyone has admired the combing and brushing which young monkeys receive from their mother. In most cases, we believe, there is no entomological reference.

The climax of the instinct which we are seeking to illustrate, following in part an old study by Dr. Paul Ballion, is to be seen when fellows of the same kin assist one another in the tasks of the toilet. This is familiar in monkeys, in cattle, and in some of the parrots that are called "inseparables." An even higher level is reached among social insects, such as ants and bees, where the workers often lick the queen and insist on her tidiness. Some of the slave ants do the same for their masters, which is going a long way. The cleanliness instinct is certainly very strong among many animals; it has become a convention in mankind, though in many cases not very clamant.

We are not prepared to say that all wild animals are fastidiously cleanly. Exceptions may be made for some, like bats and hedgehogs, which harbour fleas and other ectoparasites. One recognises in condonation that it must be very difficult for a mammal that sleeps all the winter in a confined space to avoid being victimised. Moreover, a distinction should be drawn between those ectoparasites that are symptoms of a dirty skin, like the mange mites, and those which merely indicate that the host has very palatable blood. Thus a flea is rather a minute beast of prey than a dirt parasite. It may promenade on the cleanest skin. Our general point, however, is simply that most wild mammals keep themselves very clean, and it is interesting to linger for a little over their methods.

In a lecture on mammalian toilet, Professor Frederick Wood Jones, Anatomist in the University of Adelaide, gives an account of a great variety of ways in which mammals keep themselves clean. There are rough-and-ready ways, as when a wild horse rolls on the ground or a deer rubs itself against a tree. There are obvious ways, as when a cow uses its tail to flick flies off its side. This becomes a little more deliberate when a hard part of the body is used for scratching another part, as when an antelope rubs its skin with its horns or a stag does the same with its antlers. Neater, however, is the simple toilet performance seen in the horse and some other mammals when the skin is twitched by a special muscle, the panniculus carnosus, which is a dwindled vestige in man. Skin-twitching is used to dislodge intruders, parasites, and dust; and Professor Wood Jones tells us that "twitching as a fine art is seen at its best among the marsupials."

The cat's thorough toilet is very familiar. It gets at most of its body with its tongue, and those parts that cannot thus be reached, such as the face and head, are cleaned by the side of the licked paw. It is usual to interpret the roughness of the feline tongue as adapted to rasp off the flesh from the victim's bones; but there is much to be said for Prof. Wood Jones's view that the primary utility is in the toilet. The tongue serves as "brush and comb and sponge in one." Many marsupials, such as opossums and kangaroos, when distressed by the heat, lick the whole of the forelimbs and some other parts of the body. This is " a means of providing an evaporating surface, in the absence of sweat glands." There is some toilet-licking as well in marsupials, and it occurs in many other mammals besides the cats. It is through licking the skin, their own or another's, at the time of coat-shedding that cattle and some other cud-chewers get " hair-balls " in their stomachs—curious accumulations, sometimes half-calcified.

Nearly a hundred years ago Cuvier pointed out that the six lower front teeth of the lemur, one of the half-monkeys, form a comb and are used as such. Wood Jones describes a remarkable tooth brush below the front of the lemur's tongue ; it is rapidly moved backwards and forwards, and its little horny processes remove the *débris* from the hair-combing teeth. This is what may be called a very neat adaptation. It is probable that other more or less comb-like teeth, as in some small bats and the parachuting Colugo of Borneo, are toilet instruments. But this must be proved by precise observation.

When the free-tailed bat wakes up from a sleep, hanging head downwards with its feet round a support, it sometimes behaves in a very pretty way. Keeping hold with one foot, it uses the other as a brush, dressing the fur of the head and the body. The brush proper is found on the first and fifth toe and consists of a row of stiff bristles ending like crochet-needles. Each little brush " functions somewhat after the fashion of a rake, and after it has been passed through the soft fur, it leaves its furrowed imprint clearly defined." This toilet brush has been observed in a Jamaican and in an Australian species, and there are doubtless other instances. The Jamaican species makes use of the teeth or the tongue to clean the brush after the toilet is finished, just as the lemur uses its rough " sublingua " for cleaning its combing teeth.

Our little finger, now called by the polite name of Minimus, was for centuries called Auricularis, inasmuch as it was used—and, as they said, was intended to be used—for cleaning out wax from the auricle or ear. There are more specialised toilet instruments in a variety of mammals. Thus the lemur, called Mongos, has a single claw, borne by the second digit of the foot, the other digits having nails ; and the great Cuvier said : " We have never seen the creature use this claw for any other purpose but to insert it into its ear." Professor Wood Jones points out that the greatly elongated claw of the second digit on the foot of the spiny ant-eater is a toilet instrument for scratching down to the roots of the strong spines. Similar cleaning claws occur on two toes of the spectral tarsier, and on two concrescent toes of the marsupial known as the native bear.

But, keeping to mammals, we have said enough to illustrate the variety of ways in which animals may keep themselves clean, and cleanliness is a condition of health, sometimes even of survival.

CHAPTER XXXIX

DO ANIMALS ANTICIPATE MAN ?

MUCH good-humoured fancifulness has marked the discussion of " animal anticipations of human inventions." It is not realised, for instance, that while animals show and do many wonderful things that suggest some of the achievements of which man is so proud, the result is usually attained in an entirely different way. Electric eels give a shock, but they are certainly not " electricians," as has been said ; and their electric discharge comes out of *wet* tissue. The fact is that the electric eels and the torpedo merely exhibit in exaggerated form the electrical activity evoked whenever a muscle contracts in any animal or man.

The firefly gives forth light more perfect than any that man has yet devised, for it is *cold* light without any admixture of heat rays. Thus the light of a luminescent animal is the most economical light in the world, since none of the chemical energy is wasted in making heat. Yet we cannot praise the firefly as in this respect excelling man, for it has not produced the light by attending its mind thereunto. The light is a result of a rapid fermentation, and though it serves as a sex signal in fireflies, it is often of no use at all. This is plain in the case of the luminescent bacteria that make dead fish shine at night.

One enthusiast has said that the silkworm's spinning of a silken cocoon suggested to man the possibility of making silken raiment. But there were fabrics of stronger material long before there was silk cloth, and we doubt if the sight of the silken cocoon gave man any impetus beyond suggesting that here was a very attractive material if it could only be utilised. We may praise the silkworm for its dexterity in making the silken quilt within which it undergoes its great change or metamorphosis into a moth; but we need not particularly praise it for making the silk itself, for that is the automatic secretion of glands that open on the lower lip, and is neither more nor less wonderful than the production of the saliva out of which the sea-swift builds the edible bird's-nest on the cave-cliffs of the Far East.

A not uncommon summer sight in the country is the industry of wasps in collecting wood-pulp for their papery nests. From the bare bole of a tree that has lost its bark, or from the surface of a convenient paling or gatepost, they plane off wood shavings with their mandibles. The raw material is then chewed into pulp, and this is pressed out of the mouth and manipulated in a very dexterous way to make the storeys and multiple roofs of the "bike." This is much more striking than making silk, which merely implies secreting glandular material; and it is possible that there is truth in the historical statement that man in his first paper-making deliberately followed the behaviour of the wasp. But the suggestion of using vegetable material for paper-making may have come from the early employment of sheets of the pith of the Egyptian papyrus plant. Of very ancient origin, also, was a Chinese animal-paper made from *silk* waste, which long preceded the skin-papers that we call parchment and vellum.

The single-seeded nutlet fruits of dandelions and thistles are borne far and wide by the wind, so that dissemination is secured. The superficial increase of the light material of the "down" gives a surface which the breeze catches like a sail, and the frictional resistance delays the downward pull of gravity. But no one feels constrained to credit the thistle with anticipating man's parachute or his ballooning.

A very effective adaptation has been automatically worked out in the plant, and it occurs in many degrees of excellence which indicate different grades in evolution. When we pass, however, to the little spiders which are carried by their gossamer threads on the wings of the wind we have to deal with a more complex situation. Most spiders are in the habit of paying out drag-lines of silk, and these have been utilised in various ways, as in making snares and bridges, and in saving the creature from falling into destruction. It is very interesting to find evidence of a certain degree of awareness on the gossamer spider's part, for it stands with its head to the wind in paying out its threads, it usually turns upside down as it vaults off, and it seems to be able to lengthen the ballooning threads if the breeze begins to die away, and to coil in some of the filament if the wind rises. Therefore, while we believe that the gossamer flight was not an invention or device, but rather a special utilisation of a common habit of emitting threads of silk, we feel bound to recognise some mental plasticity in the using of these in an effective way. And what shall we say of the water-spider's invention of a sub-aquatic silken nest filled with dry air—an anticipation of the diving-bell in a sense, and yet so utterly different ?

(*a*) There are many structures in the bodies of animals that are suggestive of things that man makes. The heart is a force-pump ; the midriff and the walls of the chest may suggest bellows ; the silk glands of spiders are like syringes, and the spinnerets through which the multiple jets of liquid silk are forced resemble the rose of a watering can. But these well-adapted structures are the outcome of age-long processes of varying, testing and sifting. Except in so far as their possessors put them to the proof, the animals are not their *inventors*.

(*b*) But animals also make things outside themselves, and here the approximation to man is closer. The trapdoor spider makes a neat silken hinge for the door of its burrow; some caddis-worms make effective nets in which they catch small water animals; the sacred beetles make balls of provender which they roll along the ground; the ant-lion larva makes a pitfall in the sand; the termites rear a huge edifice; the beaver builds a dam; the ape may use a stick. But it is only in a few cases that we are historically justified in saying that man has found in the animal kingdom a hint for his own inventiveness. We firmly believe, however, that he might do so, with great advantage to himself, if he had sufficient imagination and humility.

(*c*) Yet, unless we are to misunderstand the whole situation, we must keep clearly in mind that man is pre-eminently the tool-user, whereas animals show only a few hints of this. Their particular line of inventive evolution is to use many parts of their body as tools, just as man does in the case of his hand almost exclusively.

CHAPTER XL

CONCLUSIONS

1. By "mind in animals" we mean whatever in them corresponds in any degree to our own inner life of thinking,

feeling and purposing ; but we must be prepared to find a powerful stream in ourselves represented by a very slender rill in many an animal.

2. The inner or psychical life cannot be reduced to a lower common denominator of nervous impulses and the like. The psychological cannot be expressed in terms of the physiological. Mental activity cannot be explained in terms of matter and energy. To mention only one reason, we require mental activity to explain matter and energy.

3. No thinker has attained to clearness in regard to what is called, badly perhaps, the relation of " body " and " mind." We say " badly perhaps," because that way of putting the question commits one to the theory that " body " and " mind " can be thought of as separate realities or entities. Perhaps they *are* separable, as many believe, but this should not be assumed at the beginning of the inquiry. Many thinkers believe that the mind uses the body as its instrument, as a musician his violin. To others it seems that *mental* and bodily, *psychical* and physical, *subjective* and objective, are two aspects of one activity which we call Life, just like the *concave*, *or inner*, and the convex, or outer, surfaces of a dome. And there are other theories. But, in any case, the certainty is that *there are two sides* of the behaviour of man and of higher animals, and that neither can be ignored. Sometimes the physiological or bodily side is more prominent, and we say " psycho-*biosis*," or mind-BODY. At another time the psychological or mental side is more dominant, and we say " bio-*psychosis*, or body-MIND."

4. Animals seldom show more cleverness than is demanded of them by the conditions of their life, and if frequently recurring difficulties can be adequately met by some inborn predisposition of the body, as when elvers swim straight upstream, or by some ready-made or instinctive

equipment that does not need any individual apprenticeship or learning, there is not likely to be much evidence of intelligence on these occasions.

5. In many cases it seems likely that the psychological side of the animal's life does not count for very much in the ordinary behaviour. That is to say, what the creature does may be sufficiently accounted for by what has been racially enregistered in its mind-BODY, or, as some would prefer to say, in its BODY. As Spinoza warned us, we should beware of being dogmatic in regard to what the body, as body, may not be able to do. In such cases we must try to avoid two extremes. We must not think of a minute Mind, which might be called a " menticule," sitting in the organism out of employment, like an artist without a commission, because the body is sufficient unto itself. We must rather think of the creature as running according to an engrained bodily rule—running so automatically that the mental side of its behaviour is not in any high degree activated.

Along with the finely-integrated nervous system of higher animals there is a corresponding integration of the inner life, helped by memory and by perceived purpose ; and the result is an adumbration of what in ourselves we call " self," or personality. In the lower reaches of the Animal Kingdom there is probably no such psychical integration, no unified and unifying mind, but only the ever-flowing, though often slender, psychic rill that we may think of as accompanying all life. To ignore this altogether would be the extreme of reducing the animal to an automatic machine. This is to say dogmatically that mind does not count. It should be noted that while the mental aspect may not be needed to guide behaviour—for instance, by forming images and making inferences—it may nevertheless be an indispensable factor in the unifying of the life. It may be the *esprit de corps*. Moreover, feeling is a mental activity as truly as inference is.

6. In describing animal behaviour we must not be too generous, reading the man into the beast, and making every creature a Brer Rabbit. On the other hand, we must not be too stingy, trying to make out that the animal is no more than an automatic machine, or never more than a big bundle of reflex actions. We must follow what is sometimes called the " Lloyd Morgan principle "—that in describing any particular case we must not assume higher mental qualities than are necessary for a satisfactory description. In so doing we may do the animal an injustice, for we know that in our own case the simplest explanation or description is not always the true one. But it is better to err on the side of scientific parsimony than on the side of credulous generosity. Yet, again, because we can describe, without using psychological terms, a particular action like drawing our finger back from a hot coal, or like the earthworm jerking itself into its burrow on the approach of a thrush, it would be unwarrantable to conclude from this that the animal as a whole has no mind. A particular piece of behaviour may be apsychic, and yet the mental aspect of feeling, of desire, of memory, of imaging, may count for much in the life of the creature as a whole.

7. Another caution has to do with cases where an animal goes through an instinctive routine in a wooden sort of way, and in circumstances which make the performance futile, or when it fails to adjust itself to a slight change in the circumstances, as when the procession caterpillars go round and round in a circle, or when a pigeon fails to retrieve its eggs which have been removed from the nest to a distance of two inches. On seeing such exhibitions we must not

think of the animal as "unutterably stupid"; we must remember that the piece of behaviour in question has been relegated, so to speak, into the field of the instinctive, and cannot suddenly be brought into the focus of intelligence.

8. Instinctive behaviour, as in ants and bees, goes like clockwork, and in many cases it is only occasionally that it passes, say in a crisis, into original and intelligent behaviour. But we are not bound to suppose that the racial establishment of this instinct was effected entirely without intelligence. Let us suppose that an animal finds itself endowed with a new impulse, perhaps the outcome of a germinal variation in that part of the inheritance which concerns the nervous system; it may proceed to test this novelty in an intelligent or experimental way. If it is a fatal new departure, that will be the end of it; if it is a very advantageous new departure, it may come to stay. It will then be added to the racial treasure-house. Even if the novelty is not in itself big enough to be of "survival-value" in the struggle for existence, it is perhaps linked to some other character that is of vital importance, and may be thus carried in the wake of the well-established character until it is conspicuous enough to be itself sifted by natural selection.

There is no possibility, so far as we can see, of going back to the old theory that instincts result from "lapsed intelligence," or, to put it in another way, that instinctive behaviour was in previous generations intelligently controlled behaviour. The facts do not point in that direction. One must remember, for instance, that some pieces of instinctive behaviour are manifested *only once* in a lifetime, and no one can make even an individual habit of what is done only once. Moreover, there is great difficulty in substantiating, even in a single instance, the theory that an individual habituation can be entailed on subsequent generations. But it is quite legitimate to emphasise the importance of the individual organism's intelligent testing of variations in its inheritance. The creature may play the new cards in its hereditary hand, and it may play them well or ill!

9. If Reason be taken to mean, as is generally allowed, working or experimenting with general ideas or concepts, and if rational behaviour means behaviour which has *conceptual* inference as its mental correlate, then, so far as we know, animals have not Reason. This is Man's prerogative, occasionally used. The behaviour of animals sometimes gives evidence of *reasoning*, but at an intelligent, not at a rational level. That is to say, the mental correlate is *perceptual* inference, putting two and two together, making a judgment, to some extent understanding the situation. If someone says: "I call this reason," all that can be replied is that the scientific usage of the terms should be observed. It is not for amateurs to re-edit the scientific dictionary.

10. Evidence of intelligence is clear in the behaviour of apes and monkeys, cats and dogs, horses and elephants, rooks and parrots, and so on. But one must not take every case at its face value. Training by man often results in an appearance of intelligence which is not there. A clever device may be the outcome of random trying and of eliminating useless movements without even picture logic. An animal, just like a man, may take intelligent advantage of what is fortuitously discovered, as is probably the case when the Greek eagle lets the Greek tortoise fall from a height so that the carapace is broken. In certain ways the highest intelligence among animals is exhibited by those that become man's responsible partners, like shepherd dogs, horses and elephants; but allowance has to be made

for direct training. It must be granted that there may be profiting by experience below the level of intelligence, thus headless earthworms and naturally ganglionless starfishes can *learn*.

11. A large part of animal behaviour is *instinctive*, the outcome of an inborn, ready-made power of doing apparently clever things. It does not require to be learned, though it may be perfected by practice ; it is shared almost equally by all members of the species of the same sex ; it has reference to particular conditions of vital importance or of frequent recurrence. Physiologically regarded, instinctive behaviour is like a chain of reflexes, but in some cases at least it seems necessary to suppose that it is suffused with an awareness that rises above mere sensitiveness to stimuli, and backed by an endeavour that is more than generalised vital impulse. Instinct is seen at its highest and purest in ants and bees ; it is subtly mingled with intelligence in birds ; it wanes before intelligence in the higher mammals.

12. It is a common error to say that man shows intelligence, while animals show instinct. Man shows some instinctive behaviour, as well as much intelligent behaviour, and an occasional flavour of rational conduct ; animals often show both instinctive and intelligent behaviour, but some show little more than reflex actions. Man has few clear-cut instincts ; the term is often applied loosely to inborn predispositions and urges, or to the general promptings of the Primary Unconscious.

13. It is a mistake to regard instinct as a low form of intelligence or as the outcome of automatised intelligence. It is tempting to say that, just as intelligently controlled activities may become in the individual lifetime habituated or automatised, so instincts may have arisen in the history

of a race of animals. But we do not know that an individual habituation can be entailed on the offspring, and some pieces of instinctive behaviour occur only once in the life-history. Instinctive behaviour and intelligent behaviour are on different lines of evolution.

14. There seem to have been two main trends of advance in the evolution of animal behaviour. On the one hand, there is the evolution of the power of fresh adjustment, of making little experiments or tentatives. This is the line of individual initiative and it has its climax in sheer intelligence. On the other hand, there is the evolution of the capacity for enregistering profitable modes of behaviour, so that they become parts of the inheritance, requiring no more than a liberating stimulus for their activation. In both cases there is inherited capacity, but among " big-brained " types, the inheritance is mainly the free, nimble, educable, intelligent body-MIND and mind-BODY, while among " little-brained " types the inheritance is mainly a stereotyped series of reactions, never perhaps without their body-MIND aspect.

15. Along the line which we may call the power of initiative and experiment, there is not only intelligent behaviour (rising to rational conduct in man), there is the tentative plasticity of some humble animals like starfishes, where the absence of any definite nerve centres forbids the use of any term like intelligence.

16. Along the line which we may call the capacity for enregistration there is not only instinctive behaviour (at diverse levels), there are obligatory movements or tropisms, as when the elvers swim persistently upstream ; there are engrained rhythms, as when the Convoluta worms come to the surface of the sand when the tide goes out, and retreat again at the first splash of the flowing wave ; there are reflex

actions, simple and complex, as when the earthworm jerks back into its burrow, or the nestling opens its mouth and swallows if its beak is touched by the food which the unseen parent brings.

17. These two lines of animal behaviour have their respective advantages and disadvantages. Thus what is enregistered is ready-made, and it is usually quick and sure. Yet it is non-plastic and often wooden. The power of initiative is plastic, it can face change, it offers alternatives, it opens the door to choice. Yet it requires apprenticeship.

18. The two lines intersect when an animal at a juncture tries its repertory of enregistered reactions until perhaps it gets an effective answer. A trial and error method is very common at diverse levels, and it may be either a trying of engrained capacities, or a making of novel tentatives. If only one pre-established answer-back be given and that is effective, the enregistration type of behaviour is illustrated ; if the answer-back is novel, the initiative type of behaviour is illustrated ; if there is a trying of one engrained reaction after another, the two lines intersect.

19. If we picture an ostrich feather held in the left hand, sloping gently upwards, with the convex surface up and the concave surface down, and with one set of barbs directed upwards and the other set directed downwards, then we have a useful diagram of the diversity of animal behaviour. The upturned barbs may represent the various modes of initiative, tentative, experimental behaviour culminating in the high intelligence of horse and dog. The downturned barbs may represent the various modes of enregistered, engrained, reflex behaviour, culminating in the marvellous instincts of ants and bees. The convex outer surface of the whole and of each part may typify the bodily, the nervous, the physiological, the objective. The concave

inner surface of the whole and of each part may typify the mental, the psychical, the psychological, the subjective.

20. It must be kept clearly in view that the mental aspect in animal life is not restricted to control of activities and the like, it may manifest itself in feelings, in concrete purposes, in music and artistry.

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