VII
THE DAWN OF MIND

IN the story of evolution there is no chapter more interesting than the emergence of mind in the animal kingdom. But it is a difficult chapter to read, partly because "mind" cannot be seen or measured, only *inferred* from the outward behaviour of the creature, and partly because it is almost impossible to avoid reading ourselves into the much simpler animals.

Two Extremes to be avoided.

The one extreme is that of uncritical generosity which credits every animal, like Brer Rabbit—who, by the way, was the hare—with human qualities. The other extreme is that of thinking of the animal as if it were an automatic machine, in the working of which there is no place or use for mind. Both these extremes are to be avoided.

When Professor Whitman took the eggs of the Passenger Pigeon (which became extinct not long ago with startling rapidity) and placed them a few inches to one side of the nest, the bird looked a little uneasy and put her beak under her body as if to feel for something that was not there. But she did not try to retrieve her eggs, close at hand as they were. In a short time she flew away altogether. This shows that the mind of the pigeon is in some respects very different from the mind of man. On the other hand, when a certain clever dog, carrying a basket of eggs, with the handle in his mouth, came to a stile which had to be negotiated, he laid the basket on the ground, pushed it gently through a low gap to the other side, and then took a running leap over. We dare not talk of this dog as an automatic machine.

Photo: O. J. Wilkinson.

JACKDAW BALANCING ON A GATEPOST.

The jackdaw is a big-brained, extremely alert, very educable, loquacious bird.

A Caution in regard to Instinct.

In studying the behaviour of animals, which is the only way of getting at their mind, for it is only of our own mind that we have direct knowledge, it is essential to give prominence to the fact that there has been throughout the evolution of living creatures a strong tendency to enregister or engrain capacities of doing things effectively. Thus certain abilities come to be inborn; they are parts of the inheritance, which will express themselves

whenever the appropriate trigger is pulled. The newly born child does not require to learn its breathing movements, as it afterwards requires to learn its walking movements. The ability to go through the breathing movements is inborn, engrained, enregistered.

In other words, there are hereditary pre-arrangements of nerve-cells and muscle-cells which come into activity almost as easily as the beating of the heart. In a minute or two the new-born pigling creeps close to its mother and sucks milk. It has not to learn how to do this any more than we have to learn to cough or sneeze. Thus animals have many useful ready-made, or almost ready-made, capacities of doing apparently clever things. In simple cases of these inborn pre-arrangements we speak of reflex actions; in more complicated cases, of instinctive behaviour. Now the caution is this, that while these inborn capacities usually work well in natural conditions, they sometimes work badly when the ordinary routine is disturbed. We see this when a pigeon continues sitting for many days on an empty nest, or when it fails to retrieve its eggs only two inches away. But it would be a mistake to call the pigeon, because of this, an unutterably stupid bird. We have only to think of the achievements of homing pigeons to know that this cannot be true. We must not judge animals in regard to those kinds of behaviour which have been handed over to instinct, and go badly agee when the normal routine is disturbed. In ninety-nine cases out of a hundred the enregistered instinctive capacities work well, and the advantage of their becoming stereotyped was to leave the animal more free for adventures at a higher level. Being "a slave of instinct" may give the animal a security that enables it to discover some new home or new food or new joy. Somewhat in the same way, a man of methodical habits, which he has himself established, may gain leisure to make some new departure of racial profit.

From Ingersoll's "The Wit of the Wild."

TWO OPOSSUMS FEIGNING DEATH.

The Opossums are mainly arboreal marsupials, insectivorous and carnivorous, confined to the American Continent from the United States to Patagonia. Many have no pouch and carry their numerous young ones on their back, the tail of the young twined round that of the mother. The opossums are agile, clever creatures, and famous for "playing 'possum," lying inert just as if they were dead.

When we draw back our finger from something very hot, or shut our eye to avoid a blow from a rebounding branch, we do not will the action; and this is more or less the case, probably, when a young mammal sucks its mother for the first time. Some Mound-birds of Celebes lay their eggs in warm volcanic ash by the shore of the sea, others in a great mass of fermenting vegetation; it is inborn in the newly hatched bird to struggle out as quickly as it can from such a strange nest, else it will suffocate. If it stops struggling too soon, it perishes, for it seems that

the trigger of the instinct cannot be pulled twice. Similarly, when the eggs of the turtle, that have been laid in the sand of the shore, hatch out, the young ones make *instinctively* for the sea. Some of the crocodiles bury their eggs two feet or so below the surface among sand and decaying vegetation—an awkward situation for a birthplace. When the young crocodile is ready to break out of the egg-shell, just as a chick does at the end of the three weeks of brooding, it utters *instinctively* a piping cry. On hearing this, the watchful mother digs away the heavy blankets, otherwise the young crocodile would be buried alive at birth. Now there is no warrant for believing that the young Mound-birds, young crocodiles, and young turtles have an intelligent appreciation of what they do when they are hatched. They act instinctively, "as to the manner born." But this is not to say that their activity is not backed by endeavour or even suffused with a certain amount of awareness. Of course, it is necessarily difficult for man, who is so much a creature of intelligence, to get even an inkling of the mental side of instinctive behaviour.

In many of the higher reaches of animal instinct, as in courtship or nest-building, in hunting or preparing the food, it looks as if the starting of the routine activity also "rang up" the higher centres of the brain and put the intelligence on the *qui vive*, ready to interpose when needed. So the twofold caution is this: (1) We must not depreciate the creature too much if, in unusual circumstances, it acts in an ineffective way along lines of behaviour which are normally handed over to instinct; and (2) we must leave open the possibility that even routine instinctive behaviour may be suffused with awareness and backed by endeavour.

§ 2

A Useful Law.

But how are we to know when to credit the animal with intelligence and when with something less spontaneous? Above all, how are we to know when the effective action, like opening the mouth the very instant it is touched by food in the mother's beak, is just a physiological action like coughing or sneezing, and when there is behind it—a mind at work? The answer to this question is no doubt that given by Prof. Lloyd Morgan, who may be called the founder of comparative psychology, that we must describe the piece of behaviour very carefully, just as it occurred, without reading anything into it, and that we must not ascribe it to a higher faculty if it can be satisfactorily accounted for in terms of a lower one. In following this principle we may be sometimes niggardly, for the behaviour may have a mental subtlety that we have missed; but in nine cases out of ten our conclusions are likely to be sound. It is the critical, scientific way.

Bearing this law in mind, let us take a survey of the emergence of mind among backboned animals.

Senses of Fishes.

Fishes cannot shut their eyes, having no true lids; but the eyes themselves are very well developed and the vision is acute, especially for moving objects. Except in gristly fishes, the external opening to the ear has been lost, so that sound-waves and coarser vibrations must influence the inner ear, which is well developed, through the surrounding flesh and bones. It seems that the main use of the ear in fishes is in connection with balancing, not with hearing. In many cases, however, the sense of hearing has been demonstrated; thus fishes will come to the side of a pond to be fed when a bell is rung or when a whistle is blown by someone not visible from the water. The fact that many fishes pay no attention at all to loud noises does not prove that they are deaf, for an animal may hear a sound and yet remain quite indifferent or irresponsive. This merely means that the sound has no vital interest for the animal. Some fishes, such as bullhead and dogfish, have a true sense of smell, detecting by their nostrils very dilute substances permeating the water from a distance. Others, such as members of the cod family, perceive their food in part at least by the sense of taste, which is susceptible to substances near at hand and present in considerable quantity. This sense of taste may be located on the fins as well as about the mouth. At this low level the senses of smell and taste do not seem to be very readily separated. The chief use of the sensitive line or lateral line seen on each side of a bony fish is to make the animal aware of slow vibrations

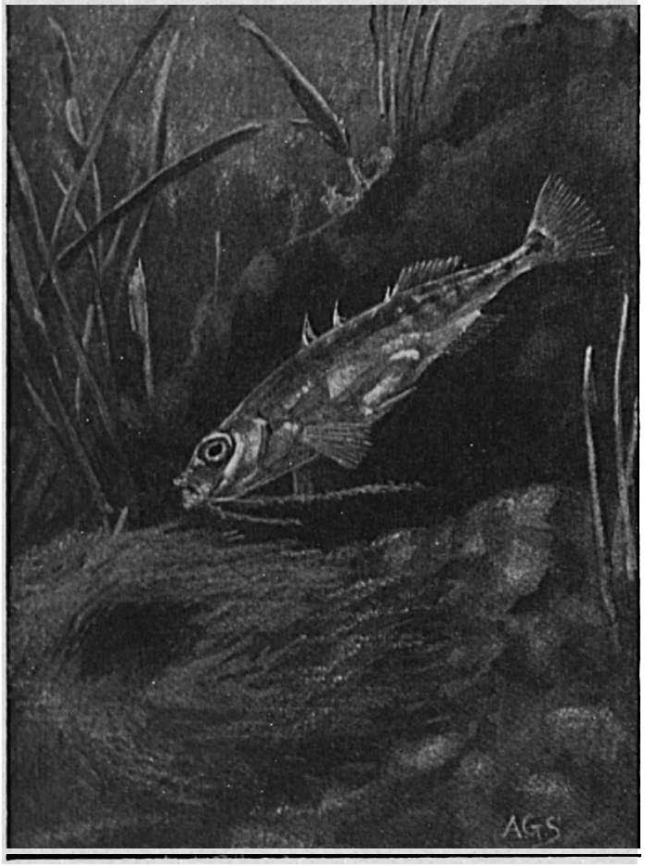
and changes of pressure in the water. The skin responds to pressures, the ear to vibrations of high frequency; the lateral line is between the two in its function.

The brain of the ordinary bony fish is at a very low level. Thus the cerebral hemispheres, destined to become more and more the seat of intelligence, are poorly developed. In gristly fishes, like skates and sharks, the brain is much more promising. But although the state of the brain does not lead one to expect very much from a bony fish like trout or eel, haddock or herring, illustrations are not wanting of what might be called pretty pieces of behaviour. Let us select a few cases.

Interesting Ways of Fishes.

The three-spined and two-spined sticklebacks live equally well in fresh or salt water; the larger fifteen-spined stickleback is entirely marine. In all three species the male fish makes a nest, in fresh or brackish water in the first two cases, in shore-pools in the third case. The little species use the leaves and stems of water-plants; the larger species use seaweed and zoophyte. The leaves or fronds are entangled together and fastened by glue-like threads, secreted, strange to say, by the kidneys. It is just as if a temporary diseased condition had been regularised and turned to good purpose. Going through the nest several times, the male makes a little room in the middle. Partly by coercion and partly by coaxing he induces a female—first one and then another—to pass through the nest with two doors, depositing eggs during her short sojourn. The females go their way, and the male mounts guard over the nest. He drives off intruding fishes much bigger than himself. When the young are hatched, the male has for a time much to do, keeping his charges within bounds until they are able to move about with agility. It seems that sticklebacks are short-lived fishes, probably breeding only once; and it is reasonable to suppose that their success as a race depends to some extent on the paternal care. Now if we could believe that the nesting behaviour had appeared suddenly in its present form, we should be inclined to credit the fish with considerable mental ability. But we are less likely to be so generous if we reflect that the routine has been in all likelihood the outcome of a long racial process of slight improvements and critical testings. The secretion of the glue probably came about as a pathological variation; its utilisation was perhaps discovered by accident; the types that had wit enough to take advantage of this were most successful; the routine became enregistered hereditarily. The stickleback is not so clever as it looks.

The Stickleback's Nest.



MALE OF THREE-SPINED STICKLEBACK, MAKING A NEST OF WATER-WEED, GLUED TOGETHER BY VISCID THREADS SECRETED FROM THE KIDNEYS AT THE BREEDING SEASON.

To find solid ground on which to base an appreciation of the behaviour of fishes, it is necessary to experiment, and we may refer to Miss Gertrude White's interesting work on American min-

The Mind of a Minnow.

nows and sticklebacks. After the fishes had become quite at home in their artificial surroundings, their lessons began. Cloth packets, one of which contained meat and the other cotton, were suspended at opposite ends of the aquarium. The mud-minnows did not show that they perceived either packet, though they swam close by them; the sticklebacks were intrigued at once. Those that went towards the packet containing meat darted furiously upon it and pulled at it with great excitement. Those that went towards the cotton packet turned sharply away when they were within about two inches off. They then perceived what those at the other end were after and joined them — a common habit amongst fishes. Although the minnows were not interested in the tiny "bags of mystery," they were even more alert than the sticklebacks in perceiving moving objects in or on the water, and there is no doubt that both these shallow-water species discover their food largely by sense of sight.

A FEMALE STICKLEBACK ENTERS THE NEST WHICH THE MALE HAS MADE, LAYS THE EGGS INSIDE, AND THEN DEPARTS.

In many cases two or three females use the same nest, the stickleback being polygamous. Above the nest the male, who mounts guard, is seen driving away an intruder.

The next set of lessons had to do with colour-associations. The fishes were fed on minced snail, chopped earthworm, fragments of liver, and the like, and the food was given to them from the end of forceps held above the surface of the water, so that the fishes could not be influenced by smell. They had to leap out of the water to take the food from the forceps. Discs of coloured cardboard were slipped over the end of the forceps, so that what the fishes saw was a morsel of food in the centre of a coloured disc. After a week or so of preliminary training, they were so well accustomed to the coloured discs that the presentation of one served as a signal for the fishes to dart to the surface and spring out of the water. When baits of paper were substituted for the food, the fishes continued to jump at the discs. When, however, a blue disc was persistently used for the paper bait and a red disc for the real food, or *vice versa*, some of the minnows learned to discriminate infallibly between shadow and substance, both when these were presented alternately and when they were presented simultaneously. This is not far from the dawn of mind.

In the course of a few lessons, both minnows and sticklebacks learned to associate particular colours with food, and other associations were also formed. A kind of larva that a minnow could make nothing of after repeated trials was subsequently ignored. The approach of the experimenter or anyone else soon began to serve as a food-signal. There can be no doubt that in the ordinary life of fishes there is a process of forming useful associations and suppressing useless responses. Given an inborn repertory of profitable movements that require no training, given the power of forming associations such as those we have illustrated, and given a consider-

able degree of sensory alertness along certain lines, fishes do not require much more. And in truth they have not got it. Moving with great freedom in three dimensions in a medium that supports them and is very uniform and constant, able in most cases to get plenty of food without fatiguing exertions and to dispense with it for considerable periods if it is scarce, multiplying usually in great abundance so that the huge infantile mortality hardly counts, rarely dying a natural death but usually coming with their strength unabated to a violent end, fishes hold their own in the struggle for existence without much in the way of mental endowment. Their brain has more to do with motion than with mentality, and they have remained at a low psychical level.

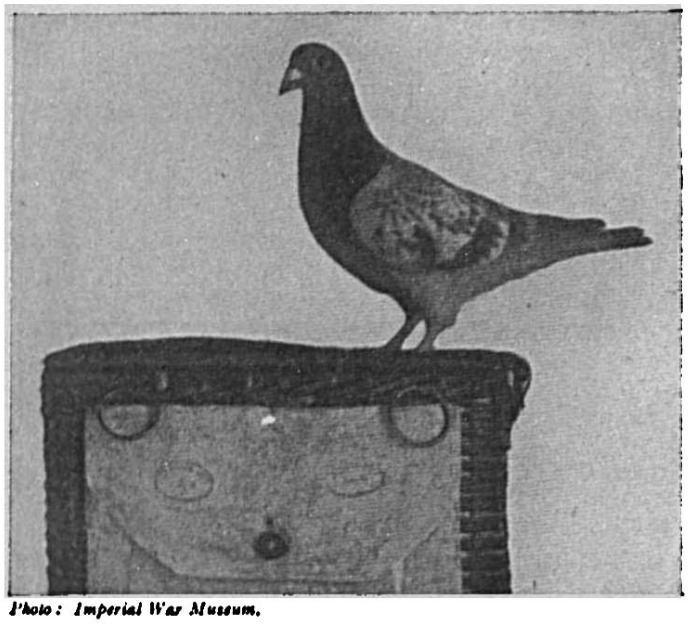


Photo: Imperial War Museum.

HOMING PIGEON.

A blue chequer hen, which during the War (in September of 1918) flew 22 miles in as many minutes, saving the crew of an aeroplane in difficulties.

Yet just as we should greatly misjudge our own race if we confined our attention to everyday routine, so in our total, as distinguished from our average, estimate of fishes, we must remember the salmon surmounting the falls, the wary trout eluding the angler's skill, the common mud-skipper (Periophthalmus) of many tropical shores which climbs on the rocks and the roots of the mangrove-trees, or actively hunts small shore-animals. We must remember the adventurous life-history of the eel and the quaint ways in which some fishes, males especially, look after their family. The male sea-horse puts the eggs in his breast-pocket; the male Kurtus carries them on the top of his head; the cock-paidle or lumpsucker guards them and aerates them in a corner of a shore-pool.

§ 3

The Mind of Amphibians.

Towards the end of the age of the Old Red Sandstone or Devonian, a great step in evolution was taken—the emergence of Amphibians. The earliest representatives had fish-like characters even more marked than those which may be discerned in the tadpoles of our frogs and toads, and there is no doubt that amphibians sprang from a fish stock. But they made great strides, associated in part with their attempts to get out of the water on to dry land. From fossil forms we cannot say much in regard to soft parts; but if we consider the living representatives of the class, we may credit amphibians with such important acquisitions as fingers and toes, a three-chambered heart, true ventral lungs, a drum to the ear, a mobile tongue, and vocal cords. When animals began to be able to grasp an object and when they began to be able to utter sufficient sounds, two new doors were opened. Apart from insects, whose instrumental music had probably begun before the end of the Devonian age, amphibians were the first animals to have a voice. The primary meaning of this voice was doubtless, as it is to-day in our frogs, a sex-call; but it was the beginning of what was destined to play a very important part in the evolution of the mind. In the course of ages the significance of the voice broadened out; it became a parental call; it became an infant's cry. Broadening still, it became a very useful means of recognition among kindred, especially in the dark and in the intricacies of the forest. Ages passed, and the voice rose on another turn of the evolutionary

spiral to be expressive of particular emotions beyond the immediate circle of sex—emotions of joy and of fear, of jealousy and of contentment. Finally, we judge, the animal—perhaps the bird was first—began to give utterance to particular "words," indicative not merely of emotions, but of particular things with an emotional halo, such as "food," "enemy," "home." Long afterwards, words became *in man* the medium of reasoned discourse. Sentences were made and judgments expressed. But was not the beginning in the croaking of Amphibia?

Senses of Amphibians.

Frogs have good eyes, and the toad's eyes are "jewels." There is evidence of precise vision in the neat way in which a frog catches a fly, flicking out its tongue, which is fixed in front and loose behind. There is also experimental proof that a frog discriminates between red and blue, or between red and white, and an interesting point is that while our skin is sensitive to heat rays but not to light, the skin of the frog answers back to light rays as well. Professor Yerkes experimented with a frog which had to go through a simple labyrinth if it wished to reach a tank of water. At the first alternative between two paths, a red card was placed on the wrong side and a white one on the other. When the frog had learned to take the correct part, marked by the white card, Prof. Yerkes changed the cards. The confusion of the frog showed how thoroughly it had learned its lesson.

We know very little in regard to sense of smell or taste in amphibians; but the sense of hearing is well developed, more developed than might be inferred from the indifference that frogs show to almost all sounds except the croaking of their kindred and splashes in the water.

The toad looks almost sagacious when it is climbing up a bank, and some of the tree-frogs are very alert; but there is very little that we dare say about the amphibian mind. We have mentioned that frogs may learn the secret of a simple maze, and toads sometimes make for a particular spawning-pond from a considerable distance. But an examination of their brains, occupying a relatively small part of the broad, flat skull, warns us not to expect much intelligence. On the other hand, when we take frogs along a line that is very vital to them, namely, the discrimination of palatable and un-

Photo: Imperial War Museum.

CARRIER PIGEON.

Carrier pigeons were much used in the War to carry messages. The photograph shows how the message is fixed to the carrier pigeon's leg, in the form of light rings.

palatable insects, we find, by experiment, that they are quick to learn and that they remember their lessons for many days. Frogs sometimes deposit their eggs in very unsuitable pools of water; but perhaps that is not quite so stupid as it looks. The egg-laying is a matter that has been, as it were, handed over to instinctive registration.

Experiments in Parental Care.

It must be put to the credit of amphibians that they have made many experiments in methods of parental care, as if they were feeling their way to new devices. A common frog lays her clumps of eggs in the cradle of the water, sometimes far over a thousand together; the toad winds two long strings round and between water-weeds; and in both cases that is all. There is no parental care, and the prolific multiplication covers the enormous infantile mortality. This is the spawning solution of the problem of securing the continuance of the race. But there is another solution, that of parental care associated with an economical reduction of the number of eggs. Thus the male of the Nurse-Frog (Alytes), not uncommon on the Continent, fixes a string of twenty to fifty eggs to the upper part of his hind-legs, and retires to his hole, only coming out at night to get some food and to keep up the moisture about the eggs. In three weeks, when the tadpoles are ready to come out, he plunges into the pond and is freed from his living burden and his family cares. In the case of the thoroughly aquatic Surinam Toad (Pipa), the male helps to press the eggs, perhaps a hundred in number, on to the back of the female, where each sinks into a pocket of skin with a little lid. By and by fully formed young toads jump out of the pockets.

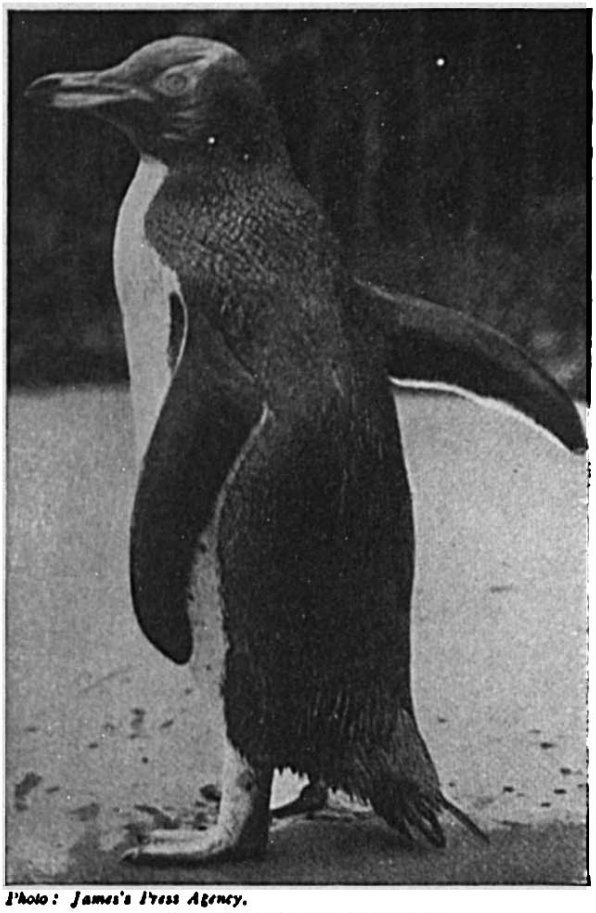


Photo: James's Press Agency.

YELLOW-CROWNED PENGUIN.

Notice the flightless wings turned into flippers, which are often flapped very vigorously. The very strong feet are also noteworthy. Penguins are mostly confined to the Far South.

In the South American tree-frogs called Nototrema there is a pouch on the back of the female in which the eggs develop, and it is interesting to find that in some species what come out are ordinary tadpoles, while in other species the young emerge as miniatures of their parents. Strangest of all, perhaps, is the case of Darwin's Frog (Rhinoderma of Chili), where the young, about ten to fifteen in number, develop in the male's croaking-sacs, which become in consequence enormously distended. Eventually the strange spectacle is seen of miniature frogs jumping out of their father's mouth. Needless to say, we are not citing these methods of parental care as examples of intelligence; but perhaps they correct the impression of amphibians as a rather humdrum race. Whatever be the mental aspect of the facts, there has certainly been some kind of experimenting, and the increase of parental care, so marked in many amphibians, with associated reduction of the number of offspring is a finger-post on the path of progress.

§ 4

We speak of the wisdom of the serpent; but it is not very easy to justify the phrase. Among

The Reptilian Mind.

all the multitude of reptiles—snakes, lizards, turtles, and crocodiles, a motley crowd—we cannot see much more than occasional traces of intelligence. The inner life remains a tiny rill.

No doubt many reptiles are very effective; but it is an instinctive rather than an intelligent efficiency. The well-known "soft-shell" tortoise of the United States swims with powerful strokes and runs so quickly that it can hardly be overtaken. It hunts vigorously for crayfish and insect larvæ in the rivers. It buries itself in the mud when cold weather comes. It may lie on a floating log, ready to slip into the water at a moment's notice; it may bask on a sunny bank or in the warm shallows. Great wariness is shown in choosing times and places for egg-laying. The mother tramps the earth down upon the buried eggs. All is effective. Similar statements might be made in regard to scores of other reptiles; but what we see is almost wholly of the nature of instinctive routine, and we get little glimpse of more than efficiency and endeavour.

In a few cases there is proof of reptiles finding their way back to their homes from a considerable distance, and recognition of persons is indubitable. Gilbert White remarks of his tortoise: "Whenever the good old lady came in sight who had waited on it for more than thirty years, it always hobbled with awkward alacrity towards its benefactress, while to strangers it was altogether inattentive." Of definite learning there are a few records. Thus Professor Yerkes studied a sluggish turtle of retiring disposition, taking advantage of its strong desire to efface itself. On the path of the darkened nest of damp grass he interposed a simple maze in the form of a partitioned box. After wandering about constantly for thirty-five minutes the turtle found its way through the maze by chance. Two hours afterwards it reached the nest in fifteen minutes; and after another interval of two hours it only required five minutes. After the third trial, the routes became more direct, there was less aimless wandering. The time of the twentieth trial was forty-five seconds; that of the thirtieth,

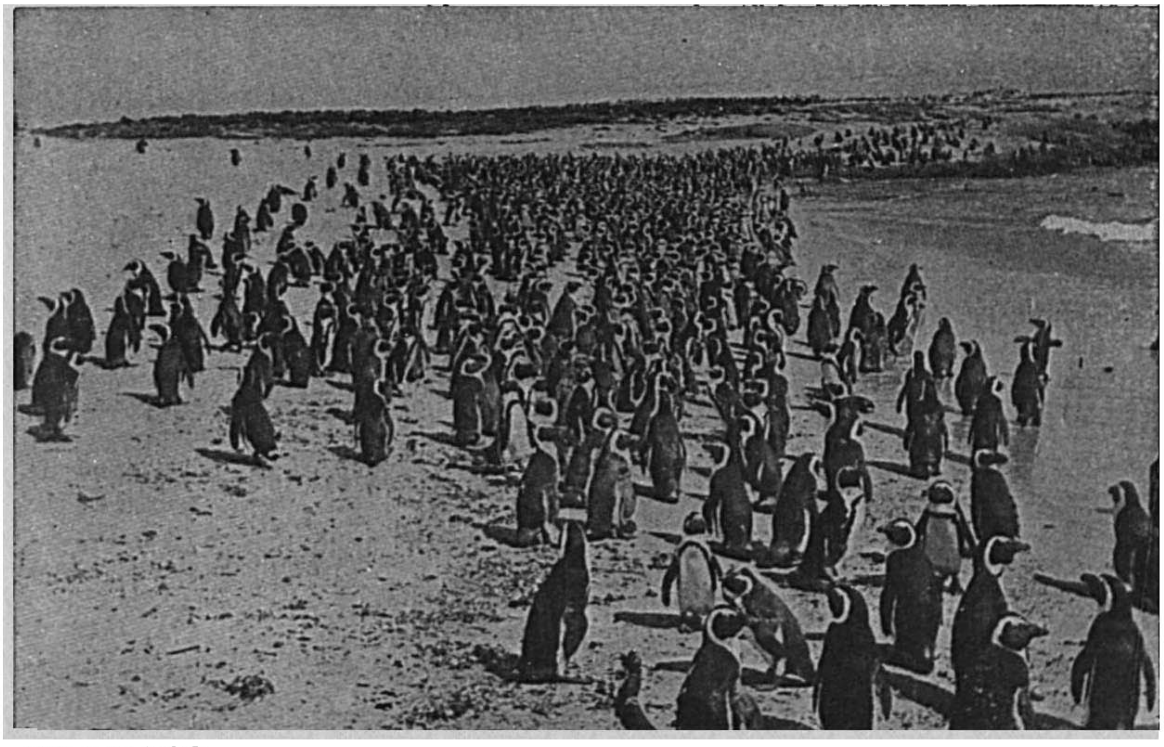


Photo: Cagcombe & Co.

PENGUINS ARE "A PECULIAR PEOPLE."

Their wings have been turned into flippers for swimming in the sea and tobogganing on snow. The penguins come back over hundreds of miles of trackless waste to their birthplace, where they breed. When they reach the Antarctic shore they walk with determination to a suitable site, often at the top of a steep cliff. Some species waddle 130 steps per minute, 6 inches per step, two-thirds of a mile per hour.

forty seconds. In the thirtieth case, the path followed was quite direct, and so it was on the fiftieth trip, which only required thirty-five seconds. Of course, the whole thing did not amount to very much; but there was a definite learning, *a learning from experience*, which has played an important part in the evolution of animal behaviour.

Comparing reptiles with amphibians, we may recognise an increased masterliness of behaviour and a hint of greater plasticity. The records of observers who have made pets of reptiles suggest that the life of feeling or emotion is growing stronger, and so do stories, if they can be accepted, which suggest the beginning of conjugal affection.

The error must be guarded against of interpreting in terms of intelligence what is merely the outcome of long-continued structural adaptation. When the limbless lizard called the Slow-worm is suddenly seized by the tail, it escapes by surrendering the appendage, which breaks across a preformed weak plane. But this is a reflex action, not a reflective one. It is comparable to our sudden withdrawal of our finger from a very hot cinder. The Egg-eating African snake Dasypeltis gets the egg of a bird into its gullet unbroken, and cuts the shell against downward-projecting sharp points of the vertebræ. None of the precious contents is lost and the broken "empties" are returned. It is admirable, indeed unsurpassable; but it is not intelligent.

§ 5

Mind in Birds.

Sight and hearing are highly developed in birds, and the senses, besides pulling the triggers of inborn efficiencies, supply the raw materials for intelligence. There is some truth, though not the whole truth, in the old philosophical dictum, that there is nothing in the intellect which was not previously in the senses. Many people have admired the certainty and alacrity with which gulls pick up a fragment of biscuit from the white wake of a steamer, and the incident is characteristic. In their power of rapidly altering the focus of the eye, birds are unsurpassed.

Photo: W. S. Berridge.

HARPY-EAGLE.

"Clean and dainty and proud as a Spanish Don."

It is an arboreal and cliff-loving bird, feeding chiefly on mammals, very fierce and strong. The under parts are mostly white, with a greyish zone on the chest. The upper parts are blackish-grey. The harpy occurs from Mexico to Paraguay and Bolivia.

To the sense of sight in birds, the sense of hearing comes a good second. A twig breaks under our feet, and out sounds the danger-call of the bird we were trying to watch. Many young birds, like partridges, respond when two or three hours old to the anxious warning note of the parents, and squat motionless on the ground, though other sounds, such as the excited clucking of a foster-mother hen, leave them indifferent. They do not know what they are doing when they squat; they are obeying the living hand of the past which is within them. Their behaviour is instinctive. But the present point is the discriminating quality of the sense of hearing;

Reproduced from "The Forces of Nature" (Messrs. Macmillan).

THE AURORA BOREALIS

The aurora borealis is one of the most beautiful spectacles in the sky. The colours and shape change every instant; sometimes a fan-like cluster of rays, at other times long golden draperies gliding one over the other. Blue, green, yellow, red, and white combine to give a glorious display of colour. The theory of its origin is still, in part, obscure, but there can be no doubt that the aurora is related to the magnetic phenomena of the earth and therefore is connected with the electrical influence of the sun.

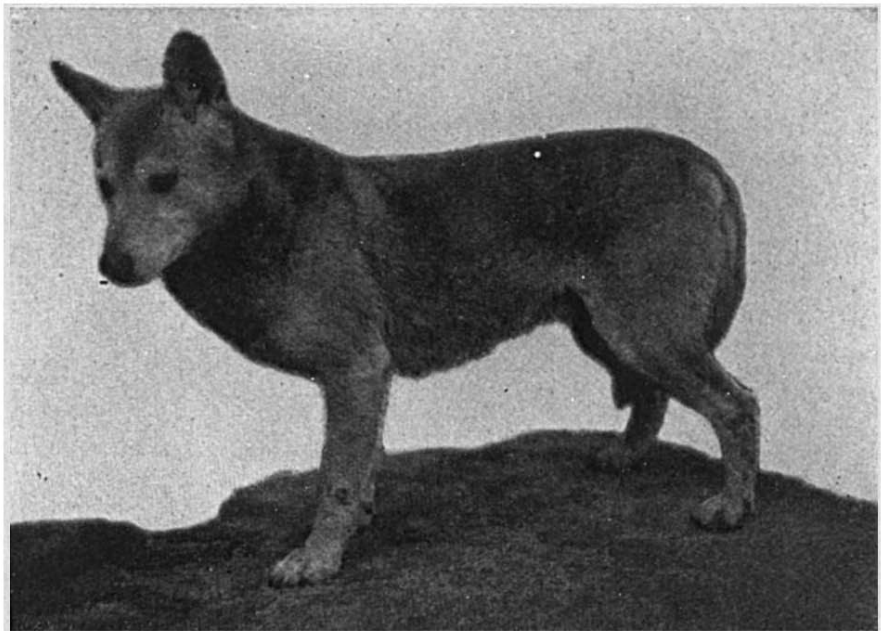


Photo: W. S. Berridge, F.Z.S.

THE DINGO OR WILD DOG OF AUSTRALIA, PERHAPS AN INDIGENOUS WILD SPECIES, PERHAPS A DOMESTICATED DOG THAT HAS GONE WILD OR FERAL.

It does much harm in destroying sheep. It is famous for its persistent "death-feigning," for an individual has been known to allow part of its skin to be removed, in the belief that it was dead, before betraying its vitality.

and that is corroborated by the singing of birds. It is emotional art, expressing feelings in the medium of sound. On the part of the females, who are supposed to listen, it betokens a cultivated ear.

As to the other senses, touch is not highly developed except about the bill, where it reaches a climax in birds like the woodcock, which probe for unseen earthworms in the soft soil. Taste seems to be poorly developed, for most birds bolt their food, but there is sometimes an emphatic rejection of unpalatable things, like toads and caterpillars. Of smell in birds little is known, but it has been proved to be present in certain cases, e.g. in some nocturnal birds of prey. It seems certain that it is by sight, not by smell, that the eagles gather to the carcass; but perhaps there is more smell in birds than they are usually credited with. One would like to experiment with the oil from the preen gland of birds to see whether the scent of this does not help in the recognition of kin by kin at night or amid the darkness of the forest. There may be other senses in birds, such as a sense of temperature and a sense of balance; but no success has attended the attempts made to demonstrate a magnetic sense, which has been impatiently postulated by students of bird migration in order to "explain" how the birds find their way. The big fact is that in birds there are two widely open gateways of knowledge, the sense of sight and the sense of hearing.

Instinctive Aptitudes.

Many a young water-bird, such as a coot, swims right away when it is tumbled into water for the first time. So chicks peck without any learning or teaching, very young ducklings catch small moths that flit by, and young plovers lie low when the danger-signal sounds. But birds seem strangely limited as regards many of these instinctive capacities—limited when compared with the "little-brained" ants and bees, which have from the first such a rich repertory of ready-made cleverness. The limitation in birds is of great interest, for it means that intelligence is coming to its own and is going to take up the reins at many corners of the daily round. Professor Lloyd Morgan observed that his chickens incubated in the laboratory had no instinctive awareness of the significance of their mother's cluck when she was brought

WOODPECKER, HAMMERING AT A COTTON-REEL ATTACHED TO A TREE.

Notice how the stiff tail-feathers braced against the stem help the bird to cling on with its toes. The original hole, in which this woodpecker inserted nuts for the purposes of cracking the shell and extracting the kernel, is seen towards the top of the tree. But the taker of the photograph tied on a hollowed out cotton-reel as a receptacle for a nut, and it was promptly discovered and used by the bird.

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 as they stood in the water did they appreciate water as the stuff they wanted, and raise their bills up to the sky. Once or twice they actually stuffed their crops with "worms" of red worsted!

Instinctive aptitudes, then, the young birds have, but these are more limited than in ants, bees, and wasps; and the reason is to be found in the fact that the brain is now evolving on the tack of what Sir Ray Lankester has called "educability." Young birds *learn* with prodigious rapidity; the emancipation of the mind from the tyranny of hereditary obligations has begun. Young birds make mistakes, like the red worsted mistake, but they do not make the same mistakes often. They are able to profit by experience in a very rapid way. We do not mean that creatures of the little-brain type, like ants, bees, and wasps, are unable to profit by experience or are without intelligence. There are no such hard-and-fast lines. We mean that in the ordinary life of insects the enregistered instinctive capacities are on the whole sufficient for the occasion, and that intelligent educability is very slightly developed. Nor do we mean that birds are quite emancipated from the tyranny of engrained instinctive obligations, and can always "ring up" intelligence in a way that is impossible for the stereotyped bee. The sight of a pigeon brooding on an empty nest, while her two eggs lie disregarded only a couple of inches away, is enough to show that along certain lines birds may find it impossible to get free from the trammels of instinct. The peculiar interest of birds is that they have many instincts and yet a notable power of learning intelligently.

Intelligence co-operating with Instinct.

Professor Lloyd Morgan was foster-parent to two moorhens which grew up in isolation from their kindred. They swam instinctively, but they would not dive, neither in a large bath nor in a current. But it happened one day when one of these moorhens was swimming in a pool on a Yorkshire stream, that 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, his head just peeping above the water beneath the overhanging bank. This was the first time the bird had dived, and the performance was absolutely true to type.

There can be little doubt as to the meaning of this observation. The moorhen has an hereditary or instinctive capacity for swimming and diving, but the latter is not so easily called into activity as the former. The particular moorhen in question had enjoyed about two months of swimming experience, which probably counted for something, but in the course of that experience nothing had pulled the trigger of the diving capacity. On an eventful day the young moorhen saw and heard the dog; it was emotionally excited; it probably did to some extent intelligently appreciate a novel and meaningful situation. Intelligence co-operated with instinct, and the bird dived appropriately.

Birds have inborn predispositions to certain effective ways of pecking, scratching, swimming, diving, flying, crouching, lying low, nest-building, and so on; but they are marked off from the much more purely instinctive ants and bees by the extent to which individual "nurture" seems to mingle with the inherited "nature." The two together result in the fine product which we call the bird's behaviour. After Lloyd Morgan's chicks had tried a few conspicuous and unpalatable caterpillars, they had no use for any more. They learned in their early days with prodigious rapidity, illustrating the deep difference between the "big-brain" type, relatively poor in its endowment of instinctive capacities, but eminently "educable," and the "little-brain" type, say, of ants and bees, richly endowed with instinctive capacities, but very far from being quick or glad to learn. We owe it to Sir Ray Lankester to have made it clear that these two types of brain are, as it were, on different tacks of evolution, and should not be directly pitted against one another. The "little-brain" type makes for a climax in the ant, where instinctive behaviour reaches a high degree of perfection; the "big-brain" type reaches its climax in horse and dog, in

THE BEAVER.

The beaver will gnaw through trees a foot in diameter; to save itself more trouble than is necessary, it will stop when it has gnawed the trunk till there is only a narrow core left, having the wit to know that the autumn gales will do the rest.

elephant and monkey. The particular interest that attaches to the behaviour of birds is in the combination of a good deal of instinct with a great deal of intelligent learning. This is well illustrated when birds make a nest out of new materials or in some quite novel situation. It is clearly seen when birds turn to some new kind of food, like the Kea parrot, which attacks the sheep in New Zealand.

Some young woodpeckers are quite clever in opening fir cones to get at the seeds, and this might be hastily referred to a well-defined hereditary capacity. But the facts are that the parents bring their young ones first the seeds themselves, then partly opened cones, and then intact ones. There is an educative process, and so it is in scores of cases.

Using their Wits.

When the Greek eagle lifts the Greek tortoise in its talons, and lets it fall from a height so that the strong carapace is broken and the flesh exposed, it is making intelligent use of an expedient. Whether it discovered the expedient by experimenting, as is possible, or by chance, as is more likely, it uses it intelligently. In the same way herring-gulls lift sea-urchins and clams in their bills, and let them fall on the rocks so that the shells are broken. In the same way rooks deal with freshwater mussels.

The Thrush's Anvil.

A very instructive case is the behaviour of the song-thrush when it takes a wood-snail in its beak and hammers it against a stone, its so-called anvil. To a young thrush, which she had brought up by hand, Miss Frances Pitt offered some wood-snails, but it took no interest in them until one put out its head and began to move about. The bird then pecked at the snail's horns, but was evidently puzzled when the creature retreated within the shelter of the shell. This happened over and over again, the thrush's inquisitive interest increasing day by day. It pecked at the shell and even picked it up by the lip, but no real progress was made till the sixth day, when the thrush seized the snail and beat it on the ground as it would a big worm. On the same day it picked up a shell and knocked it repeatedly against a stone, trying first one snail and then another. After fifteen minutes' hard work, the thrush managed to break one, and after that it was all easy. A certain predisposition to beat things on the ground was doubtless present, but the experiment showed that the use of an anvil could be arrived at by an untutored bird. After prolonged trying it found out how to deal with a difficult situation. It may be said that in more natural conditions this might be picked up by imitation, but while this is quite possible, it is useful to notice that experiments with animals lead us to doubt whether imitation counts for nearly so much as used to be believed.

§ 6

The Mind of the Mammal.

When we watch a collie at a sheep-driving competition, or an elephant helping the forester, or a horse shunting waggons at a railway siding, we are apt to be too generous to the mammal mind. For in the cases we have just mentioned, part of man's mind has, so to speak, got into the animal's. On the other hand, when we study rabbits and guinea-pigs, we are apt to be too stingy, for these rodents are under the average of mammals, and those that live in domestication illustrate the stupefying effect of a too sheltered life. The same applies to domesticated sheep contrasted with wild sheep, or even with their own lambs. If we are to form a sound judgment on the intelligence of mammals we must not attend too much to those that have profited by man's training, nor to those whose mental life has been dulled by domestication.

Instinctive Aptitudes.

What is to be said of the behaviour of beavers who gnaw the base of a tree with their chisel-edged teeth till only a narrow core is left—to snap in the first gale, bringing the useful branches down to the ground? What is to be said of the harvest-mouse constructing its nest, or of the squirrel making cache after cache of nuts? These and many similar pieces of behaviour are fundamentally instinctive, due to inborn predispositions of nerve-cells and muscle-cells. But in mammals they seem to be often attended by a certain amount of intelligent attention, saving the creature from the tyranny of routine so marked in the ways of ants and bees.

Besides instinctive aptitudes, which are exhibited in almost equal perfection by all the members of the same species, there are

Photo: F. R. Hinkins & Son.

THE THRUSH AT ITS ANVIL.

The song-thrush takes the snail's shell in its bill, and knocks it against a stone until it breaks, making the palatable flesh available. Many broken shells are often found around the anvil.

acquired dexterities which depend on individual opportunities. They are also marked by being outside and beyond ordinary routine —not that any rigorous boundary-line can be drawn. We read that at Mathura on the Jumna doles of food are provided by the piety of pilgrims for the sacred river-tortoises, which are so crowded when there is food going that their smooth carapaces form a more or less continuous raft across the river. On that unsteady slippery bridge the Langur monkeys (*Semnopithecus entellus*) venture out and in spite of vicious snaps secure a share of the booty. This picture of the monkeys securing a footing on the moving mass of turtle-backs is almost a diagram of sheer dexterity. It illustrates the spirit of adventure, the will to experiment, which is, we believe, the main motive-force in new departures in behaviour.

Sheer Dexterity.

A bull-terrier called Jasper, studied by Prof. J. B. Watson, showed great power of associating certain words with certain actions. From a position invisible to the dog the owner would give certain commands, such as "Go into the next room and bring me a paper lying on the floor." Jasper did this at once, and a score of similar things.

Power of Association.

Lord Avebury's dog Van was accustomed to go to a box containing a small number of printed cards and select the card TEA or OUT, as the occasion suggested. It had established an association between certain black marks on a white background and the gratification of certain desires. It is probable that some of the extraordinary things horses and dogs have been known to do in the way of stamping a certain number of times in supposed indication of an answer to an arithmetical question (in the case of horses), or of the name of an object drawn (in the case of dogs), are dependent on clever associations established by the teacher between minute signs and a number of stampings. What is certain is that mammals have in varying degrees a strong power of establishing associations. There is often some delicacy in the association established. Everyone knows of cases where a dog, a cat, or a horse will remain quite uninterested, to all appearance, in its owner's movements until some little detail, such as taking a key from its peg, pulls the

trigger. Now the importance of this in the wild life of the fox or the hare, the otter or the squirrel, is obviously that the young animals learn to associate certain sounds in their environment with definite possibilities. They have to learn an alphabet of woodcraft, the letters of which are chiefly sounds and scents.

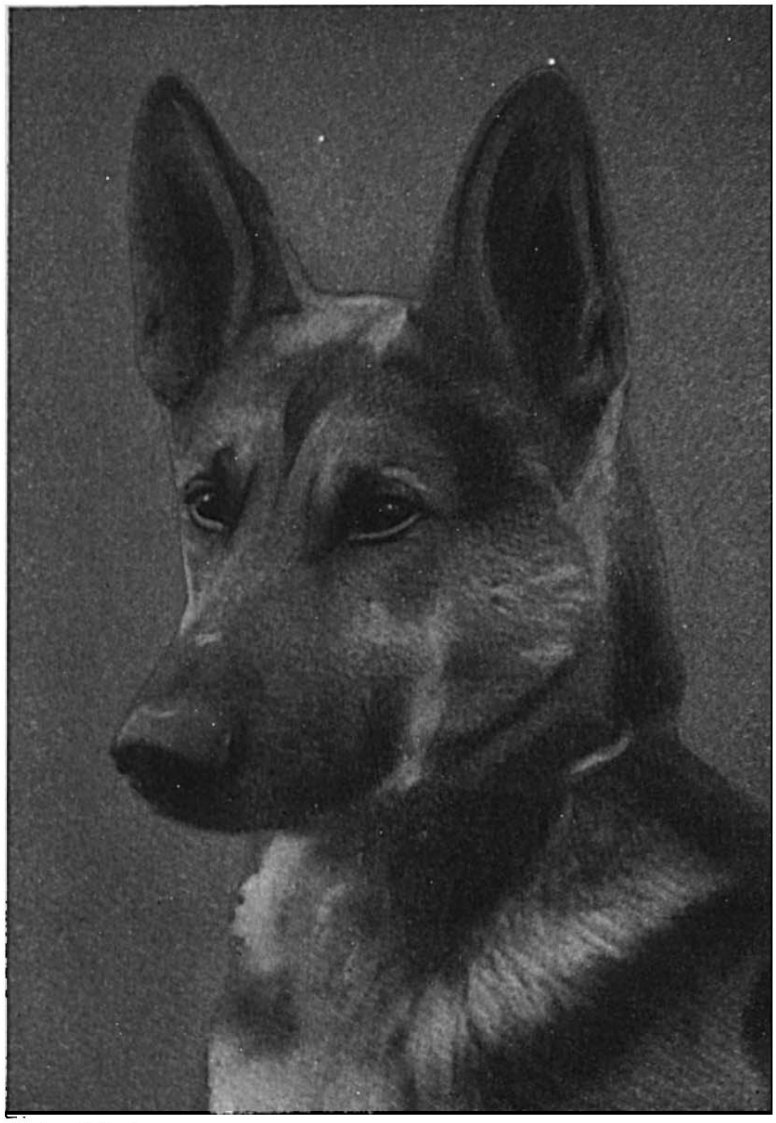


Photo: Lafayette.

ALSATIAN WOLF-DOG.

An animal of acute senses and great intelligence. It was of great service in the war. (The dog shown, Arno von Indetal, is a trained police dog and did service abroad during the war.)

The dancing or waltzing mouse is a Japanese variety with many peculiarities, such as having only one of the three semicircular canals of the ear well developed. It has a strong tendency to waltz round and round in circles without sufficient cause and to trip sideways towards its dormitory instead of proceeding in the orthodox head-on fashion. But this freak is a very educable creature, as Professor Yerkes has shown. In a careful way he confronted his mouse-pupil with alternative pathways marked by different degrees of illumination, or by different colours. If the mouse chose compartment A, it found a clear passage direct to its nest; if it chose compartment B, it was punished by a mild electric shock and it had to take a round-about road home. Needless to say, the A compartment was sometimes to the right hand, sometimes to the left, else mere position would have been a guide. The experiments showed that the dancing mice learn to discriminate the right path from the wrong, and similar results have been got from other mammals, such as rats and squirrels. There is no proof of learning by ideas, but there is proof of learning by experience. And the same must be true in wild life.

The Dancing Mouse as a Pupil.

Many mammals, such as cats and rats, learn how to manipulate puzzle-boxes and how to get at the treasure at the heart of a Hampton Court maze. Some of the puzzle-boxes, with a reward of food inside, are quite difficult, for the various bolts and bars have to be dealt with in a particular order, and yet many mammals master the problem. What is plain is that they

gradually eliminate useless movements, that they make fewer and fewer mistakes, that they eventually succeed, and that they register the solution within themselves so that it remains with them for a time. It looks a little like the behaviour of a man who learns a game of skill without thinking. It is a learning by experience, not by ideas or reflection. Thus it is very difficult to suppose that a rat or a cat could form any idea or even picture of the Hampton Court maze—which they nevertheless master.

Learning Tricks.

Given sufficient inducement many of the cleverer mammals will learn to do very sensible things, and no one is wise enough to say that they never understand what they are doing. Yet it is certain that trained animals often exhibit pieces of behaviour which are not nearly so clever as they look. The elephant at the Belle Vue Gardens in Manchester used to collect pennies from benevolent visitors. When it got a penny in its trunk it put it in the slot of an automatic machine which delivered up a biscuit. When a visitor gave the elephant a halfpenny it used to throw it back with disgust. At first sight this seemed almost wise, and there was no doubt some intelligent appreciation of the situation. But it was largely a matter of habituation, the outcome of careful and prolonged training. The elephant was laboriously taught to put the penny in the slot and to discriminate between the useful pennies and the useless halfpennies. It was not nearly so clever as it looked.

Using their Wits.

In the beautiful Zoological Park in Edinburgh the Polar Bear was wont to sit on a rocky peninsula of a water-filled quarry. The visitors threw in buns, some of which floated on the surface. It was often easy for the Polar Bear to collect half a dozen by plunging into the pool. But it had discovered a more interesting way. At the edge of the peninsula it scooped the water gently with its huge paw and made a current which brought the buns ashore. This was a simple piece of behaviour, but it has the smack of intelligence—of putting two and two together in a novel way. It suggests the power of making what is called a " perceptual inference."

On the occasion of a great flood in a meadow it was observed that a number of mares brought

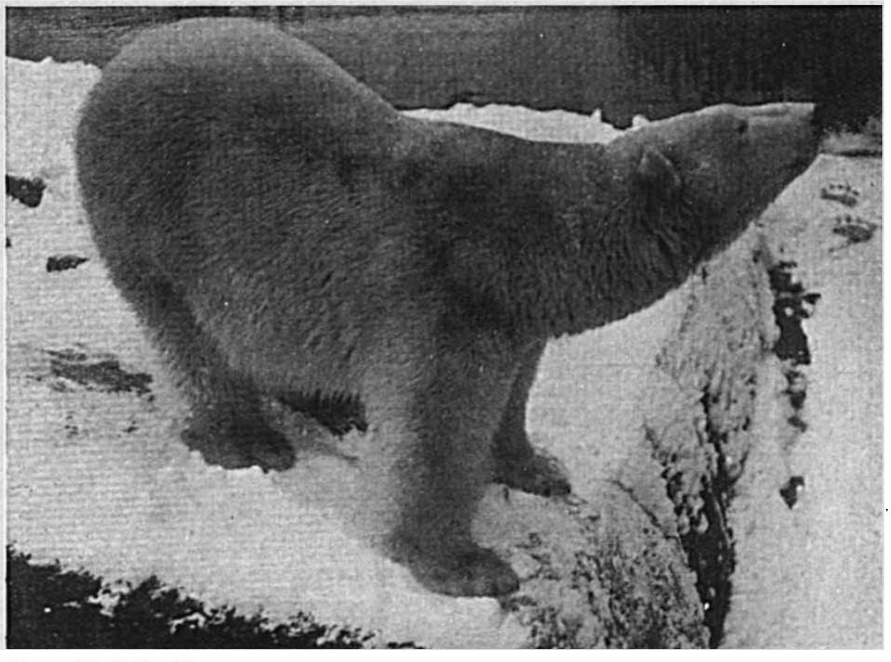
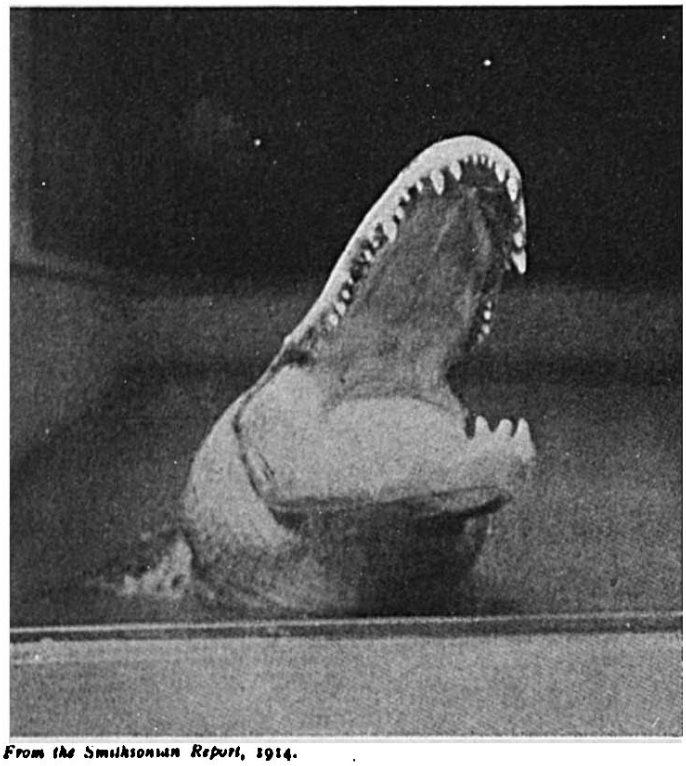


Photo: W. S. Berridge.

THE POLAR BEAR OF THE FAR NORTH.

An animal of extraordinary strength, able with a stroke of its paw to lift a big seal right out of the water and send it crashing along the ice. The food consists chiefly of seals. The sexes wander separately. A hole is often dug as a winter retreat, but there is no hibernation. A polar bear in captivity has been seen making a current with its paw in the water of its pool in order to secure floating buns without trouble—an instance of sheer intelligence.

their foals to the top of a knoll, and stood round about them protecting them against the rising water. A dog has been known to show what was at any rate a plastic appreciation of a varying situation in swimming across a tidal river. It changed its starting-point, they say, according to the flow or ebb of the tide. Arctic foxes and some other wild mammals show great cleverness in dealing with traps, and the manipulative intelligence of elephants is worthy of all our admiration.



From the Smithsonian Report, 1914.

AN ALLIGATOR "YAWNING" IN EXPECTATION OF FOOD.
Note the large number of sharp conical teeth fixed in sockets along the jaws.

§ 7

Why is there not more Intelligence?

When we allow for dexterity and power of association, when we recognise a certain amount of instinctive capacity and a capacity for profiting by experience in an intelligent way, we must admit a certain degree of disappointment when we take a survey of the behaviour of mammals, especially of those with very fine brains, from which we should naturally expect great things. Why is there not more frequent exhibition of intelligence in the stricter sense?

The answer is that most mammals have become in the course of time very well adapted to the ordinary conditions of their life, and tend to leave well alone. They have got their repertory of efficient answers to the ordinary questions of everyday life, and why should they experiment? In the course of the struggle for existence what has been established is efficiency in normal circumstances, and therefore even the higher animals tend to be no cleverer than is necessary. So while many mammals are extraordinarily efficient, they tend to be a little dull. Their mental equipment is adequate for the everyday conditions of their life, but it is not on sufficiently generous lines to admit of, let us say, an interest in Nature or adventurous experiment. Mammals always tend to "play for safety."

We hasten, however, to insert here some very interesting saving clauses.

Experimentation in Play.

A glimpse of what mammals are capable of, were it necessary, may be obtained by watching those that are playful, such as lambs and kids, foals and calves, young foxes and others. For these young creatures let themselves go irresponsibly, they are still unstereotyped, they test what they and their fellows can do. The experimental character of much of animal play is very marked.

It is now recognised by biologists that play among animals is the young form of work, and that the playing period, often so conspicuous, is vitally important as an apprenticeship to the serious business of life and as an opportunity for learning the alphabet of Nature. But the playing period is much more; it is one of the few opportunities animals have of making experiments without too serious responsibilities. Play is Nature's device for allowing elbow-room for new departures (behaviour-variations) which may form part of the raw materials of progress. Play, we repeat, gives us a glimpse of the possibilities of the mammal mind.

A squirrel is just as clever as it needs to be and no more; and of some vanishing mammals, like the beaver, not even this can be said. Humdrum non-plastic efficiency is apt to mean stagnation. Now we have just seen that in the play of young mammals there is an indication of unexhausted possibilities, and we get the same impression when we think of three other facts. (*a*) In those mammals, like dog and horse, which have entered into active co-operative relations with man, we see that the mind of the mammal is capable of much more than the average would lead us to think. When man's sheltering is too complete and the domesticated creature is passive in his grip, the intelligence deteriorates. (*b*) When we study mammals, like the otter, which live a versatile life in a very complex and difficult environment, we get an inspiriting picture of the play of wits. (*c*) Thirdly, when we pass to monkeys, where the fore-limb has become a free hand, where the brain shows a relatively great improvement, where "words" are much used, we cannot fail to recognise the emergence of something new—a restless inquisitiveness, a desire to investigate the world, an unsatisfied tendency to experiment. We are approaching the Dawn of Reason.

Other Glimpses of Intelligence.

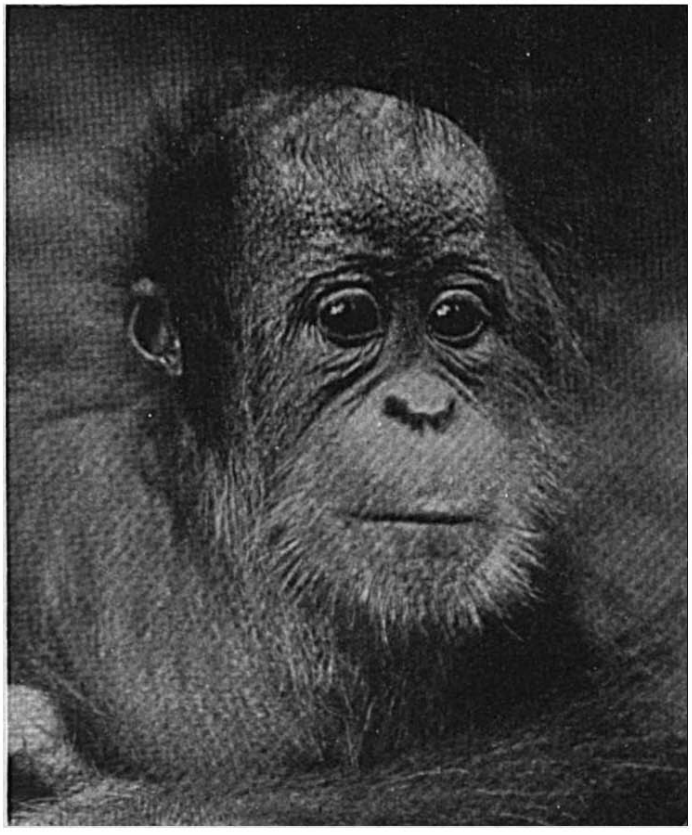


Photo: W. P. Dando.

BABY ORANG.

Notice the small ears and the suggestion of good temper. The mother orang will throw prickly fruits and pieces of branches at those who intrude on her maternal care.

THE MIND OF MONKEYS

§ 8

There is a long gamut between the bushy-tailed, almost squirrel-like marmosets and the big-brained chimpanzee. There is great variety of attainment at different levels in the Simian tribe.

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 man, 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, 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.

Keen Senses.

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-leg has been emancipated. It has ceased to be indispensable as an organ of support; it has become a climbing, grasping, lifting, handling organ. The fore-limb has become a free hand, and everyone who knows monkeys at all is aware of the zest with which they use their tool. They enjoy pulling things to pieces—a kind of dissection—or screwing the handle off a brush and screwing it on again.

Power of Manipulation.

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 splendidly 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."

Activity for Activity's Sake.

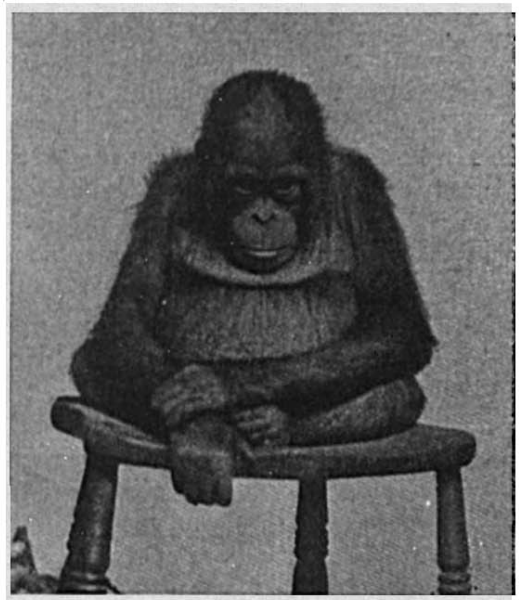


Photo: Gambier Bolton.

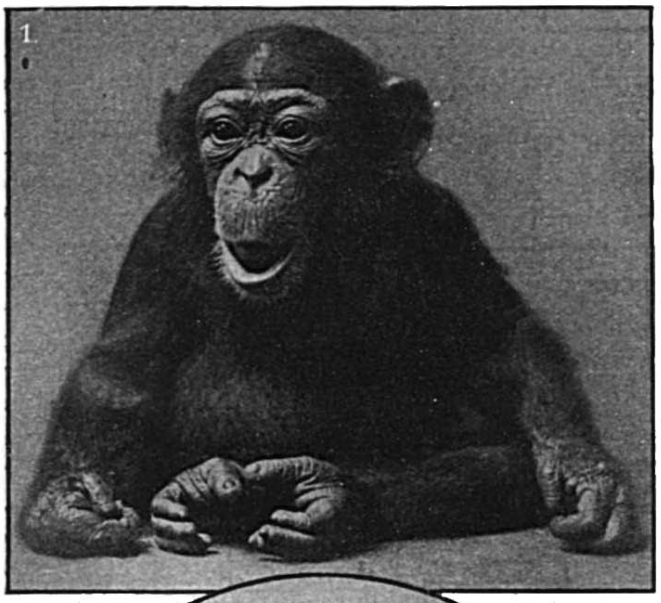
ORANG-UTAN.

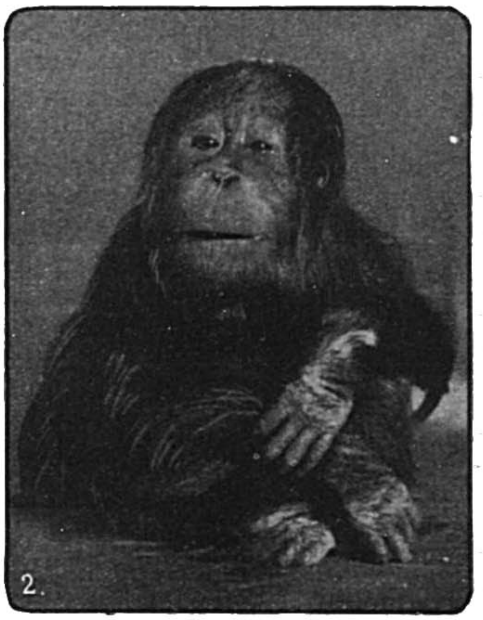
A large and heavy ape, frequenting forests in Sumatra and Borneo, living mainly in trees, where a temporary nest is made. The expression is melancholy, the belly very protuberant, the colour yellow-brown, the movements are cautious and slow.

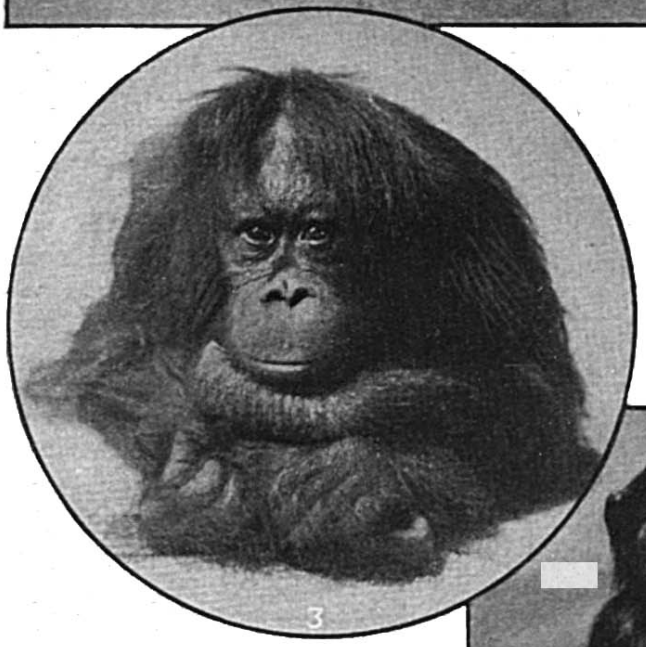
This applies to mental activity as well, and the quality is one of extraordinary interest, for it shows the experimenting mood at a higher turn of the spiral than in any other creature, save man. It points forward to the scientific spirit. We cannot, indeed, believe in the sudden beginning of any quality, 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 psychologist whom we have quoted tells of a monkey which happened to hit a projecting wire so as to make it vibrate. 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."

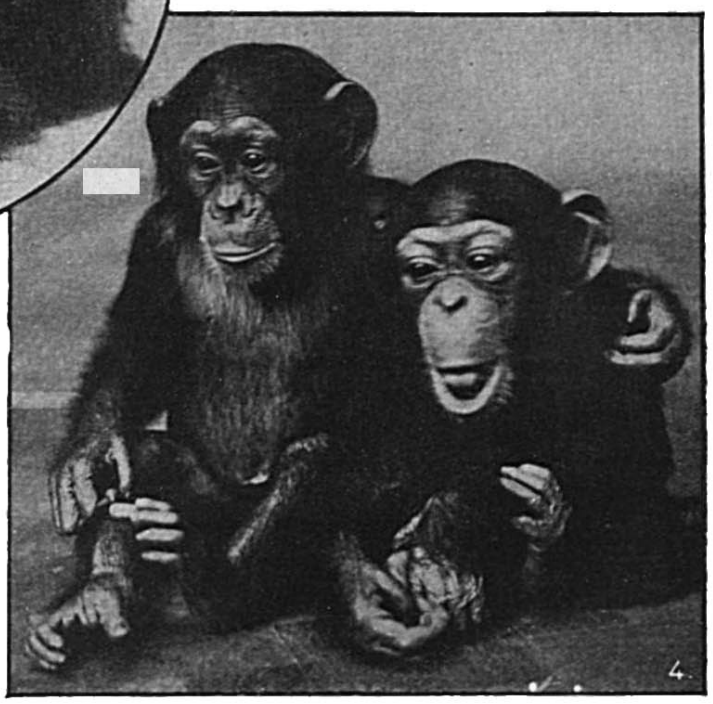
Sheer Quickness.

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 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









1. CHIMPANZEE.
2. BABY ORANG-UTAN.
3. ORANG-UTAN.
4. BABY CHIMPANZEES.

Photos: James's Press Agency.

In his famous book on *The Expression of the Emotions in Man and Animals* (1872) Charles Darwin showed that many forms of facial expression familiar in man have their counterparts in apes and other mammals. He also showed how important the movements of expression are as means of communication between mother and offspring, mate and mate, kith and kin.

The anthropoid apes show notable differences of temperament, as the photographs show. The chimpanzee is lively, cheerful, and educable. The orang is also mild of temper, but often and naturally appears melancholy in captivity. This is not suggested, however, by our photograph of the adult. Both chimpanzee and orang are markedly contrasted with the fierce and gloomy gorilla.

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."

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.

Quick to Learn.

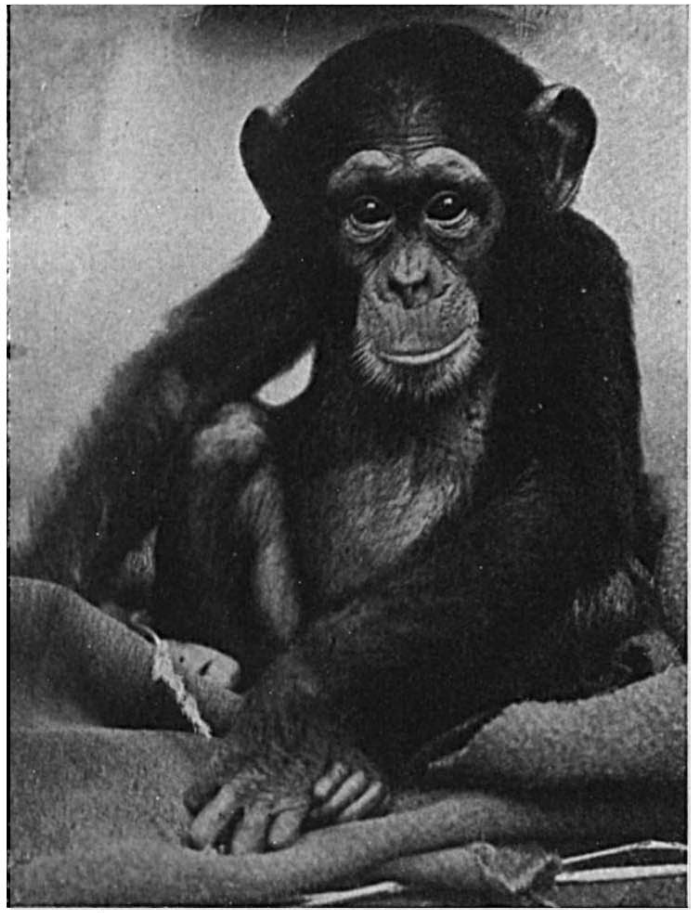


Photo: W. P. Dando.

CHIMPANZEE.

An African ape, at home in the equatorial forests, a lively and playful creature, eminently educable.

Some of us remember Sally, the chimpanzee at the "Zoo" with which Dr. Romanes used to experiment. She was taught to give her teacher the number of straws he asked for, and she soon learned to do so up to five. If she handed a number not asked for, her offer was refused; if she gave the proper number, she got a piece of fruit. If she was asked for five straws, she picked them up individually and placed them in her mouth, and when she had gathered five she presented them together in her hand. Attempts to teach her to give six to ten straws were not very successful. For Sally "above six" meant "many," and besides, her limits of patience were probably less than her range of computation. This was hinted at by the highly interesting circumstance that when dealing with numbers above five she very frequently doubled over a straw so as to make it present two ends and thus appear as two straws. The doubling of the straw looked like an intelligent device to save time, and it was persistently resorted to in spite of the fact that her teacher always refused to accept a doubled straw as equivalent to two straws. Here we get a glimpse of something beyond the mere association of a sound—"Five"—and that number of straws.

The Case of Sally.

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

The Case of Lizzie.

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."

Trial and Error.

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.

Two chimpanzees in the Dublin Zoo were often to be seen 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 someone said, "What mimics they are!" Now we do not know whether that was or was not the case with the 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 the 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.

Imitation.

Perhaps the cleverest monkey 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

The Case of Peter.

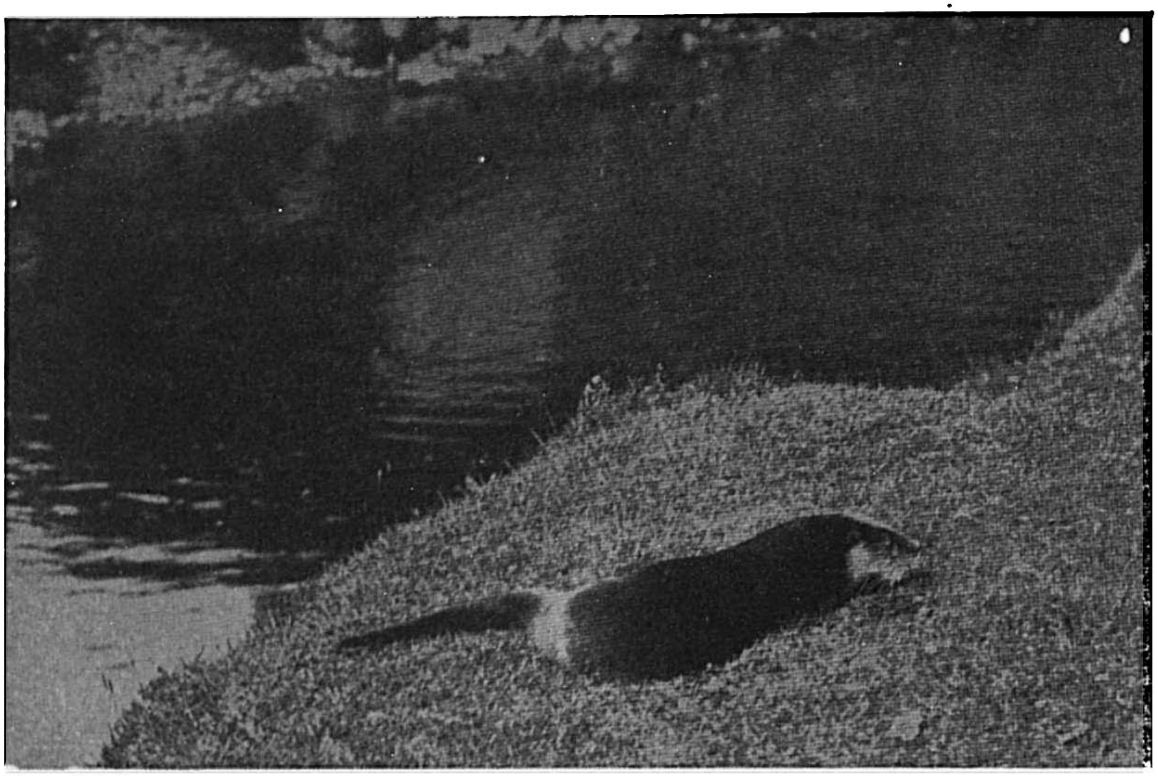


Photo: C. Reid.

COMMON OTTER.

One of the most resourceful of animals and the "most playsomest crittur on God's earth." It neither stores nor hibernates, but survives in virtue of its wits and because of the careful education of the young. The otter is a roving animal, often with more than one resting-place; it has been known to travel fifteen miles in a night.

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 remains Man's prerogative.

The Bustle of the Mind.

In mammals like otters, foxes, stoats, hares, and elephants, what a complex of tides and currents there must be in the brain-mind! We may think of a stream with currents at different levels. Lowest there are the *basal appetites* of hunger and sex, often with eddies rising to the surface. Then there are the *primary emotions*, such as fear of hereditary enemies and maternal affection for offspring. Above these are *instinctive aptitudes*, inborn powers of doing clever things without having to learn how. But in mammals these are often expressed along with, or as it were through, the controlled life of *intelligent activity*, where there is more clear-cut perceptual influence.

Higher still are the records or memories of individual experience and the registration of individual habits, while on the surface is the instreaming multitude of messages from the outside world, like raindrops and hailstones on the stream, some of them penetrating deeply, being, as we say, full of meaning. The mind of the higher animal is in some respects like a child's mind, in having little in the way of clear-cut ideas, in showing no reason in the strict sense, and in its extraordinary educability, but it differs from the child's mind entirely in the sure effectiveness of a certain repertory of responses. It is efficient to a degree.

"Until at last arose the Man."

Man's brain is more complicated than that of the higher apes—gorilla, orang, and chimpanzee—and it is relatively larger. But the improvements in structure do not seem in themselves sufficient to account for man's great advance in intelligence.

The rill of inner life has become a swift stream, sometimes a rushing torrent. Besides perceptual inference or *Intelligence*—a sort of picture-logic, which some animals likewise have—there is conceptual inference—or *Reason*—an internal experimenting with general ideas. Even the cleverest animals, it would seem, do not get much beyond playing with "particulars"; man plays an internal game of chess with "universals." Intelligent behaviour may go a long way with mental images; rational conduct demands general ideas. It may be, however, that "percepts" and "concepts" differ rather in degree than in kind, and that the passage from one to the other meant a higher power of forming associations. A clever dog has probably a generalised percept of man, as distinguished from a memory-image of the particular men it has known, but man alone has the concept Man, or Mankind, or Humanity. Experimenting with concepts or general ideas is what we call Reason.

Here, of course, we get into deep waters, and perhaps it is wisest not to attempt too much. So we shall content ourselves here with pointing out that Man's advance in intelligence and from intelligence to reason is closely wrapped up with his power of speech. What animals began—a small vocabulary — he has carried to high perfection. But what is distinctive is not the vocabulary so much as the habit of making sentences, of expressing judgments in a way which admitted of communication between mind and mind. The multiplication of words meant much, the use of words as symbols of general ideas meant even more, for it meant the possibility of playing the internal game of thinking; but perhaps the most important advance of all was the means of comparing notes with neighbours, of corroborating individual experience by social intercourse. With words, also, it became easier to enregister outside himself the gains of the past. It is not without significance that the Greek Logos, which may be translated "the word," may also be translated Mind.

Photo: W. S. Berridge.

YOUNG CHEETAHS, OR HUNTING LEOPARDS.

Trained to hunt from time immemorial and quite easily tamed. Cheetahs occur in India, Persia, Turkestan, and Africa.

§ 9

Looking Backwards.

When we take a survey of animal behaviour we see a long inclined plane. The outer world provokes simple creatures to answer back; simple creatures act experimentally on their surroundings. From the beginning this twofold process has been going on, receiving stimuli from the environment and acting upon the environment, and according to the efficiency of the reactions and actions living creatures have been sifted for millions of years. One main line of advance has been opening new gateways of knowledge—the senses, which are far more than five in number. The other main line of advance has been in most general terms, experimenting or testing, probing and proving, trying one key after another till a door is unlocked. There is progress in multiplying the gateways of knowledge and making them more discriminating, and there is progress in making the modes of experimenting more wide-awake, more controlled, and more resolute. But behind both of these is

the characteristically vital power of enregistering within the organism the lessons of the past. In the life of the individual these enregistrations are illustrated by memories and habituations and habits; in the life of the race they are illustrated by reflex actions and instinctive capacities.

We must not shirk the very difficult question of the relation between the bodily and the mental side of behaviour.

(*a*) Some great thinkers have taught that the mind is a reality by itself which plays upon the instrument of the brain and body. As the instrument gets worn and dusty the playing is not so good as it once was, but the player is still himself. This theory of the essential independence of the mind is a very beautiful one, but those who like it when applied to themselves are not always so fond of it when it is applied to other intelligent creatures like rooks and elephants. It may be, however, that there is a gradual emancipation of the mind which has gone furthest in Man and is still progressing.

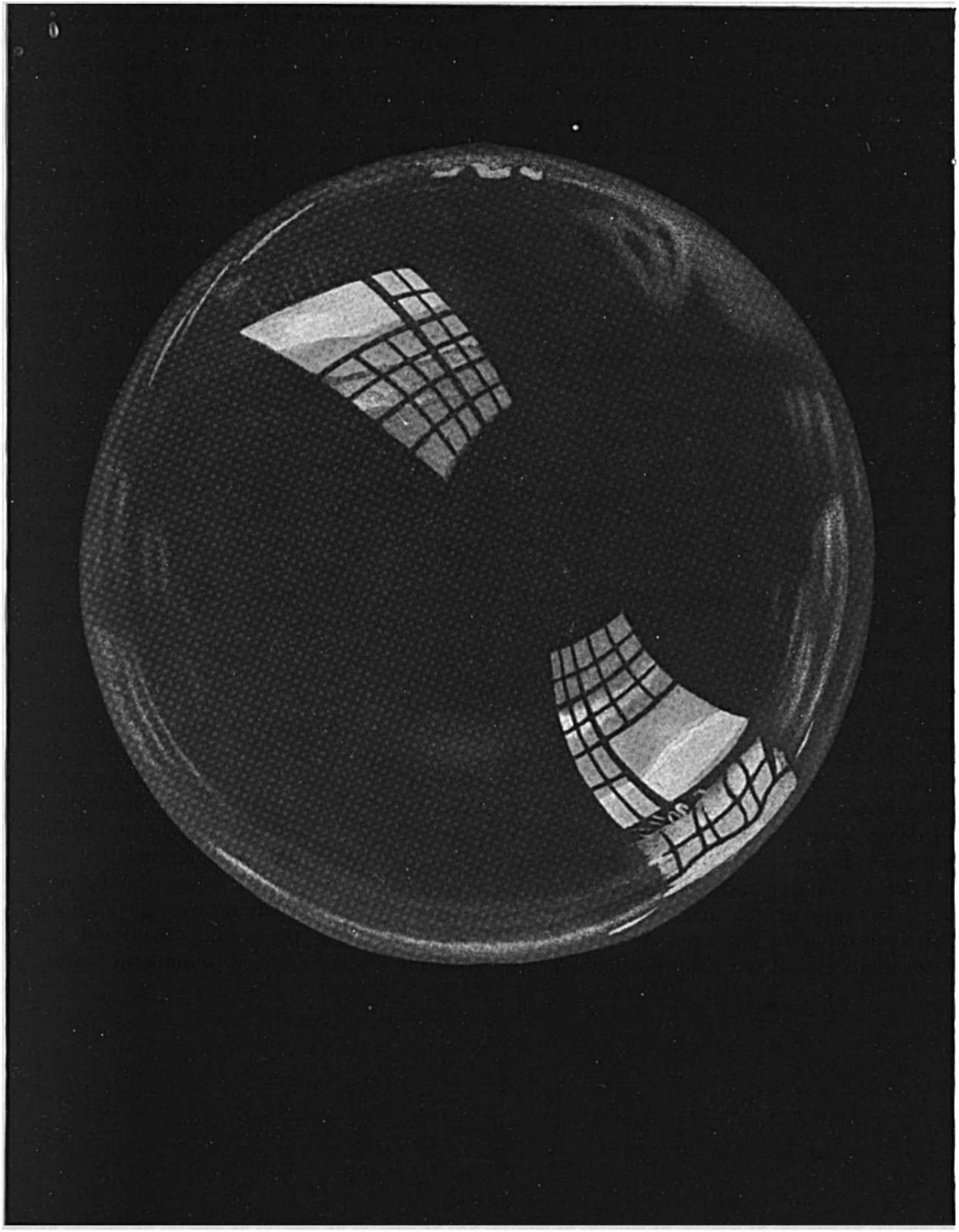
Body and Mind.

(*b*) Some other thinkers have taught that the inner life of thought and feeling is only, as it were, an echo of the really important activity—that of the body and brain. Ideas are just foam-bells on the hurrying streams and circling eddies of matter and energy that make up our physiological life. To most of us this theory is impossible, because we are quite sure that ideas and feelings and purposes, which cannot be translated into matter and motion, are the clearest realities in our experience, and that they count for good and ill all through our life. They are more than the tickings of the clock; they make the wheels go round.

(*c*) There are others who think that the most scientific position is simply to recognise both the bodily and the mental activities as equally important, and so closely interwoven that they cannot be separated. Perhaps they are just the outer and the inner aspects of one reality—the life of the creature. Perhaps they are like the concave and convex curves of a dome, like the two sides of a shield. Perhaps the life of the organism is always a unity, at one time appearing more conspicuously as Mind-body, at another time as Body-mind. The most important fact is that neither aspect can be left out. By no jugglery with words can we get Mind out of Matter and Motion. And since we are in ourselves quite sure of our Mind, we are probably safe in saying that in the beginning was Mind. This is in accordance with Aristotle's saying that there is nothing in the end which was not also in kind present in the beginning—whatever we mean by beginning.

What has led to the truly wonderful result which we admire in a creature like a dog or an otter, a horse or a hare? In general, we may say, just two main processes—(1) testing all things, and (2) holding fast that which is good. New departures occur and these are tested for what they are worth. Idiosyncrasies crop up and they are sifted. New cards come mysteriously from within into the creature's hand, and they are played—for better or for worse. So by new variations and their sifting, by experimenting and enregistering the results, the mind has gradually evolved and will continue to evolve.

In conclusion.



Reproduced from "The Forces of Nature" (Messrs. Macmillan).

A SOAP BUBBLE

The iridescent colours sometimes seen on a soap bubble, as in the illustration, may also be seen in very fine sections of crystals, in glass blown into extremely fine bulbs, on the wings of dragon-flies and the surface of oily water. The different colours correspond to different thicknesses of the surface. Part of the light which strikes these thin coatings is reflected from the upper surface, but another part of the light penetrates the transparent coating and is reflected from the lower surface. It is the mixture of these two reflected rays, their "interference" as it is called, which produces the colours observed. The "black spots" on a soap bubble are the places where the soapy film is thinnest. At the black spots the thickness of the bubble is about the twenty-five-thousandth part of an inch. If the whole bubble were as thin as this it would be completely invisible.