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# KINGDOM OF THE BEASTS

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TEXT BY JULIAN HUXLEY

PHOTOGRAPHS BY

W. SUSCHITZKY

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## KINGDOM OF THE BEASTS

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THE MAMMALS—most people persist in calling them just Animals, but birds and snakes and fish and insects and jelly-fish and amoeba are all animals—the Mammals have always provided man with most of the characters in fables and animal legends, and also most of his repertory of pets and children's toys. The reason is simple: they are man's closest relatives among the bewildering variety of living things. It is because of this that the moralist and the satirist can use different mammals as representatives of different types of human character, that pet-keepers and animal-lovers in general prefer dogs and horses and cats to ducks or lizards or insects, that the average child will love a teddy-bear or a bunny-rabbit in preference to a fish or spider or even a bird toy:

Man indeed *is* a mammal. Zoologically speaking, he is a representative of the class Mammalia in the phylum Vertebrata, not of any of the other four Classes into which the higher vertebrates fall—the Birds, the Reptiles, the Amphibians, and the Fish; and he is of course much more remote from any of the non-vertebrate phyla—whether Arthropods like butterflies or lobsters, Annelids like earthworms or leeches, or Molluscs like snails or octopuses, let alone Coelenterates like sea-anemones or jelly-fish, Protozoa like amoeba, or trypanosomes, Round-worms, Tapeworms, Wheel-animalcules or Sponges.

One of the distinguishing features of mammals is that for which they are named—the possession of glands secreting milk. Years ago at a lunch-party my son, aged about eight, proceeded to show off his new-found knowledge of this fact: "Mummy, you're a mammal," he piped up; "and Jane (the maid) is a mammal; and *you're* a mammal (pointing an indicative finger at the lady guest); but Father's not a mammal, and *he* (the lady guest's husband) isn't a mammal." This of course wasn't technically correct. Mammals are animals in which the female nourishes the young with milk (though the male has rudimentary nipples to demonstrate that he too is built on the mammalian plan); but at least the boy had begun his zoological education; as well as providing a subject for lunch-table conversation.

However, milk is not the mammals' only diagnostic character: the other is the possession of hair, which was indispensable for the evolution of their warm-bloodedness—in other words

the capacity to keep their temperature more or less constant, at a level which in most climates is well above that of their surroundings. In exceptional cases (large size, very hot surroundings, etc.) the body-hair can be lost without impairing the capacity for temperature-regulation.

In addition, the great majority of mammals belong to the sub-class called Placentals, from the fact that the young, up to an advanced stage of development, are nourished within the mother's body by means of the wonderful organ known as the placenta, which brings outgrowths of the blood-system of mother and offspring into intimate contact and so makes possible the transfer of dissolved food-substances and oxygen from the mother, and of waste-products from the foetus.

The Placentals have an amazingly perfected system of temperature-regulation. They also show the highest average level of intelligence, or ability to learn by experience, found in any animal class: this is visibly correlated with a unique degree of development of the part of the brain concerned with intelligent behaviour—the cerebral cortex. Indeed, the mammalian body is an astounding mechanism for successful living; and if creatures like dogs and cats and pigs and horses, not to mention human beings, were not so familiar, every mammal would seem a miracle.

To this astounding mechanism for successful living constituted by the mammalian body I shall return. First I shall describe some of the ways in which the mammalian stock has turned its wonderful organization to account during the process of evolution so as to exploit different types of surroundings and different modes of life. In this task I have the aid of Mr Suschitzky's beautiful photographs, which often tell the animals' story better than pages of description. The creatures portrayed can all be seen in the Zoos or Natural History Museums of our cities, so that any interest aroused by this book can easily be followed up by personal observation.

Whenever a new and successful plan of animal organization has been developed in the course of evolution, the new type will always radiate out in a fan of diverse specializations, to fill all the possible niches and ways of life available. In so doing, each specializing line comes to acquire what I may call a character of its own, a characteristic appearance and mode of behaviour appropriate to its way of life. If it is their obvious general kinship which permits man to recognize himself in the beasts, it is their special characters which have made it possible to humanize the different beasts and use them as symbols of different types of human character—the sly fox, the greedy pig, the fierce but noble lion, the patient ass, the timid hare.

This process of adaptive radiation is beautifully illustrated by the placental mammals. They are at home in the waters and in the air as well as on and under the ground and in the trees; they live in every zone from the equatorial to the polar; and they range from powerful carnivores and huge herbivores to humble eaters of shellfish, fruits, honey, fish, bark, earthworms and insects. Some actively pursue large prey, others filter small animals out of the sea-water, others spend their time grazing, still others lay up stores of food against a rainy day. The only major region uninvaded by mammals is the deep sea (though toothed sperm-whales seek the

giant cuttlefish on which they feed at depths down to 2000 or even 3000 feet); and the only major way of life they have left unexploited is that of the internal parasite.

The radiation has produced a series of main types of mammals—the flesheaters, the ungulates, odd-toed and even-toed, the elephants, the whales, the rodents, the insectivores, the bats, and the monkeys, to name only the more important and familiar ones. And then each type has undergone a radiation of its own, producing the assemblage of animals we call an Order—the Carnivora to include the flesheaters, the Cetacea the whales and dolphins, the Primates the lemurs, monkeys, apes and man, and so on.

Consider first the Carnivores. The lion is, quite rightly, the popular epitome of a carnivorous killer, for it represents a high point of specialization for a flesh-eating life. Its dog-teeth are enlarged into great fangs, its molars act as flesh-cutting scissors; its terrible claws can grip and wound and tear, but when not needed can be withdrawn into their sheaths, leaving the padded feet free for swift running; its prodigious strength enables it to kill creatures much larger than itself, up to half a ton or more, and even to leap over a high stockade while carrying a cow in its mouth. From time immemorial men have called it the King of Beasts.

Zoologically, the lion is one of the two giant members of the cat family. There are plenty of other species of cats, showing the same flesh-eating specialization of teeth and claws, but each adapted to fill a slightly different niche. Thus the lion is adapted to live in fairly open country where big game is abundant as prey and where his tawny uniformity blends with the surroundings (though the faint spots of the young lion cub must be a reminiscence of an earlier time when ancestral lions lived in a more wooded habitat). The tiger is as big, but inhabits denser cover, where his stripes simulate the shadows of reeds or stems, and through which his thinner body can more readily make its way. Leopards and jaguars, on the other hand, live in forests where their spotted markings imitate the dappling of sun and shade through the leaves.

The cats also show a great diversity of size, each size of cat adjusted to a particular size of prey: the leopard lives on smaller animals than the lion or tiger, while the lynx descends to hares and rabbits, and the domestic cat to rats and mice.

The Cheetah, or Hunting Leopard, is essentially a cat specialized for running down its prey in the open; accordingly it is much longer-legged than the true cats, has much less fully retractable claws, and is capable of an astonishing speed: there is a record of a cheetah having covered nearly half a mile at over 71 miles an hour! It is indeed the swiftest of all land animals. The cheetah's feline affinities are revealed by its purring as well as by its general appearance. It is not only easily tamed but easily trained. In various countries such as India and Persia it has long been used to furnish royal sport, and is today employed in East Africa to catch antelopes for export to Zoos. The cheetah is one of my favourite animals, and Mr Suschitzky has admirably caught its friendly and alert expression.

Hyenas, on the other hand, while also relatives (though more distant ones) of the cats, are, to me at least, definitely unattractive, not to say repulsive, with their body sloping to weak

Plate  
1-2

4-6, 11

7-8

9-10

13

hindquarters, their slinking manner, their snarling faces, and their carrion-feeding habits. Their only beauty is the beauty of their adaptation to their unpleasant way of life. Their jaws are immensely powerful, and their main molar teeth have been converted into a marvellous set of shears, capable of cutting paper as well as of shearing bones in pieces.

Where hyenas are plentiful they make the night hideous with their horrible howling, sometimes rising to a burst of demoniac laughter. Hyenas sometimes "laugh" in the Zoo, and no one who has heard them is likely to forget the experience. Once in East Africa, when sleeping in a cabin in my host's grounds, I was woken by the presence of a large animal in the little room. As I had gone to bed to the sound of the hyena's diabolical serenade, and as hyenas, though cowardly, are powerful and greedy and will sometimes attack, I was considerably alarmed. Luckily, the animal turned out to be my host's Alsatian dog; but I wished that I had been warned that he might pay me a visit!

Hyenas are often believed to be hermaphrodite: in Africa you will be told many stories of male hyenas being shot, and then turning out to be carrying young. However, the creatures are actually as bisexual as all other higher vertebrates: the mistake has arisen because the external genitals of the female are much enlarged and look almost like those of a male. Why hyenas should have evolved in this way nobody knows, especially as it must make the continuation of the race rather difficult.

When last in the Middle East I was surprised to learn that hyenas still lived in the Lebanon range, even within sight of the rich and cosmopolitan city of Beirut. I ought really to have remembered that the natural range of numerous large mammals, and especially large carnivores, is very wide, though in many creatures it has been much reduced by man. Bears were a prized article of export from Britain to Imperial Rome; wolves were not exterminated from Scotland until the mid-eighteenth century; while lions ranged into Greece in historic times. Hyenas differ from lions in that they still survive in the Middle East as well as in Africa, while the lions of the region finally died out in the nineteenth century.

The Viverridae, typified by the Civet-cats, must have been derived from the same ancestral stock as the true cats, but they are longer-faced and shorter-legged, more omnivorous, more tropical (though one small species, the Genet, reaches Spain and France) and on the whole smaller; they are mostly tree-living animals, ready to eat anything from birds and small mammals to fruits, worms, and large insects. A favourite Zoo member of the family is the Binturong, with his amiable disposition, his long bushy prehensile tail, and his eyes looking like brown marbles.

*Civet* is the name given to the fatty secretion produced by civet-cats in special glands. Though this has a powerful and to us very disagreeable musky smell, men early discovered that when diluted and mixed with other scents it was a valuable ingredient in the manufacture of perfumes. Its value to the animal seems to be two-fold. When discharged in quantity it acts as a defensive weapon which will sicken dogs or other attackers; and when lightly smeared on landmarks it serves to delimit the animal's territory as a warning against intruders.



Many mammals are constructed to secrete a substance with one or both of these functions. In the skunks it is capable of nauseating the most ferocious of enemies when squirted at them, and the skunk advertises its possession of this formidable chemical weapon by unhurriedly flaunting its conspicuous black-and-white pattern. Beavers, martens and mongooses have similar glands with which they mark conspicuous objects in their territories, and everyone is familiar with the way in which dogs leave their "visiting-cards" on posts. In ground-squirrels the glands are on the back, and in many antelopes you can see the channels of glands leading forward from the eyes, with whose secretion they mark twigs on selected trees. This common use of smell signals by mammals is of course a consequence of the high development of their olfactory sense. Smell is the king of the senses in the mammals, as sight is in the birds.

Another main sub-group of carnivores is that of the dog family. Some of them, like the foxes, are solitary hunters of small creatures; others, like the hunting dogs and the wolves, hunt larger prey in organized packs; while still others, like the jackals, are scavengers and semi-parasites on larger beasts of prey as well as hunters.

The dogs include some of the most intelligent of the carnivores: the solitary foxes have a proverbial cunning, while the gregarious wolves have a highly developed group organization and loyalty, as you may read in Konrad Lorenz's *King Solomon's Ring*. This characteristic has given us our domestic dogs, which are mainly (some authorities believe solely) derived from wolves, for prehistoric man was able to switch the animal's loyalty from the pack and attach it to himself. As a result, the dog became the first domestic animal, and early man transported his dogs to every corner of the globe, including even Australia. Correlated with their intelligence, the dogs have a highly developed sense of play: no one who has seen a litter of fox-cubs playing will ever forget the charming sight.

The foxes provide an excellent illustration of one of the so-called Geographical Rules of zoology—the rule that in warm-blooded animals appendages like the limbs and ears decrease in size with increase of latitude, and so are smaller in arctic than in tropical regions. This is, of course, a straightforward adaptation to prevent heat-loss in the cold, to promote it in the warm. The exaggerated external ears of the Fennec Fox in the hot semi-desert regions of Africa serve chiefly to radiate heat out of the body; while those of the Arctic Fox are reduced to a minimum. The same thing, by the way, is to be seen in the elephants. The subarctic mammoth was small-eared, while the African elephant flaps his enormous ears to get rid of surplus heat from his huge body.

The bears took a quite different line of evolution. They are typically bulky and awkward-looking creatures, though sometimes capable of a surprising turn of speed, and are mostly omnivorous, though the Polar Bear is almost entirely flesh-eating. Their amiable appearance masks a dangerous and sometimes ferocious nature, especially in the Polar Bear and the giant Grizzly and Kodiak Bears, which may weigh nearly a ton. The young is born very tiny, usually in the den where the mother is living on her fat during the winter.

32 The Giant Panda, whose comical clown-like black-and-white pattern is so endearing, is that paradoxical creature, an entirely herbivorous carnivore. It looks like a bear, but has become specialized for living on bamboos in the moist forests of Western China. The ancestral panda had lost its true thumbs; but the Giant Panda has since enlarged a sesamoid bone in its hand as a substitute, with a rather makeshift joint like a clumsy thumb which renders it capable of grasping the bamboo shoots. Having apparently few enemies, and with an unlimited food supply at hand for the taking, the Giant Panda has no need for high intelligence, and indeed is distinctly stupid.

30-1, 33-4 Though the Giant Panda looks like a bear, it, like the pretty little ginger-coloured small Common Panda, is probably an offshoot of the Raccoon family. Raccoons, when dead, provide American college boys with coonskin coats: when alive, they are delightful little animals, very intelligent, with the curious habit of washing their food before eating.

36 Two other familiar Zoo representatives of the Raccoon family are the amiable Kinkajou, 35 with its prehensile tail, and the inquisitive tree-living Coati, with its long uptilted snout. The coati has a passion for scent: if you give it a piece of blotting-paper with a few drops of scent on it, the coati will roll it into a ball, sniff at it, and then rub it up and down the root of its tail!

There remains one further large branch of land carnivores—the Weasel family. The typical weasel is a long slinky creature with short legs, specialized for pursuing its prey through dense cover or underbrush. Our British Weasel and Stoat are an excellent example of a frequent phenomenon—the utilization of two different-sized versions of an almost identical model to cope with different-sized prey. The chief difference between them, apart from size, is that stoats in the northern part of their range turn white in winter, when their skins are used as ermine. 37-8 The weasel tribe indeed provides some of the finest furs in the world, like Skunk and Marten, and especially Mink and Sable.

Other weasels have taken to the trees, like the Pine Marten (now, alas, extremely rare in Britain) and the Beech Marten, while the Glutton is the biggest and most formidable member of the group.

Badgers too belong to the weasel family. They are mostly omnivorous burrowers, and have evolved a stockier body with powerful fore-limbs. In spite of its rather clumsy look, our British species is a playful creature, whose interesting habits, such as airing its bedding and spring cleaning its set (as a badger's burrow is called) have been excellently described in Ernest Neal's *The Badger*.

40 The Otters are essentially large weasels which have become specialized for an aquatic, fish-eating life, with webbed feet and wonderful powers of swift swimming under water. Our British Otter even when adult is one of the most playful of animals; it has invented the sport of sliding on snow, either glissading down a slope on its belly or sliding for a short distance (apparently sometimes on its back) after getting up speed on the level.

The Sea-Otter is even more aquatic, and has taken to living on clams and sea-urchins: it has a precious pelt, and is very much bigger. It is exceedingly rare, and you are never likely to find one in a Zoo: but in Bourlière's admirable book, *The Natural History of Mammals*, you can see pictures of it asleep floating on its back, with its arms grasping a frond of kelp to prevent itself drifting out to sea. It is one of the half-dozen tool-using animals: when confronted with a clam-shell too strong to crack with its teeth, it fetches a stone from the bottom, turns on its back, puts the stone on its stomach, and breaks the clam open by hammering it on the stone.

There remain the Seals. These must have branched off from the ancestral carnivore stock very early in its evolutionary history, to become the truly aquatic section of the Order, with blubber underlying hair as chief heat-retaining mechanism, with feet not merely webbed but transformed into fin-like flippers, and with the capacity to stay submerged for fifteen to twenty minutes, and even to sleep on the bottom, coming up automatically to breathe at regular intervals.

41-50

Seals, as you can read in Fraser Darling's *Naturalist on Kona*, or Ronald Lockley's *Seals and the Curragh*, are in some ways appealingly human: they are playful, they are intelligent, they weep real tears, they indulge in a melancholy "singing" and in elaborate courting dances, they have attractive babies. There is indeed an old Norse legend that they were once men, partially transformed into fish by an only half-efficient spell.

In their 30 or 40 million years of evolution, the seals have radiated out into three main branches. Those which are described by Fraser Darling and Lockley, and can be seen in rocky bays round our coasts, belong to the most highly specialized branch, the earless seals. They have lost their external ears, and their hind legs have become so radically converted into swimming organs that they are quite useless on land. They include that giant among seals, the Sea-elephant, whose males have an inflatable proboscis, and may reach seven yards in length. The "seals" that perform in circuses and are fed for the delectation of Zoo visitors are more properly called sea-lions or eared seals. They still retain small external ears, and they can turn their hind flippers forward to serve as legs—though very clumsy ones—on land. They are astonishingly agile, and obviously enjoy doing acrobatic tricks such as balancing balls on their noses.

49-50

41-8

Lastly there is the Walrus, sole species of a strange type, whose appearance, with huge tusks and "walrus moustache", is familiar from Lewis Carroll's ballad of *The Walrus and the Carpenter*. Both tusks and moustache are adaptations for its specialized habit of feeding on bottom-living-creatures like clams and starfish: the tusks serve to rake the clams and other food out of or off the sea-bed, and the stiff quill-like bristles of the moustache help to shovel them into its mouth. They have solved the problem of sleeping in the sea by inflating their neck so as to drift about upright with only their nostrils out of water.

I have treated the carnivores in some detail, because they (with the aid of Suschitzky's photographs) illustrate so beautifully the basic evolutionary fact of adaptive radiation. Cats, hyenas, civets; bears, pandas, raccoons; dogs, wolves, foxes; weasels, badgers, otters; seals, sea-lions, walruses—all have sprung from the one original little pre-carnivore type of some 50 million years ago.

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At the other pole of specialization from the carnivores are the herbivores on which so many of them prey. Carnivores and herbivores have evolved in mutual relation. The carnivores have become ever more bold or more cunning for pursuit, the herbivores ever more alert or timid for escape. Increasing speed in the one has been met by increasing speed in the other; both have evolved their sense of smell to the highest pitch, while the herbivores show an extreme development of their other organs for distant detection—eyes and ears. Specialized herbivores need a huge bulk of food, so they must spend much of their waking life grazing or browsing or nibbling, often in the dangerous open spaces of grassy plains or fields. Their teeth have become cropping tools and miniature grindstones, while those of carnivores are made to grip and kill and cut.

The most elaborate and successful living machines for utilizing grass or leaves are the ruminants, which have radiated out to produce the array of deer and giraffes, antelopes, gazelles, sheep and goats, cattle and buffaloes. Their great biological invention was the ruminant stomach, which enables them to chew the cud—in other words to bolt their food in the open, and then, in some less dangerous spot, to bring it up again, to be ground fine in the mouth. One of the most fascinating things in the Zoo is the sight of a giraffe's cud travelling slowly up his long neck to be chewed.

51-2 Most ruminants (such as sheep, for instance) have lost their upper incisor teeth, and use their gums, aided by their lips and their large and powerful and often roughened tongues, to crop their food. Their molar teeth are truly grinders, little millstones with projecting ridges, as you can see if you pick up a sheep's or cow's tooth in the fields.

As for their legs, they are mostly long, for speed. For greater strength they have become pillar-like, with the side-toes lost, the basal bones of the two centre ones fused into a single cannon-bone; their nails, instead of growing out as claws, have become hooves—a pair of horny shoes on each foot, for better grip on the ground. As most baby ruminants have to run with their parents from the start instead of growing up in a safe den or lair, they are born with disproportionately long legs, and can keep up with their mothers a few hours after birth—an astonishing achievement of nature.

55-62 The antelopes are, I would say, the perfection of ruminant life. The pictures show their large liquid eyes for detecting an enemy far off, their big and mobile ears to catch every sound, their sensitive nostrils, and their long faces to accommodate their battery of grinding teeth and their enormous smelling organs. These last are spread out over scrolls of thin bone in the nose, as you can see in a sheep's or cow's skull. Their beautiful legs are sometimes more aristocratic-looking even than those of a racehorse.

62 Most ruminants have horns, often in both sexes, but in most deer and some antelopes only in the males. They can be powerful weapons of defence, like the sabre-shaped horns of the Oryx which are dangerous even to lions; or equally powerful weapons of offence, for fighting between  
70-1 males, like the horns of bison and wild bulls.

The most amazing are the antlers of deer, which strictly speaking ought not to be called horns, as they are just naked bone, without any horny sheath. Except in reindeer, only the stags grow them, while the hinds are hornless. Each year the antlers fall off, and grow again next season. A knob of bone buds out of the skull, covered with the soft skin, full of blood-vessels, called the velvet. The bud grows and branches, and eventually the velvet dries and is wiped off by the stag. The young stag forms only a single spike, but in each succeeding year new branches or "points" are produced, until a large red deer or wapiti may have twenty points or more. Stags use their antlers in duels for their harems of hinds; but the antlers seem to be useful also in preventing unnecessary fighting: when a young stag sees the huge antlers of an old animal, he usually thinks better of challenging him, and sheers off. 65-7 68

The Reindeer and the Caribou have antlers in both sexes, and antlers with a peculiar downward-projecting brow-tine: it has been suggested that this may help the animals clear the snow from the lichen on which they feed. The Pronghorns of North America are antelopes which, however, resemble deer in shedding their horns each year. 66

Ruminants vary in size even more than carnivores, from a few pounds to over a ton, ranging from tiny Chevrotains or Mouse-deer up to Giant Elands, Moose, Wild Cattle and Bison. The majority of them are gregarious. The Bison—miscalled Buffalo—once roamed the American prairies in huge hordes: now they survive only in special reserves. The bulls are magnificent creatures, with enormous shaggy heads and fore-quarters. 63 70-1

The Yak is an ox whose funny-looking coat of long hair is an adaptation to the cold of the high plateaus of Central Asia that are its home: like the true Wild Ox or Aurochs, it has been domesticated by man. Among domestic beasts none are finer than the Ankole and Watusi Cattle of East Africa, with their immense sweeping horns. In old days they were used, rather like tanks, in tribal warfare: herds were driven down steep hills into the enemy ranks. 76 74-5

Giraffes are without doubt the most spectacularly improbable of mammals: as the country bumpkin said when he first saw one in the Zoo, "I always said as how there wasn't any such an animal, and now I've seen one I know there isn't." They represent the extreme of specialization possible for browsing on high foliage. They grow 17 or 18 feet tall, and it is a never-to-be-forgotten sight to see a giraffe bring his great head with its liquid eyes down from its towering height to the level of the mere human visitor. Their enormously elongated neck enables them to reach food inaccessible to any other land mammal, and serves as a periscope which they can protrude above the sea of foliage to scan the horizon for enemies. When next you go to the Zoo, you can see the giraffe's eighteen-inch snaky tongue, which in nature serves to pull the leaves off the branches of the thorn-trees, while the lozenge pattern of its skin is a beautiful bit of disruptive camouflage. 84-6, III

Giraffes too have horns, but these are merely little stumps of bone covered with skin and hair. They fight by striking sideways and downwards with the head: in the giraffe house at the London Zoo is a glass plate covering a dent in the wooden pillar, which, as the inscription tells

you, was caused by a blow aimed by a giraffe at its keeper—a blow which luckily missed its mark.

One of the most exciting zoological events of the twentieth century was the discovery by Sir Harry Johnston, of the Okapi in Central Africa. The striped skin first suggested that it was a forest zebra, but when a whole specimen was secured, it turned out to be a short-necked giraffe specialized for life in the equatorial forest instead of in the thorn-tree savannah of the African game-plains.

82-3 Besides the true ruminants, the even-toed ungulates include the camels and the pigs. Everybody knows what a camel looks like, but few people know that in all probability no truly wild camels exist. They are all domesticated, and the "wild" camels of central Australia and southern Spain should more properly be called feral—animals which have escaped from their slavery to man to establish themselves in freedom in new surroundings. Most people associate camels with the Sahara; but camels were not introduced into Africa until the beginning of the Christian era, so that the great desert remained uncrossed before the late Roman Empire.

Camels have three remarkable adaptations for desert life—their stomachs, their feet and their humps. The Zoo visitor unfortunately cannot see the extraordinary complexity of the camel's stomach, which enables the animal (among other things) to store water for astonishingly long periods: a good camel can go easily five days without drinking. But he can see the feet, with their ingenious cushion-like pads that spread the animal's weight on soft sand; and the humps, which serve as a reserve of fat for the animal to draw upon when food is scarce or even absent. The humps also serve man as a source of food: in the souks of North Africa and the Middle East you can see skinned camel humps exposed for sale, the white fat tastefully cut into decorative patterns.

Remains the pig family. The pig is a monument to man's ability to transform nature. The best domestic breeds are huge, fat, greedy and dirty: but the wild boar, from which they have been skilfully derived by a few thousand years of selective breeding, is a fierce, lean, and active creature.

87-8 Some wild pigs, like the Warthog and the Red River Hog, are endearingly ugly. It is a delightful sight to see a warthog in Africa bolting for safety with his little tail held stiffly erect, and then, when he gets to his burrow, quickly reversing to go down stern first, so that his tusks are ready to face an attacker.

90-4 Hippopotamus means river-horse: and certainly hippos look very horse-like when seen in the water with only the tops of their heads protruding. Zoologically, however, they are giant pigs specialized for life in tropical lakes and rivers. They can stay submerged for many minutes at a time, and can walk about on the river-bottom. But they mostly feed on land: in central Africa you can see their well-trodden paths leading from the water's edge to their feeding-grounds. When not feeding, they find safety in the water, and spend much of their time floating at the surface with just their nostrils and eyes and the top of their heads emerging.

The other chief group of herbivores is the odd-toed ungulates or Perissodactyles, in which

the central of the five toes has been enlarged, instead of the middle and fourth toes together, as in the even-toed group. In the horses, only the middle toe is left; in the tapirs and rhinos the middle toe is enlarged, but the hind feet are three-toed, and the fore-feet four-toed or three-toed, thus spreading the animal's weight.

The horse family includes the wild horses, the wild asses, and the zebras ("donkeys in football jerseys", as the little boy called them). They are the aristocrats of the odd-toed ungulates, beautifully specialized for grass-eating and rapid running. But they were at a biological disadvantage as against the ruminants in not being able to chew the cud; and accordingly, while the ruminants spread and multiplied, the horses have been reduced to a handful of species. 96-100

The tapirs are nocturnal browsers, with the nose turned into an incipient trunk. They live in moist tropical forests, where they provide one of the rare sources of meat to the human inhabitants. They are a primitive and in the long run a rather unsuccessful type: the group was widespread in the warm climates of 10 to 20 million years ago, extending even to western Europe and Britain; but most of them became extinct before or early in the Ice Age, leaving only two widely separated remnants, one in tropical America, the other in Malaya—a striking example of discontinuous distribution, but explained by past history. 95

Rhinoceroses too were once much more widespread. Today some of them are on the verge of extinction owing to the unfortunate superstition prevalent in India and China, that their horns are a potent medicine for male sexual debility. They include the most prehistoric-looking of all mammals, with their nasal horns (*rhinoceros* means nose-horn), in the White Rhino up to five feet long, their semi-jointed armour of thickened hide, and their stupidity. In spite of their clumsy appearance, they can get up a speed of nearly 30 miles an hour, and the blind charges of African rhinos are extremely alarming. Like various large herbivores, some of them have fixed rounds for their grazing, moving on day by day to complete the circuit in two or three weeks. In Malaya, one caused considerable perturbation by walking through a temporary hospital that had been erected on its track. 100-4

In the tropics, really large mammals, with their low surface relative to their bulk, not only have no need of a hairy coat, but are under the biological necessity of getting rid of it so as to lose heat more easily. Accordingly we find that existing hippos, rhinos and elephants all have their hair reduced to a minimum, though extinct species, from cold climates, like the Woolly Rhinoceros and the Mammoth, had an abundant coat.

In passing, I may mention that the extreme of hairlessness has been evolved in the Sand-rat or Sand-puppy, *Heterocephalus glaber*. This ugly little rodent burrows in the loose sand of the Somaliland deserts, which is often hot enough to blister a man's hand. In relation to this unpleasant habitat it is entirely naked, apart from a few sensitive hairs on its wrinkled leathery skin.

Elephants are sometimes lumped together with rhinos and hippos under the name of pachyderms or "thick-hides". But this common characteristic has been independently evolved, and does not indicate common ancestry.

Elephants are the largest existing land animals: a big African bull elephant may weigh up to six tons. In spite of their necessarily awkward-looking legs, which have to be made like big pillars to support their huge bulk, elephants are very far from being clumsy, but are capable of remarkable manipulative skill (strictly speaking, I suppose one should not say manipulative, which implies the possession of hands, but trombipulative, for it is their trunks which, with their strength and flexibility, provide them with a handling organ). As elsewhere, manipulative capacity has promoted intelligence; this is very evident when you see captive elephants stacking great logs of timber.

To me at least, elephants are the most interesting of animals, not excluding dogs or apes. Not only their intelligence and skill, but their docility, their social organization, their daily habits and their love-life are fascinating, as you can read in J. H. Williams' delightful book *Elephant Bill*.

Elephants also have the most specialized teeth of any animal. Their upper incisors have grown into tusks, which may reach eleven feet in length and anything up to 226 pounds apiece in weight—much heavier than even a big man: toothache in a sixteen-stone tooth would be formidable! The grinders are equally unique. They are elaborately ridged and much elongated, and come into action successively, new ones being pushed forward by the growth of bone behind them and its resorption in front of them, as the old ones are ground down to nothing by use.

Elephants, besides being the largest land animals, are the longest-lived of all non-human mammals, with a life-span up to nearly 70 years; and they have the longest gestation period of any animal—between 20 and 21 months. I once saw a pregnant cow elephant in an American Zoo, who was so puzzled and bothered by the quickening of her baby inside her that every time the foetus moved the mother tried to kick it with her hind foot!

Elephants, both Indian and African, have often been used in war. Some of the elephants with which Hannibal crossed the Alps were Indian, but most were African, though they were not the familiar giant bush type, but belonged to the smaller forest species. This was abundant in North Africa in classical times, but was later exterminated there through deforestation and human persecution. When I attended the International Ornithological Congress in Basle last year, I saw on the Cathedral what seems to be the first representation of elephants north of the Alps: but the sculptor can only have known of them by hearsay, as his version is singularly far from the truth.

After the elephants, the whales. Though the African elephant is the biggest of all land animals, he is so much smaller than a big whalebone whale that he would have ample clearance top and bottom within a whale's skin; for the biggest whales reach nearly a hundred feet in length and well over a hundred tons in weight.

Blue Whales are also the fastest-growing of all organisms. Their ovum is no bigger than a woman's or any other placental mammal's. Yet from this microscopic speck a new-born whale

eight yards long and weighing over ten tons is produced in 11 or 12 months; and at two years, it is said, the female Blue Whale is seventy feet long and ready to reproduce.

The basis for this astonishing growth is simple—super-abundant food. The whalebone whales get their name from the wonderful array of long thin horny plates called whalebone or baleen hanging inside the mouth-cavity from the upper jaw, which act as a filter to strain out food from the water taken in at the mouth. Whalebone whales in fact are filter-feeders, like sponges or oysters, but they are built on such a huge scale that the creatures they filter off are not microscopic, but quite large animals—small fish, the active pelagic snails known as sea-butterflies, and above all the two-to-three-inch shrimp *Euphausia superba* or krill, which occurs in vast swarms in subantarctic waters. Since the whales constantly migrate to where food is most abundant, it is hardly an exaggeration to say that they spend most of their life swimming through a magnified but uncooked Scotch broth, made with shrimps instead of barley: so it is no wonder they grow so fast.

Most cetaceans, however, are active hunters of large prey. The Sperm Whale is the largest carnivore in the world, reaching 50 to 60 feet in length, and feeding mainly on the gigantic squids and cuttlefish of the sea's middle deeps. In pursuit of these it can dive to extraordinary depths, and stay submerged for at least an hour and a quarter. The spiny suckers of the struggling squids leave scars all over the whale's head and fore-parts as you could see until recently, on the life-size model in the excellent exhibition of whales and whaling in the London Zoo.

Recent research seems to show that the "blow" of a whale, which it expels from its lungs on surfacing, is not just steam but a spout of foamy material containing myriads of fatty droplets. The fat serves to absorb the nitrogen of the inspired air and prevent it entering the blood under pressure during diving, so preventing the animal from suffering from what divers call the bends, the terrible cramps due to bubbles of nitrogen forming in the blood when the diver returns too quickly to the surface from a deep dive. The Sperm Whales dive deeper than any other whales and the huge reservoir of spermaceti in their heads seems to be a store of the fatty material needed to make the safeguarding foam.

Whaling has so sadly reduced the world's stock of whales, that there has had to be an international agreement rationing the quantity that may be taken. Even so, the position is disquieting, and the regulations may have to be tightened up.

The whales provide an excellent demonstration of the superiority of the placental mammal to other vertebrate models, for even though they have had to readapt themselves from land to sea-life, they have attained a larger size and greater speed than any fish, whether carnivores like the giant toothed sharks, or filter-feeders like the basking sharks, which only reach some 40 feet in length. Blue whales can propel their huge bulk through the water at the astonishing rate of nearly 25 miles an hour, and can maintain a cruising speed of 14 or 15 knots for hours on end.

Besides these giants there are many other products of the cetacean radiation—ferocious Killer Whales preying on other whales and on seals, fish-eating Dolphins and Porpoises, and Narwhals. Male Narwhals have their left upper front tooth prolonged into a long spirally-grooved

ivory "horn". In the Middle Ages this commanded enormous prices as unicorn's horn, to which all kinds of magic virtues were ascribed. Even when, as occasionally happens, narwhals grow a second tusk on the right, it too has a left-handed spiral. This asymmetry of the narwhal's tusk is a special case of the general asymmetry of the skull in all Cetacea, which you can see in the skeletons in the Natural History Museum: but what the reason for this may be, we do not know.

Porpoises can now be successfully kept in captivity in the great modern aquaria, like Marineland in the U.S.A., which serve as the Whipsnades of the sea. Here they are revealed as intelligent, playful and good-humoured creatures. They are even capable of purposeful and altruistic co-operation. When a newly-introduced porpoise stunned itself against the wall of the aquarium, two others swam down on either side of it, lifted it to the surface, and held it there so that it could breathe until it recovered. Such actions presumably are an extension of the necessary instinct of the female porpoise, which lifts her newborn baby to breathe at the surface until it is capable of taking care of its own respiration.

Cetaceans provide beautiful illustrations of the evolutionary processes. The fact that they are descended from four-legged, hairy-coated land mammals is shown by the vestigial hind-limb bones embedded in their flanks, and the few bristly hairs on the smooth blubber-lined skin near their mouth. And the process of adaptation to special environment and mode of life is demonstrated by their secondary evolution of a streamlined body-form deceptively like that of a swift-swimming fish. Such convergent evolution is frequent, but is never complete in every detail: in cetaceans, for instance, though propulsion depends mainly on the tail, as in fish, the tail-fin is set horizontally instead of vertically.

Anyone who wants to learn more about whales should read Herman Melville's great book *Moby Dick*, which combines observed natural history with mythological imagination in a remarkable way.

Now let us pass from maximum to minimum size. In the fable, the enormous elephant is freed by the tiny mouse, which is less than one hundred-thousandth of his weight. But an elephant is much smaller than a whale, and an ordinary mouse is some seven times as heavy as a harvest mouse, which weighs only about a fifth of an ounce. (Actually, the Pigmy Shrew is even a little smaller, but I am sticking to mice as more familiar.) Thus a big whalebone whale is about 30 million times heavier than an average harvest-mouse.

Mice are typical rodents, and rodents are typically small: the South American Capybara, a giant aquatic cavy which may grow to a length of four feet, is very exceptional.

Small size is a disadvantage to warm-blooded animals in cold climates, because as the bulk of the animal grows *absolutely* smaller, its surface, through which it loses heat to the outer air, becomes *relatively* larger: of two animals of the same shape, but one with twice the length of the other, the smaller will have one-eighth of the larger's bulk, but one-quarter of its surface. Accordingly we find that as we travel polewards, harvest-mice fade out before mice, mice before lemmings, and lemmings before hares.

Rodent means gnawer: and rodents are mammals which have their front or incisor teeth transformed into gnawing tools—little curved chisels with permanently growing roots, constantly pushing out new tooth-substance to take the place of what is worn away. When one of a pair of opposed teeth is lost, the other, meeting no resistance, goes on growing, sometimes right through the animal's skull.

Rodents have radiated to produce a great variety of specialized models: there are the familiar rats and mice; the pack-rats and the aquatic muskrats or musquash; chinchillas with their wonderful fur; the hamsters; the jumping jerboas and kangaroo rats of arid regions; the squirrels—tree-squirrels, flying squirrels and ground-squirrels; the cavies; the beavers with their engineering instincts; the cane-rats and coypus; and the porcupines with their formidable quills. 121-2  
113-14  
117-18  
119-20

The cavies include the aforementioned Capybaras, the familiar Guinea-pigs, and the Patagonian cavies that you can see wandering about at Whipsnade, which have evolved into imitation hares, but with an absurd little black button for a tail. The Coypu, whose valuable fur is called nutria, is a big aquatic animal which may weigh up to 20 lbs. The "giant sewer-rats" exhibited in fairs are not rats at all, but harmless herbivorous Coypus. Coypus which escaped from fur-farms have now established themselves over a wide area in East Anglia. 115, 118  
117

Muskrats too escaped from British fur-farms and spread with alarming rapidity. As their burrows do serious damage to the banks of streams and canals, an extensive campaign was organized against them, and they were eventually exterminated in Britain.

Hares and Rabbits used to be classed with the Rodents; but though they possess gnawing front teeth, these seem to have been evolved quite independently, and they are now placed in a separate group. Though both they and the true rodents have permanently growing incisor-teeth for gnawing, and also cheek-pouches for hastily gathered food to be taken away from danger and chewed or stored at leisure (thus fulfilling some of the functions of the ruminant's stomach), these devices seem to be the product of adaptive convergence, and to have been independently evolved in the two stocks. 111-12

Although rabbits are among the most familiar of animals, it was only in 1939 that the extraordinary nature of their feeding and digestive habits was discovered (or more strictly, rediscovered, since it was originally described in a paper in a veterinary journal in 1882, but then overlooked and forgotten). They practise what is known as *refection* (which, by the way, has nothing to do with what happens in a monastic Refectory). They nibble and graze morning and evening. As the food passes through the gut, it is partially digested, and enriched with B-vitamins by the action of bacteria in the large intestine. Then, when they are back in their burrows during the middle of the day and also around midnight, it is extruded in the form of soft droppings, and immediately re-eaten! In its second passage through the alimentary canal, the valuable B-vitamins are absorbed, digestion is completed, and the unusable residue is voided in the familiar hard pellets.

Hares too practise this "double eating": and it is possible that the habit was known in

antiquity, but later forgotten. For refection is not dissimilar to chewing the cud; and in the Bible, the hare is declared tabu as food for the reason that "he cheweth the cud but divideth not the hoof" (Lev. xi. 6.).

People tend to be sentimental about "dear little bunnies". But though baby rabbits are certainly very attractive, the adults have many less agreeable traits. Thus their sexual life may be described as promiscuous-polygamous. The does will mate with any buck which happens to be available: the bucks fight for this availability, and each warren is usually the sexual kingdom of one old male tyrant. They also do a great deal of damage. The losses caused by rabbits to agriculture in Britain, before the introduction of myxomatosis, were conservatively estimated at fifty million pounds a year; and in Australia they reached astronomical proportions. Myxomatosis should be a great boon to the human species.

Rabbits are not indigenous to north-western Europe. In Britain they were introduced in historical times, possibly by the Romans, but more probably by the Normans. During the Middle Ages, warrens were valuable properties, yielding fur, and the species had to be carefully protected. Rabbits were hardly known in Scotland before the nineteenth century, and only well within the last hundred years did they become so abundant in Britain as to constitute a pest. These at first sight puzzling facts are almost certainly due to the extermination or reduction of their natural enemies—birds of prey, foxes, stoats, and other carnivores.

Rabbits, including the American Cotton-tail as well as our European species, provide an admirable example of recognition marks; their white tails, elevated as they run to their burrows in alarm, serve as signals of danger and guides to safety for their fellows, who have frequently been alerted by an auditory warning signal—a violent thumping with the hind feet. It is only man's cleverness in inventing long-range weapons which has turned this device into a liability. Many deer and antelopes employ their tails in a similar but even more striking fashion.

111-12

In domestication, the rabbit, together with the Rockdove, the Jungle-fowl, the cat, the horse, and of course the dog (though here the picture is complicated by the possible double origin of domestic dogs from two wild species) demonstrates the power of conscious human selection to produce new types, and to realize possibilities which natural selection was unable to elicit.

This has not happened with hares. Indeed man has never fully domesticated hares, in the sense of establishing permanent breeds, though various people, including the poet Cowper, have succeeded in keeping individual hares as pets.

The Hare differs from the Rabbit in being solitary instead of gregarious, and in sleeping or resting in a "form" in the open, instead of in the safety of a burrow. In relation to this latter fact, not only are hares much longer-legged and speedier than rabbits, but are born in a much more developed state and can run much sooner.

The British hares provide a small-scale example of what we shall see illustrated on a large scale by the Marsupials—the effect of geographical accidents on biological evolution. There are two species of hare in Europe, the Brown Hare, adapted to warmer conditions, and the Blue

Hare, to colder ones. At the end of the Ice Age both Britain and Ireland were still connected with the Continent, and the cold-loving Blue Hare was soon able to colonize them as the ice retreated. But the area was not warm enough for the Brown Hare until a good deal later, and by this time Ireland had been cut off from Britain. Accordingly in Britain the two species competed, and the Blue Hare became restricted to the mountains of Scotland, which were too cold for the Brown Hare. But in Ireland there was no competition, and the Blue Hare was able to establish itself all over the country, on low as well as high ground. In this milder climate, the Irish population of Blue Hares has evolved into a distinct subspecies, and has almost lost the capacity to turn white in winter, which is found in the Scottish subspecies and to an even greater extent in the Blue Hares of Scandinavia.

The Brown Hare's remarkable mating antics in early spring have given rise to the phrase "as mad as a March Hare", and to the creation by Lewis Carroll of that agreeably crazy character, the March Hare, in *Alice in Wonderland*.

I have left the Insectivores to the end of the Placentals, though logically, or at least biologically, they should be close to the beginning. For they are a primitive group, whose construction must be very like that of the earliest placentals, back in the Cretaceous epoch nearly 70 million years ago.

Specialized forms almost invariably lose certain structures, while other structures of the same sort are strongly differentiated or enlarged. Thus, in ruminants, only two toes remain on each foot, but they are elongated and very much specialized for tiptoe running, with only the enlarged nail or hoof in contact with the ground: and they have lost their upper incisor and dog-teeth, while their molars have become large and elaborate grinding mechanisms. In contrast, carnivores have their dog-teeth much enlarged, while some of the molars have been lost.

The insectivores have remained generalized: they retain the placentals' full original complement of teeth and toes—44 teeth and 20 toes; they run on the soles of their feet, not on the tips of their toes; and their brains are primitive, with small and poorly-constructed cerebral hemispheres. They are an excellent example of a persistent primitive type.

However, like all other groups, they have radiated out into different ways of life. There are three main subtypes in western Europe—the little Shrews, which look rather like mice but are in no way related to them, and include species that are unique among mammals in having a venomous bite; the Hedgehog, which protects itself by rolling into a ball bristling with sharp spines; and the Mole. The mole is a miracle of specialization for an underground life. Its limbs have been converted into exceedingly efficient shovels for scooping out the earth loosened by the powerful snout; the fur is so dense that it does not get messed up with earth; and the eyes have degenerated to mere useless vestiges. It can tunnel through the earth at a speed of ten or even twelve feet an hour. It must be very efficient at its job of capturing earthworms, since it needs more than its own weight of worms every day to keep alive.

In warmer regions there are the large aquatic Desmans, with webbed feet; the jumping jerboa-like Elephant-shrews; and the arboreal Tree-shrews. The Tree-shrews are particularly

interesting, for in their anatomy and habits they must be very like the ancestral form from which the Primates, including ourselves, are descended.

125 Bats may be described as flying insectivores. Their specialization for aerial life started very early in placental evolution, probably 50 million years ago, and by now they are represented by a large number of species of very different types. However, although definitely a successful evolutionary experiment, they are not nearly so successful as the other group of aerial warm-blooded vertebrates, the birds. They are neither so numerous, nor so varied, and they do not range into nearly such high latitudes. This falling short is due, it seems, to two facts. First, their flying organs are not made of dead horny feathers but of bare warm living skin with a jointed framework of slender bones (mainly the enormously elongated bones of the second to fifth fingers), and so they lose heat much more readily. And secondly, both fore and hind limbs have been roped in to the construction of their wings, while in birds the hind limbs were left wholly free and so could become specialized in all sorts of useful ways, such as swimming, running, or gripping prey, which were impossible in bats.

Quite recently it has been discovered that bats find their prey and avoid obstacles by a kind of sound-radar. When in flight they emit "supersonic" squeaks all the time, 20 or 30 or more every second, and these sounds reflected back to their ears give warning of any solid object in the vicinity. When this was first discovered, biologists were puzzled as to how the bat was able to distinguish the reflected echo from the original sound. The answer is simple—they never hear the original sound: they have a wonderful piece of nervous machinery which automatically puts the ear out of action (by causing a little muscle to contract) each time the "supersonic" squeak is produced. I have put "supersonic" in quotes, because the sounds are supersonic only to us: the bat's ear is of course perfectly able to hear them.

There are two major types of bat—the little short-faced bats, to which all European and indeed all temperate species belong, and the long-faced fruit-bats or "flying foxes" from the tropics, which are much bigger, with a wing-spread of up to five feet.

125 The fruit-bats are easier to keep in captivity, and are the type you are likely to find in a Zoo. Though they can crawl about with the aid of their clawed thumbs, they spend most of their time, when not in the air, hanging head downwards by their hind feet, and with their leathery wings, which look rather like bits of an umbrella, wrapped round their furry bodies. In the tropics you may see vast roosts of flying-foxes all suspended like large animated fruits from the upper branches of tall trees. As they fly in to roost, they suddenly turn head downwards and hook themselves on to a branch with amazing agility.

It is interesting to find that, just as some flowers depend for their fertilization on moths, others on bees, others on birds, still others rely on fruit-bats as their pollinators. As bats apparently have a great dislike of getting their wings tangled up among leaves, such flowers are usually borne on long pendant spikes hanging down clear of the tree's foliage.

The short-faced small bats were originally and typically still are insect-eaters; but some have

specialized on new diets. The ill-famed Vampires, though unpleasant enough, bear very little resemblance to the Dracula-like figments of travellers' tales. They are quite small, the common species only about three inches in body-length. They have large sharp upper incisors shaped "like small guillotines", to quote one authority: with these they scrape a shallow wound in the skin, and lap up the blood with their tongues like a cat lapping milk. Cattle and especially horses are the chief sufferers, though hens and human beings are occasionally attacked. Another bat has taken to a fish diet, swooping down like an Osprey to catch fish at the surface of the water by means of its clawed hind-feet.

★

This rapid survey makes it clear, I hope, that each different type of placental mammal is adapted to and specialized for some particular way and place of life. That gives us the basic answer to *why* they are what they are; but there remains the question of *how* they have become what they are. Just on a century ago, Darwin gave the basic answer to this: by natural selection accumulating favourable variations so as to produce a gradual change towards better adaptation and fuller specialization. During the last fifty years, this purely theoretical answer of Darwin's has been confirmed by the progress of genetics on the one hand, and by the evidence of fossils on the other. I don't propose to go into the genetical side of the matter, beyond saying that we have plenty of evidence that natural selection is everywhere in operation, and can produce evolutionary change by working on the small units of variation provided by the mutation of genes and inherited in Mendelian fashion.

Fossils often show us the actual course of evolution: and whenever this is so, the picture is of a slow change, a progressive specialization over tens of millions of years, usually affecting many separate species and lines of one stock at the same time.

The best example is still the earliest to be discovered—the horse family, of whose characters and evolution Dr G. G. Simpson gives an admirable account in his book *Horses*. All horses today have only one toe per foot, with the side toes reduced to vestigial splint-bones. But, as you can see in the Natural History Museum, there was a time when some horses were one-toed and others three-toed, and a still earlier time when all were three-toed. What is more, these earlier horses (or pre-horses as they might better be called) were all much smaller and shorter-legged, their grinding teeth were shorter and had less complicated grinding patterns, and their three equal toes had much less well-developed hooves. Furthermore, horse fossils are abundant enough to demonstrate the imperceptible gradualness of the transformation from the three-toed to the one-toed modern type, which took over 30 million years.

They also demonstrate a second very important point—namely that the process eventually stopped, and the horse type became stabilized: from about 5 million years ago it has shown no essential change, no further movement in the old direction, but merely a ringing of minor changes—wild horses, asses and zebras—on the established theme of the one-toed high-toothed

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type: selection had pushed the stock as far as it could profitably go in this particular direction. It took a long time to exhaust the possibilities of this trend of specialization; but exhausted they eventually were, and from then on selection acted to stabilize the type, not to change it.

A third point revealed by the fossils is the fact of widespread extinction. Most of the three-toed lines were not transformed into one-toed types, but after a shorter or longer time simply died out, as did many one-toed species (including all those inhabiting the New World during the Ice Age.)

These three facts about the course of adaptive radiation seem to hold good universally—gradual improvement for a particular way of life, accompanied by extinction of many side branches, and ending in stabilization without further improvement. The fossil record reveals the same sort of thing happening in all the other mammal types which have left sufficient fossil remains, including elephants, ruminants, camels, carnivores, rodents and rhinoceroses.

The fossil record also reveals two other interesting and indeed remarkable facts. One is the existence of periods when extinction is much more widespread than in others. For the mammals, such a drastic time was the Pleistocene or Ice Age, when a large number of powerful and previously successful types were wiped out—sabre-toothed tigers, giant sloths, mastodons and mammoths, giant bison and wild cattle, cave-bears and cave-lions, Irish elk (giant fallow-deer), giant armadillos with one-piece armour (Glyptodons), woolly rhinoceroses, giant beavers, the South American false horses (Litopterna), the strange odd-toed but clawed herbivores called Chalicotheres, and many others. Such widespread extinction seems usually to be due to drastic changes in climate, though towards the end of the Ice Age man's hunting must have accelerated the process.

The second fact is that the adaptive radiation of a large group such as the mammals takes place in successive bursts, and that many lines produced during the earlier bursts either become wholly extinct or much reduced in numbers and importance when faced with the competition of the later improved types. Thus in the odd-toed ungulates the huge horned Titanotheres had become dominant among herbivores by the Oligocene period, over 30 million years ago; but then they all became extinct, probably because they could not compete successfully with the later-evolving rhinoceroses. Among these latter, one of the earliest types to evolve and also to die out was the giant Baluchitherium, the largest land mammal known.

Other archaic herbivores originated, developed, and became extinct even earlier. Thus, at the very beginning of the Tertiary, perhaps 60 million years ago, during the Paleocene, the Dinocerata (or Amblypods), a group of clumsy primitive herbivores with five toes and unconvoluted brains, developed rapidly, giving rise to strange types like Uintatherium: this was a bulky creature with four horns and huge tusk-like canines in the upper jaw. However, they all disappeared before the end of the Eocene, doubtless overwhelmed by the competition of other later-developing ungulates, bigger-brained and more mechanically efficient.

Another early and soon-extinguished line of archaic herbivores is represented by the

extraordinary *Arsinoitherium*, with its pair of enormous frontal horns, from the Lower Oligocene of Egypt, about 35 million years ago.

*Extinct Mammals:*  
11

Some early members of successful lines are often very peculiar. Thus the giraffes produced strange types with big irregular horns like *Sivatherium*. One line of elephants that enjoyed considerable success for a considerable time was that of the dinotheres (*Deinotherium*) of the Miocene and Pliocene periods. These animals possessed large down-turned lower tusks, presumably for digging, and probably a trunk.

*Extinct Mammals:*  
10, 2

These early-extinguished groups can perhaps be compared with early models of some new type of machine—hastily exploiting the possibilities of the situation, but so clumsy (and in the case of the mammal so stupid) that they could not compete with later models, more finely built and with more intelligence put into their construction; for the later-evolving groups of mammals were on the whole more agile and bigger-brained. But in addition, there were other early-evolving clumsy types of which a small number have managed to survive in spite of the competition of improved models, usually because they have successfully taken to some very special way of life. The most interesting of these are the Edentates (not so-called, as the little girl in the Zoo imagined, because they inhabited the Garden of Eden, but because their teeth are lacking or poorly developed). Among Zoo familiars in this group we have the Sloths, the Anteaters, the rather pig-like Armadillos (which also eat ants), and the Armadillos, which make up for their primitive general construction by their wonderful jointed bony armour-plating.

126, 127-30  
131-3

This succession of increasingly improved steps of construction has occurred not only within the Placentals, but in mammals as a whole. In the first main stage, the earliest mammals still laid large-yolked, shelled eggs like their reptilian ancestors. In the second or Marsupial stage, the embryo passes the early stages of development within the mother's body, but the arrangements for nourishing it are rather primitive, so that it must be born while still tiny, and from then on has to be sheltered in a special pouch or *marsupium* on its mother's belly, and fed by being glued to its mother's nipple. It was only in the third or placental stage that the embryo could continue to grow to a large size and advanced development in its maternal shelter before being born. The placentals also have improved the basic construction of their brains.

The advantages enjoyed by the placentals were so great that wherever they spread they caused the total extinction of the egg-laying mammals and the virtual extinction of the marsupials. In all the vast area of the Old World and the Americas, only two families of marsupials exist, one of them consisting only of rare and inconspicuous forms, and only one species, the North American Opossum (*Didelphis marsupialis*) has succeeded in colonizing the North American continent.

But, as every schoolboy knows, in Australia there are plenty of marsupials, and even two genera of egg-laying mammals. This is the result of a geographical accident. Land contacts between Australia and the rest of the world were severed some time in the Cretaceous, over 60 million years ago, before the appearance, or at least the successful rise, of the placentals. The

egg-laying and pouched mammals were in time to colonize Australia, but the sea barred the Placentals from entry there. Free from competition with their more efficient and later-evolved relatives, the Australian marsupials were able not merely to survive, but to undergo a large-scale adaptive radiation on their own, producing a number of creatures unknown elsewhere, like Kangaroos and Koalas.

134 But before dealing with this, I must say a word about the egg-laying mammals. They are a less efficient model than the marsupials: and so it came about that even in Australia they were almost extinguished. Two types only survived, the Duckbill Platypus and the Spiny Anteater or Echidna, and they only managed to do so by occupying very restricted niches in nature.

The first specimens of Platypus, sent back by the early explorers, were regarded by most zoologists as fakes:—how, they asked, could Nature produce an animal with fur and milk like a mammal, eggs like a reptile, and bill and webbed feet like a duck? Their suspicions were unjustified. The bill and the webbing of the feet are not ancestral, but specialized adaptations to life in the water; the fur and the milk are proofs of their mammalian nature; while the eggs are a relic of their reptilian descent. Though they are truly mammalian in secreting milk, they are very primitive in having no teats: the mother platypus lies on her back and squirts out her milk into a “saucer” of bare skin, whence the baby platypuses lap it up.

Platypuses are not uncommon in the rivers of the cooler parts of Australia, where they feed much after the manner of a duck. Echidnas, on the other hand, are specialized eaters of ants, living only in drier areas and protected from their enemies by formidable quills like a porcupine's.

Physicists and chemists sometimes tell the evolutionary biologist, with a touch of condescending pity, that his science is on an inferior plane because he can't make experiments. However, Nature can do so, and the cutting off of Australia from the rest of the world with a population of Marsupials but no Placentals was an outstanding experiment in evolution, enabling us to draw clear-cut conclusions.

The main conclusion is that all new types, provided they are free of more efficient competitors, will radiate out in the same general way, to exploit the different possibilities of the situation. In this case the marsupials, faced by the virgin spaces of Australia, produced almost the same range of types as the placentals did later in the rest of the world—fierce carnivores, including civet-like types such as the Dasyures and Native Cats, swift plains-living grass-eaters, tree-climbing and even parachuting omnivores, fruit-eaters, sloth-like leaf-eaters, ant-eaters, mole-like worm-eaters, marmot-like burrowers, creatures like mice and rats and jerboas, flower-feeders with brush-tongues, like those of the lorries or flower-feeding parrots, to suck up nectar and any insects that stick to it.

135 In addition to their two-hundred-odd existing species, the Australian marsupial stock produced some remarkable giant types which, like their placental counterparts, became extinct during the climatic revolutions of the Ice Age—herbivorous wombats as big as ground sloths or rhinoceroses, giant kangaroos much taller than a man, marsupial “lions”.

In this radiation, some types were evolved with an extraordinary superficial resemblance to their placental opposite numbers; the most remarkable of these are the Tasmanian Wolf and the Marsupial Mole, which any casual observer would take for a "real" wolf and mole, but which betray their true nature by their pouches and various details of their anatomy; while the Flying Phalanger (or Opossum, as it is commonly but erroneously called in Australia) is superficially very like a flying squirrel. 138-9

Other types fill the same niche in the economy of nature as their placental counterparts, but achieve this by means of a different mode of construction. The most familiar of these are of course the Kangaroos and Wallabies; but the Koala Bear leads a sloth's life right side up instead of upside-down and the Tasmanian Devil combines some of the characteristics of bears and wild-cats. 136-7, 1

Kangaroos are really extraordinary creatures. When at full speed they jump in prodigious bounds of their hind legs, with their tails stuck straight out behind: leaps of well over thirty feet have been recorded, and speeds up to 30 miles an hour. In walking, however, their tail acts as a fifth limb, on which and on their tiny fore-limbs they support themselves while swinging their hind-legs forward for the next step. And when in fighting mood, they use the tail like a shooting stick, occasionally resting all their weight on it while bringing up their hind-legs with their formidable claws to rip at the enemy.

The baby kangaroo is born when no bigger than a human thumb-joint, and still extremely under-developed, a mere embryo thrust into the harsh outer world. But, like all newborn marsupials, it is endowed with a powerful instinct to climb up whatever surface it finds itself on. In nature, this is the skin of a female kangaroo's belly, which its mother has made smooth for it by licking. Eventually its efforts bring it to the lip of the wide-open pouch: it tumbles in, finds a teat, and becomes glued to it for several weeks. Later it becomes unstuck and only takes nourishment at intervals; and eventually it leaves the pouch to explore the outer world and learn the taste of grass, but returns to its mother when tired or at the threat of danger. It is amusing to see a well-grown young kangaroo or wallaby scramble head-first into a pouch only just big enough to hold him, and then turn round so that he can stick his head out and survey the world.

There are several minor variations on the kangaroo theme—the Tree-Kangaroos, which manage to scramble about in trees without any very obvious arboreal adaptations; the Wallabies, which are smaller and less speedy versions of Kangaroos; and the Rock-Wallabies which scamper about the rocks and scree of the barren desert ranges of central Australia. In some parts of western Australia, wallabies are so abundant that they take the food out of the sheeps' mouths, and their numbers have to be kept down. 136-7

Koalas are known to everyone because of their comic teddy-bear appearance, with noses that look as if made out of leather. Their endearing qualities are, it must be admitted, partly the outcome of their trustful stupidity. They are trustful because they have no natural enemies, and stupid because their way of life makes very little call on intelligence. Unlike squirrels, or still 1

more, monkeys, they have not developed real hands—that is to say, organs capable of handling objects. All they have is a set of powerful curved hooks like sharp umbrella-handles (and also like the similar hooks by which the sloth suspends himself upside-down) with which they can hold on to prevent themselves falling, and which they can use to shovel bunches of leaves into their mouths. For they are not carnivorous hunters of tit-bits, but eat only leaves (about 2½ lb. a day), and leaves only of a few species of Eucalyptus.

Their trusting disposition makes them easy to photograph, as I found when I climbed a gum-tree (the first tree I had climbed in ten years) to take a picture of one: the animal simply sat and stared at me, until it was at the near limit of my camera. It also makes them easy to kill: and hundreds of thousands or perhaps even millions of them were killed in past years to make gloves out of their skins. As a final irony, many of the Koala-skin gloves were shipped to Canada, to be used by fur-trappers there, because they were cheaper than gloves from any Canadian fur-bearers!

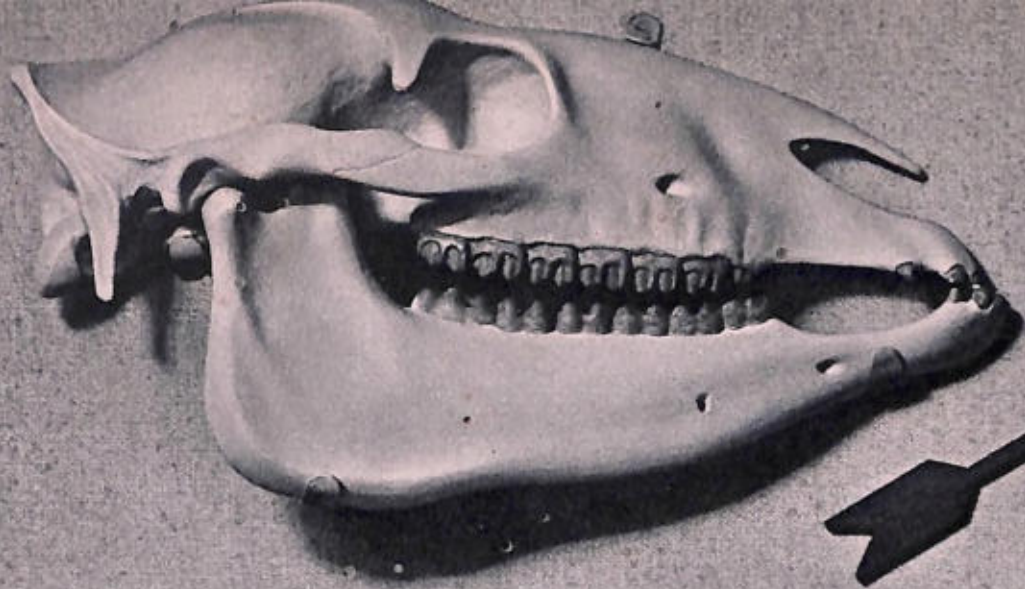
As a result, the species was almost exterminated. However, at the eleventh hour they were officially protected, and to such good purpose that they are now multiplying again, and surplus stock is being exported from the reserves to colonize Eucalyptus forests elsewhere.

I said before that no placentals had reached Australia. This is not strictly true. Flying animals can bridge a sea gap, and there are as many bats in Australia as in any other continent. In fact the fruit-bats or flying-foxes are so abundant in some parts as to be a menace to fruit-growers, as you can read in Francis Ratcliffe's delightful book of Australian natural history, *Flying Fox and Drifting Sand*.

Furthermore, small rodents have an almost uncanny capacity for getting transported across stretches of sea from island to island. A stock of such "island-hopping" rodents managed to reach Australia perhaps 15 or 20 million years ago, and have radiated out into a number of rat-like creatures not found elsewhere.

Much later, Man has introduced other placentals. The dog—"yellow dog dingo" as Kipling called him—ran wild after being brought in by the aborigines and is now a serious pest, killing thousands of sheep every year. Foxes were introduced to provide sport for the first colonists, and in some parts have become a scourge. And of course the rabbit, imported by the early white settlers to provide a source of meat, has multiplied to an extent unknown in its original home, to become Australia's Public Enemy No. 1. Luckily, research has at last found a weapon to use against it, in the shape of myxomatosis; and the probability now is that rabbits will be kept down to a reasonable level.

Indeed, whenever a placental mammal has been successfully introduced into the continent, it has shown itself superior to the native marsupials in the struggle for existence. The placental, as I said before, is an improved model of a mammal: its superiority resides not only in its more efficient method of reproduction, but also in its greater intelligence and versatility. Why evolution never led to high intelligence in Australian marsupials is somewhat of a mystery. Perhaps it has



### OLIGOCENE HORSE—*MIOHIPPIUS*.

Three complete toes on front foot, the outer toe being reduced to a short splint.  
Middle toe in front and hind feet much larger than the others. Foot longer than in *Eohippus*.  
Three premolar teeth exactly like the molar teeth. Crowns of the teeth a little higher than in *Eohippus*, and a little more complicated.  
*Miohippus* is ancestral to *Anchitherium* of the Miocene of Europe.



### EOCENE HORSE—*EOHIPPIUS*.

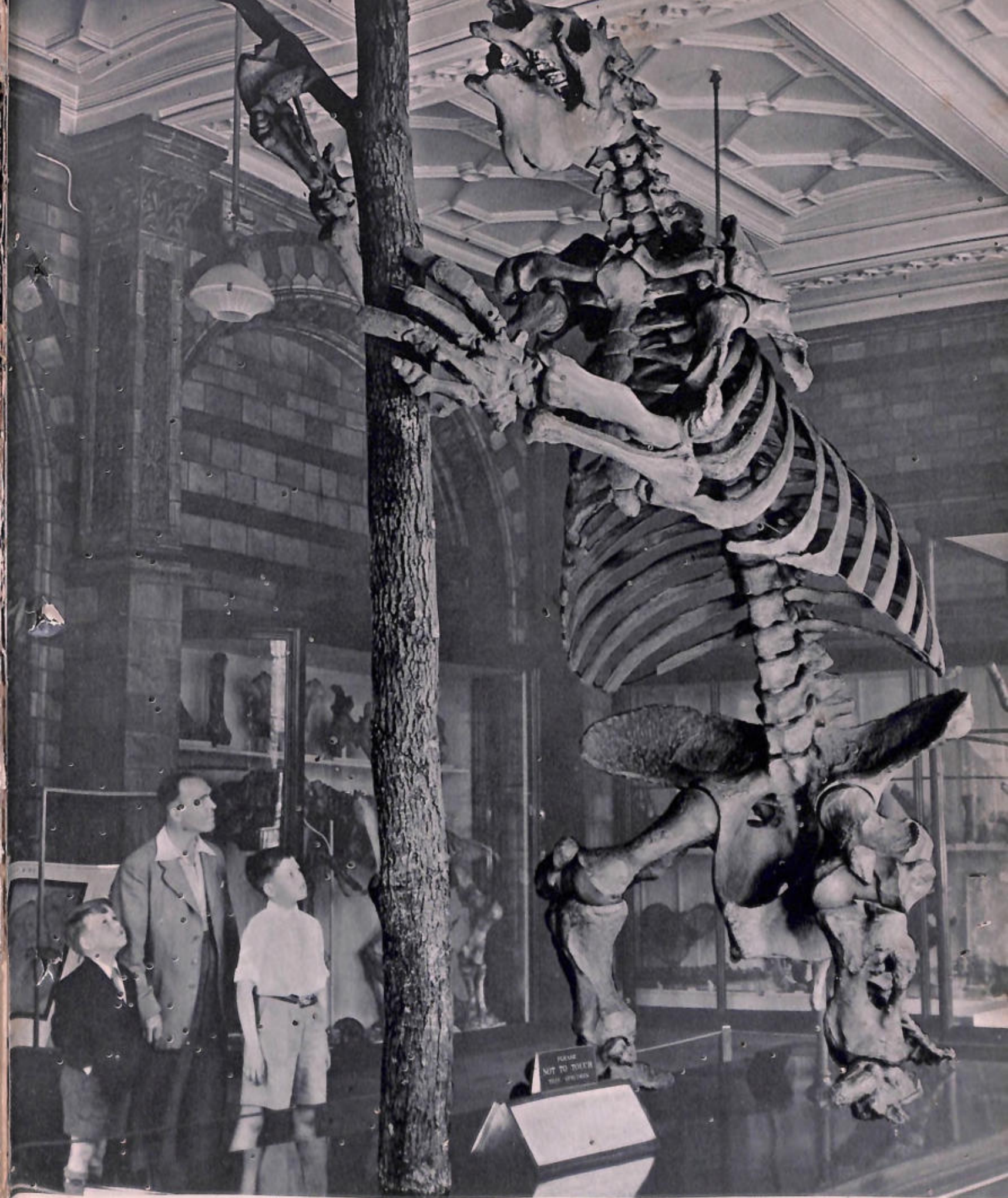
Four complete toes on front foot. The first vestigial or lost. The third a little larger, and the fifth a little smaller, than the others.  
Three complete toes on the hind foot, and tiny vestiges of the first and fifth toes. The middle, or third, toe, is a little larger than the others.  
Premolar teeth simple, not like the molars. Molar teeth low-crowned, with low, rounded cusps.



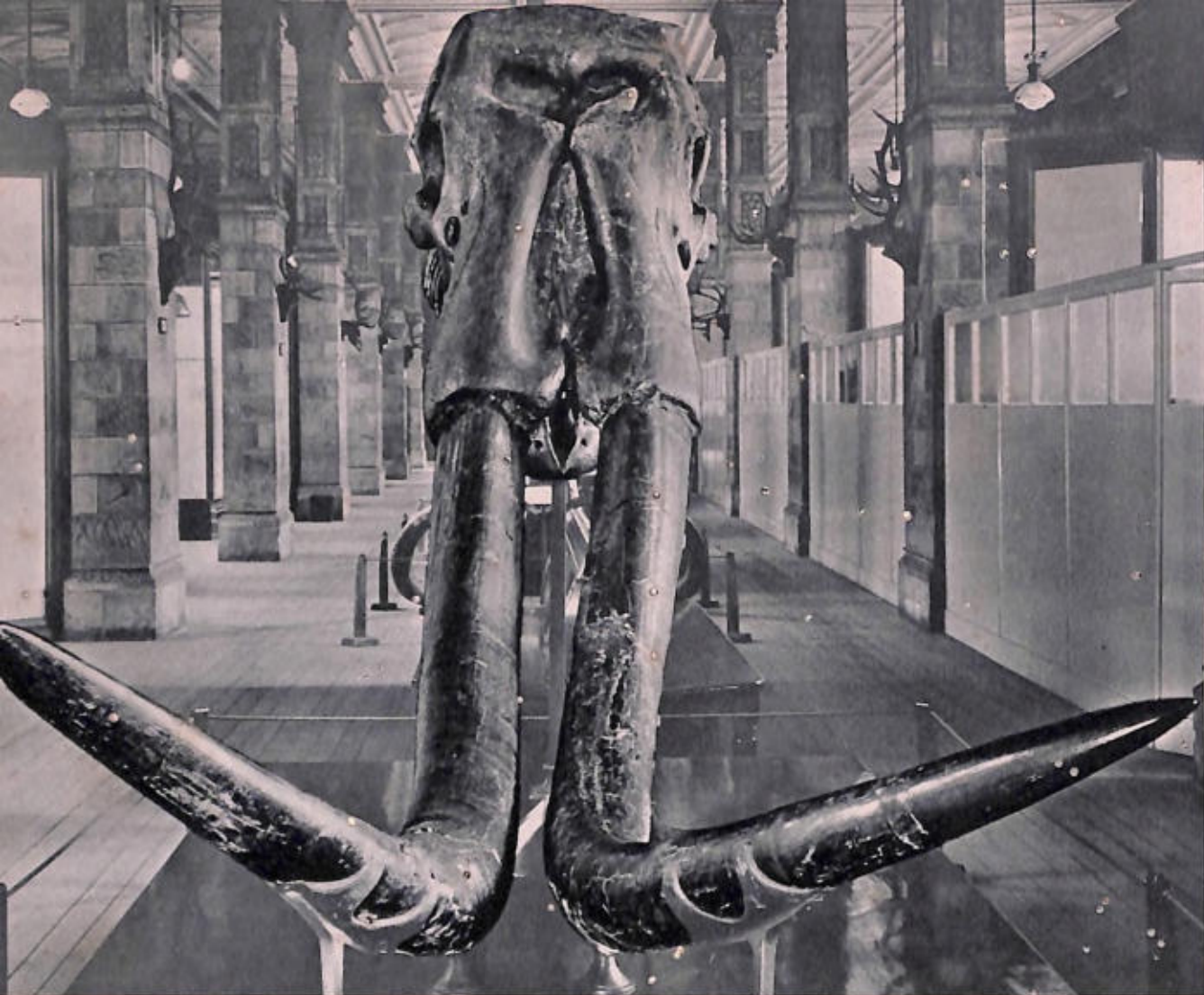
2 DEINOTHERIUM



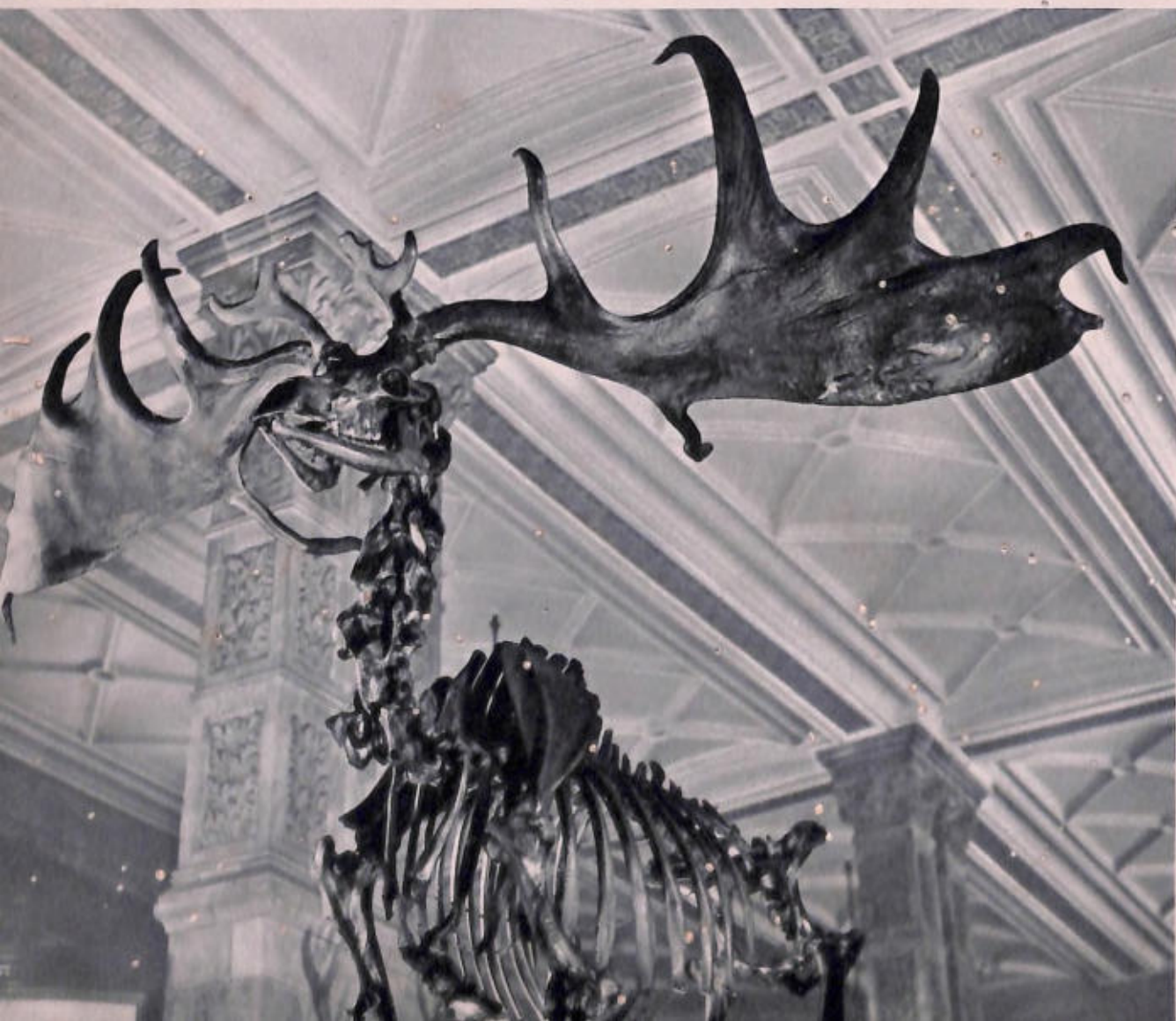
3 SMILODON



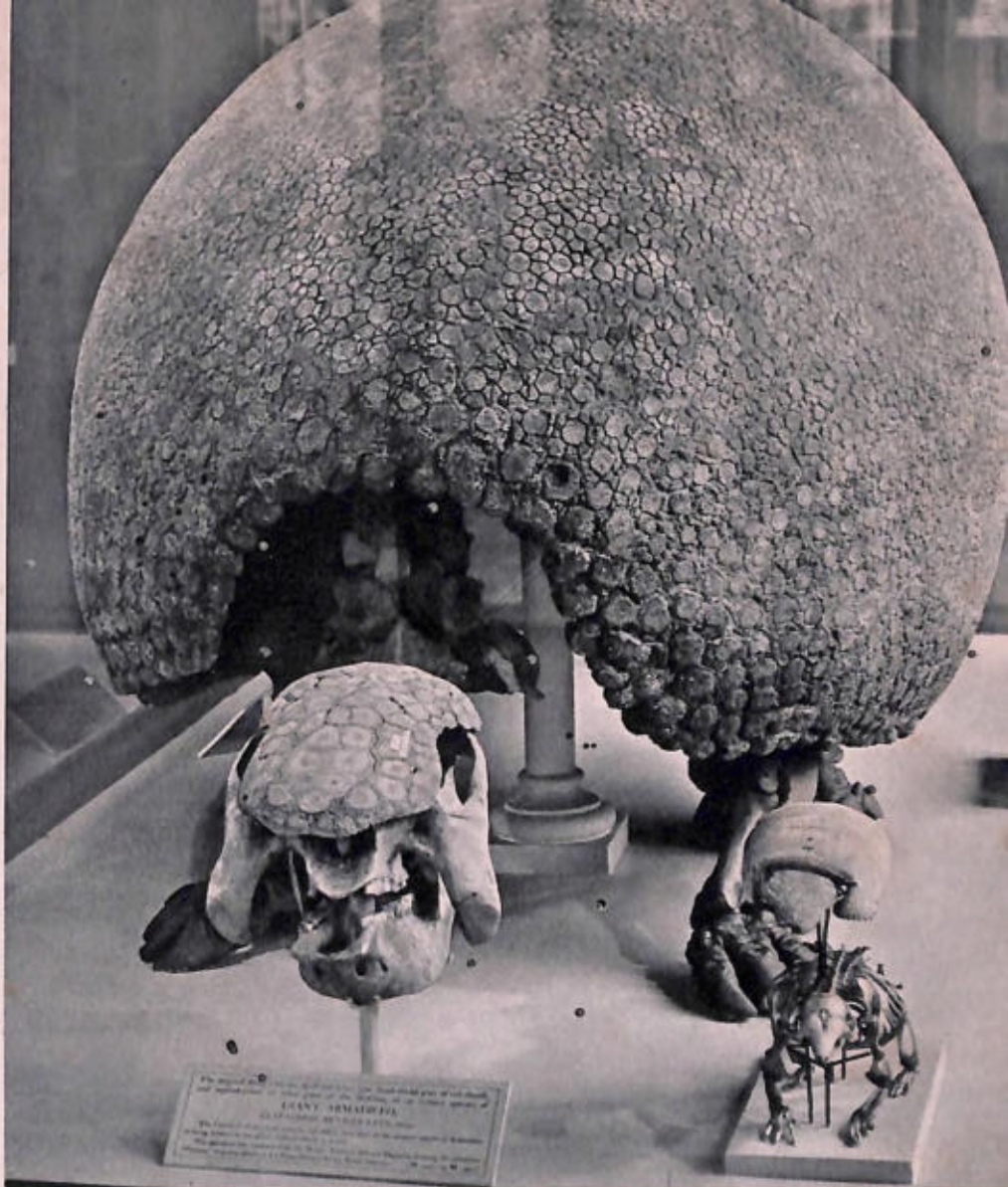
4 MEGATHERIUM



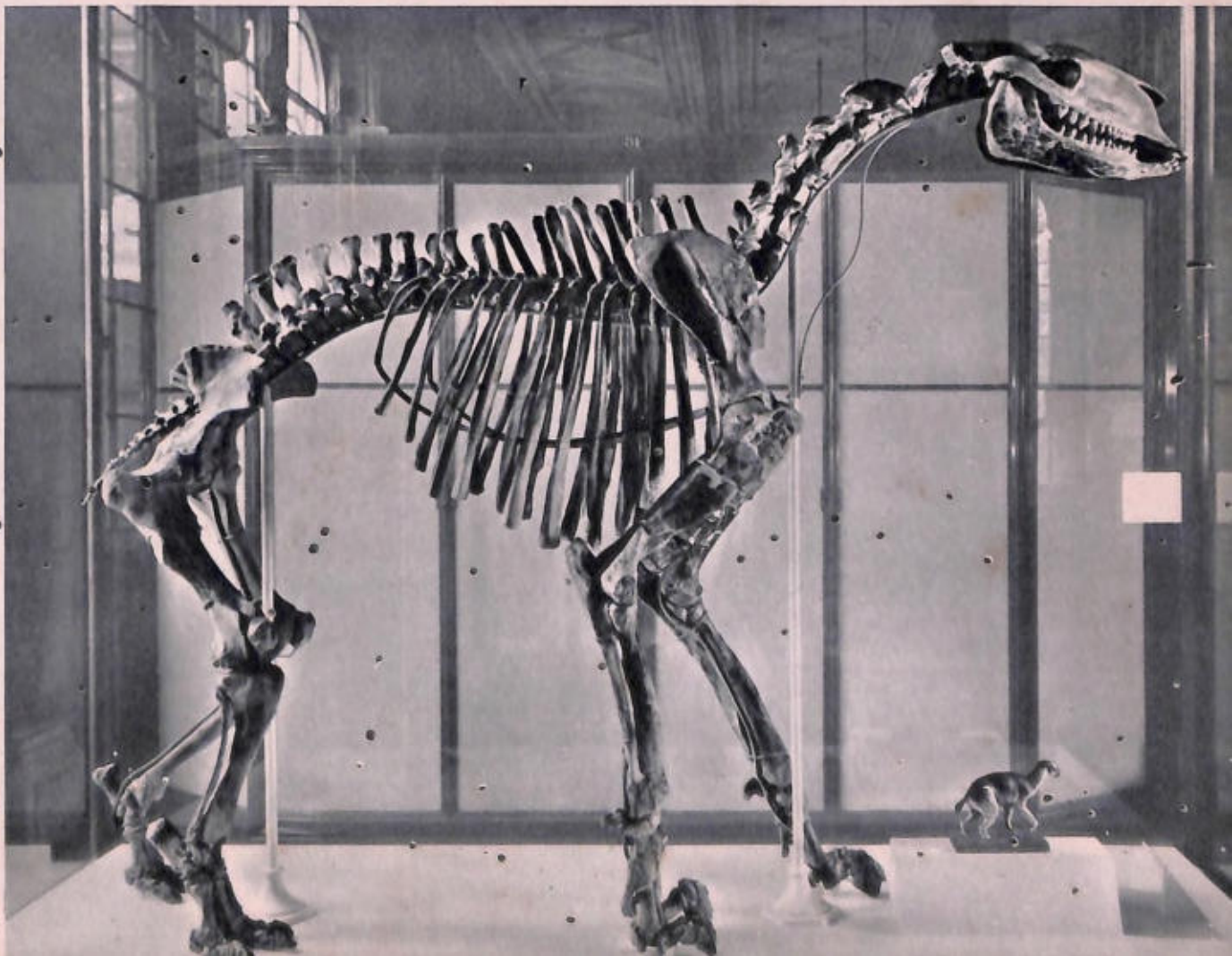
5 STEGODON



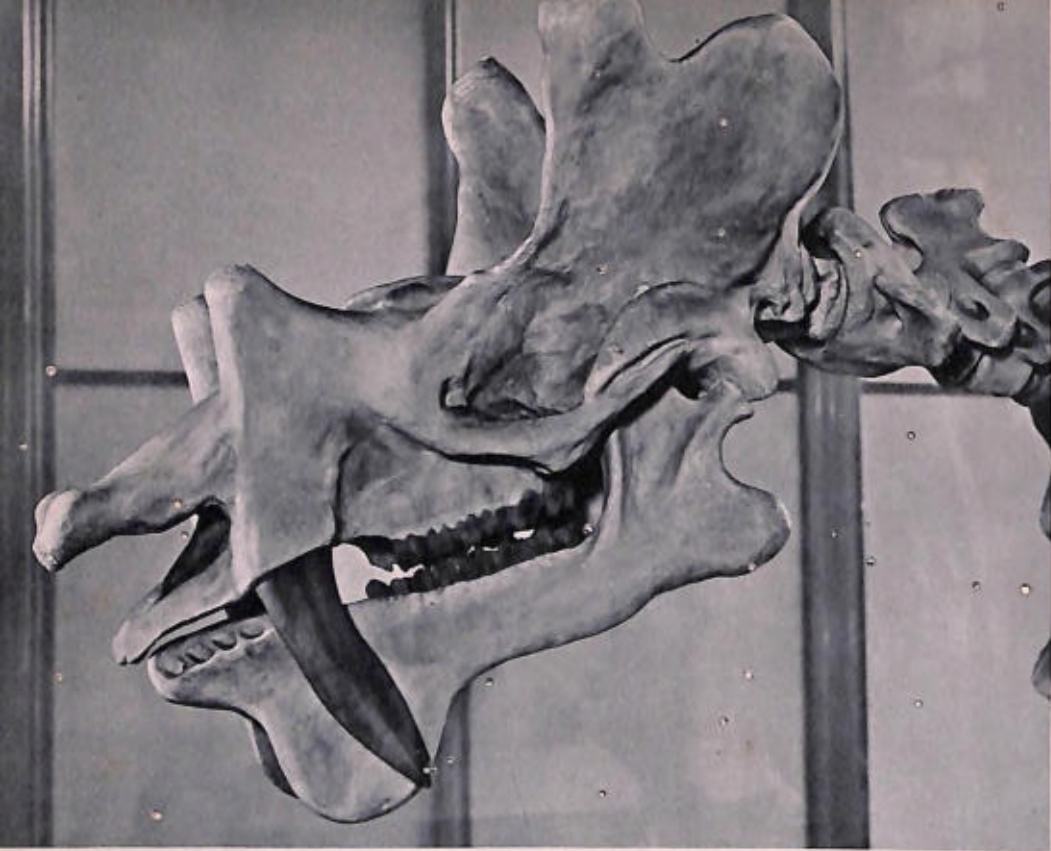
6 MEGALOCEROS



7 GLYPTODON



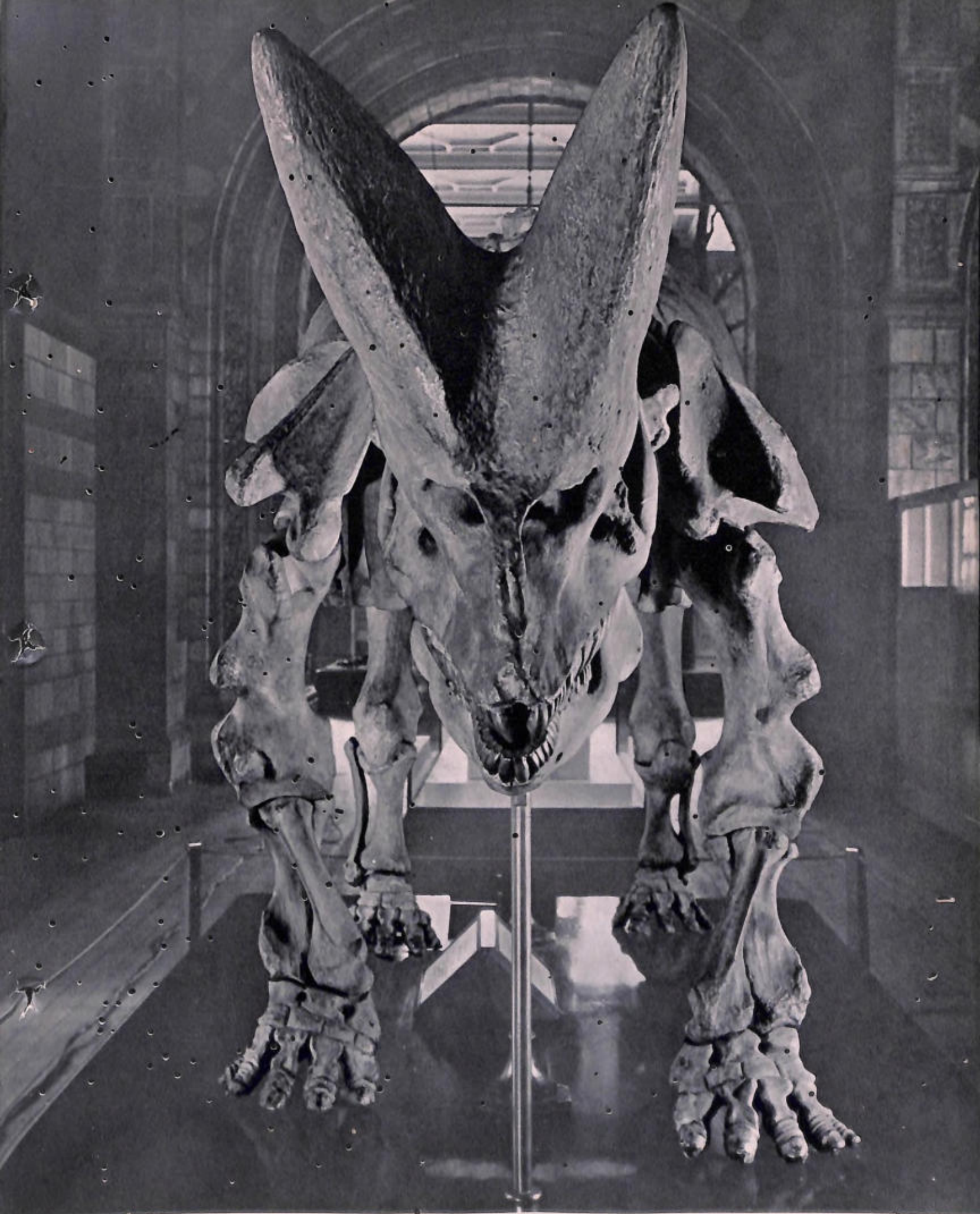
8 MOROPUS

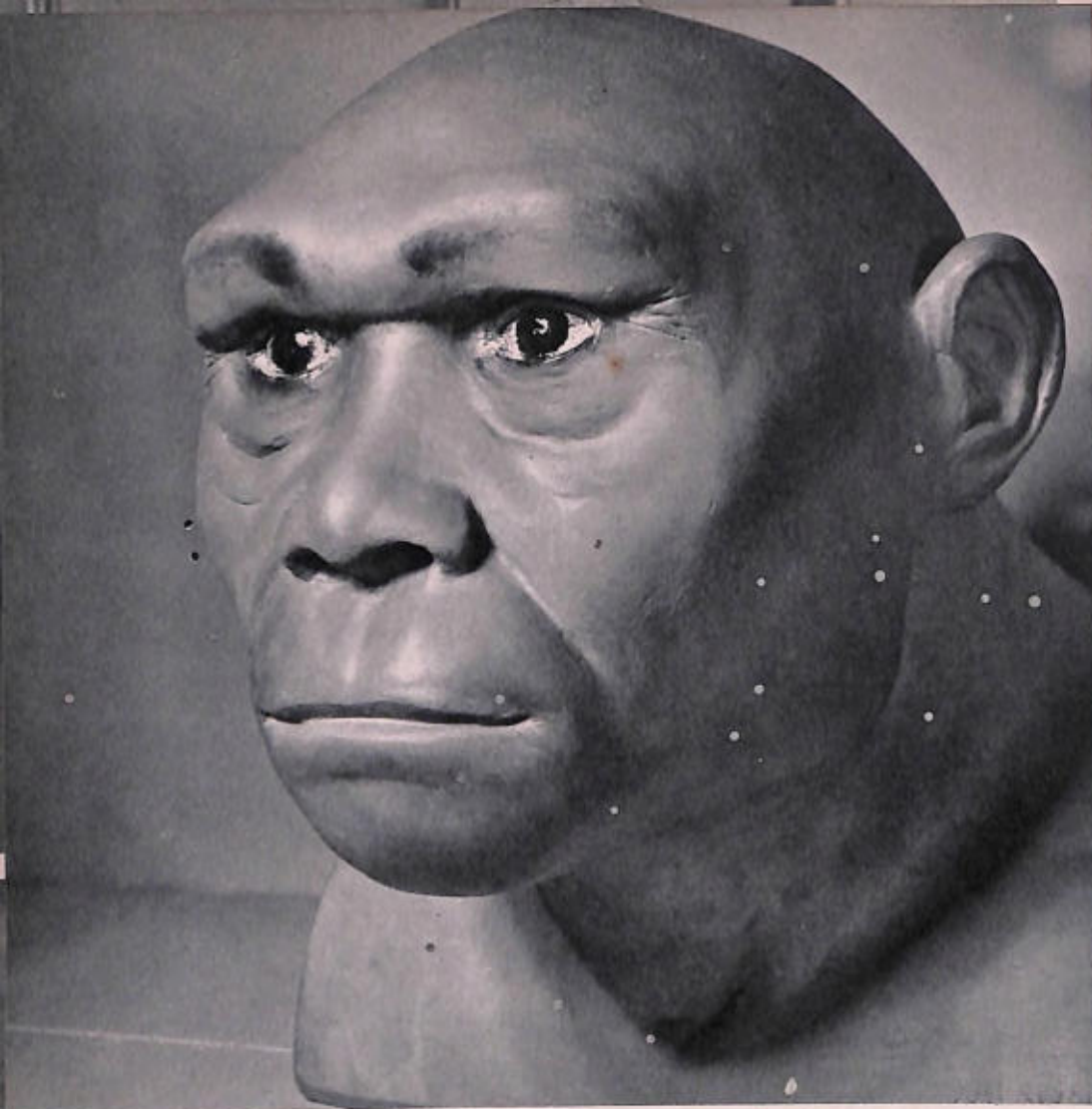


9 UINTATHERIUM

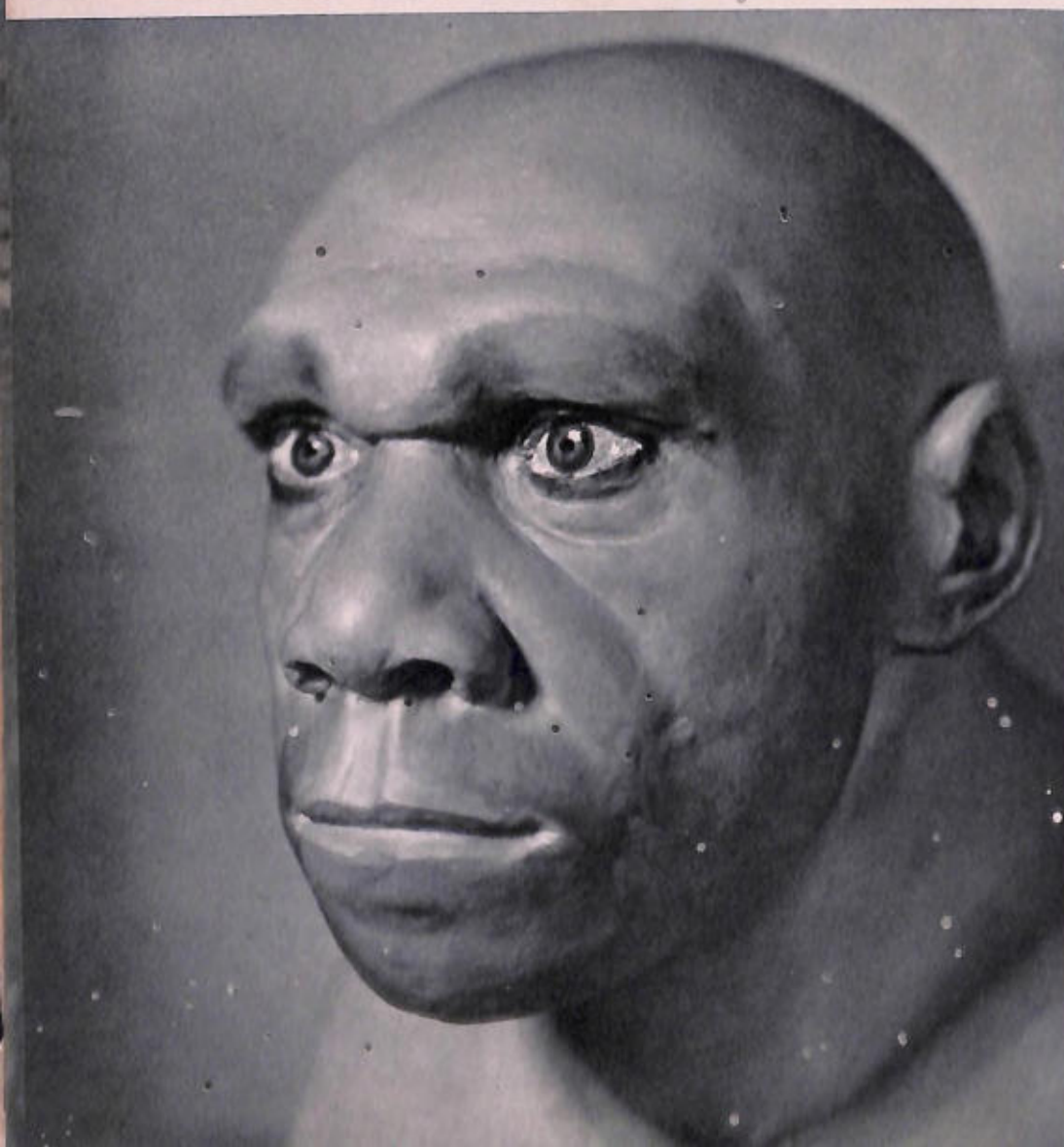


10 SIVATHERIUM





12 PITHECANTHROPUS



13 HOMO NEANDERTHALENSIS

something to do with the less intense biological competition in Australia; perhaps also with the fact that placentals are and marsupials are not provided with a *corpus callosum*, a communicating system of nerve-fibres between the two cerebral hemispheres of the brain.

I have left the Primates to the end, for in them the story of the mammals ends and the human story begins. Many people still find the fact of man's evolution from monkeys repugnant: but actually man could not have evolved except from some sort of monkey.

Man is the latest dominant type to be produced in evolution. He owes his dominant position to an enlarged and improved brain and to the new type of mind that went with it. This has given him increased learning ability, together with reason and imagination, conceptual thought and true speech: and these in turn have given him the unique capacity of transmitting accumulated experience down the generations, and so of developing science and art and religion and civilization. Animal evolution proceeds slowly and blindly: it is based on the self-reproduction and self-variation of matter, and guided by the automatic process of natural selection. Man's evolution, on the other hand, is faster and more conscious, and is now almost entirely cultural. It is based on the self-reproduction and self-variation of mind, and is increasingly guided by knowledge and purpose.

But, you may ask, why was brain-power so specially important at this stage of evolution as to give rise to the latest and the most successful of all the dominant dynasties of life that have ruled the earth successively since life began? The answer, it seems, is that all other lines of advance had reached their limit. Some time in the Pliocene, perhaps 5 million years ago, all the purely material and physiological possibilities of life had been exhausted. It is mechanically impossible to have a land animal bigger than a *Baluchitherium* (and even it must have been inefficient, for it became extinct while Elephants were able to survive and prosper). Physiologists make it clear that it is impossible to construct an eye with greater acuity of vision than a Falcon's. It would be theoretically possible to have a temperature-regulating mechanism even more precise than ours and the other placentals and the birds: but it would not be of any biological advantage, and so natural selection could not produce it. It seems impossible to build a land animal with a greater turn of speed than a Cheetah or a flying animal faster than a large Swift. Digestion, nervous conduction, muscular contraction, pre-natal care of young—all reached their limits and became stabilized before the Pliocene.

The one possibility that had not been fully utilized was the possibility of mental betterment or improved awareness—better organization of experience, greater capacity to profit by it, and especially the capacity to transmit it down the generations. It was this new realm of possibility that lay open to our hominid ancestors, and the exploitation of it on the basis of improved brain-power that produced man as the latest dominant type in life's evolution.

The first steps towards this new brain-power could only have been evolved in an omnivorous tree-dwelling animal, with hands adapted to grasp the branches and to pick up and manipulate small objects, with binocular vision, and capable of judging distance and appreciating shape.

Furthermore, for the precursor of man to develop good learning capacity it was necessary for only one young to be born at a birth, and for the young to develop slowly, with a long period of dependence for its education. And such a combination of characters spells a monkey, or something very like it.

There are four main grades in Primate evolution—lemur, monkey, ape, and man. The first three are, with a few exceptions, tree-living, the last ground-living.

145 The true Lemurs are still dog-faced, with long muzzles, relying largely on smell, and not  
141 nearly so intelligent or inquisitive as the monkeys. Other lemuroids, like the Tarsier, the Potto,  
143-4 and the Galago have begun to use sight more than smell, and so have larger eyes, capable of  
binocular vision, and shorter faces. Galagos are not very intelligent, but extremely agile. We  
used to have a pet Galago which we sometimes let out in the living-room. It had the spectacular  
but disconcerting habit of taking huge flying leaps from a curtain-rod or a chair-back to land on  
someone's head or shoulder, steering itself in mid-air by flicking its long tail to one side or the  
other. Mealworms were its favourite food: it demonstrated its grasping capacity by holding two  
mealworms in its little hands as if they were miniature sausages, and then taking alternate bites  
off their ends.

Monkeys typically have short faces and binocular vision; their brains are relatively much  
larger; and their intelligence, or at least their curiosity and versatility, much greater. There have  
been two quite separate monkey radiations, one in the New World and one in the Old. New  
146 World monkeys, such as the lanky-limbed Spider Monkey and the amusing chattering Capuchin  
or the Humboldt's Woolly Monkey looking like a furry black baby, have prehensile tails which  
act as a very efficient fifth limb in their climbing activities. Some of them are highly intelligent.  
But they never produced an animal of ape grade, perhaps just because their prehensile tails were  
so admirably adapted for tree-life that they never developed their fore-limbs as specialized hands  
and their hind-limbs as specialized feet.

147-8 The Marmosets are sometimes called Half-monkeys. They stand in a somewhat similar  
relation to the New World true monkeys as the lemuroids do to monkeys in general, though  
they are not so varied nor so primitive. They are small tree-living creatures, often with bushy  
tufts of lightly-patterned hair, and are unique among mammals in that the males carry the young,  
handing them to the female to be nursed as occasion demands.

151-2 Most Old World monkeys are tree-dwellers, but some, like the Baboons and Drills and  
Mandrills, are ground animals, hunting in packs.

Only among monkeys do you find bright colours like blue or red or green: the colours of all  
other mammals are restricted to the ranges between black and white, and from brown to yellow  
and russet. This is because all mammals except primates are colour-blind—they cannot see  
colours, but only shades of dark or light. Primates, on the other hand, which rely mainly on  
sight instead of smell, have developed colour-vision to help them distinguish differently-coloured  
objects; and some of them have taken advantage of this capacity to develop patches of bright

colours as signals or sign-stimuli. The male Mandrill is outstanding in this respect, with his bare furrowed cheeks of light blue and scarlet nose, which he displays in threat against other males; and some other monkeys "wear their club colours in the wrong place", as P. G. Wodehouse wrote, and have developed scarlet or blue posteriors as sexual signals. 151

\* The true or anthropoid apes are more man-like in being entirely tailless, bigger-brained, and with fore-limbs specialized as arms for swinging from branch to branch and hind-limbs for walking. The existing apes, the Gorilla, the Chimpanzee, the Orang-utan, and the Gibbons, are the few survivors of a group which was much more abundant in mid-Tertiary times, but was later reduced in numbers by the climatic revolutions of the Ice Age and through the competition of the new type—Man—to which the early anthropoids gave rise. 153-9

There is an old story of an Indian babu applying for a job who put "failed B.A." among his qualifications. The Apes might be described as "failed men": they are so nearly human and yet so definitely sub-human. The common ancestor of existing apes and men would certainly have had to be classified as an ape, with hairy coat and ape-size brain, but would equally certainly have been more human in general build than any apes existing today. These have all continued to use both fore and hind limbs alike for locomotion and for grasping objects, and have become specialized for an arboreal arm-swinging life, especially the Gibbons; whereas pre-man must have descended from the forest trees to a life in open country, where his hind-limbs could become solely legs and his arms could be converted from tree-swinging or walking limbs into solely manipulative organs. 153-4

The great apes are all intelligent, but vary in temperament. The Gorilla, for instance, tends to be morose and shut in on himself, while the Chimpanzee is an inquisitive extrovert, but lacking in perseverance. Young chimpanzees have been brought up in human families, as you can read in Cathy Hayes' book *The Ape in our House*. For the first few years they outstrip human infants, but human children shoot ahead as soon as they can talk. The decisive difference between apes and man, in fact, is speech. Not only do apes not talk in nature, but they cannot be taught to do so even when brought up entirely among humans. By true speech, I mean the use of words to denote things or ideas, instead of just sounds to denote feelings or emotional situations. It is this, together with the power of abstraction or concept-forming thought, which has provided man with his new method of evolution—evolution by means of cultural change based on accumulated experience—and made him the latest dominant type of life. 158-9

But he did not achieve this at one bound. Several million years of gradual evolution were needed to make modern man, *Homo sapiens*, out of his ape-like ancestor. The change involved various features of the pre-human stock. For one thing, it had to lose its hairy coat. This was achieved by prolonging an early stage of development. A chimpanzee at birth has hair on its head but hardly any on its body: man has simply retained this phase during the whole of life. He has also retained the early form of face, without bony brow-ridges or protruding jaws, and the relatively large size of cranium, characteristic of the new-born ape, though in addition he

has of course added new size and complexity to his brain, especially in the association areas of his cerebral hemispheres. He has developed a protruding instead of a receding chin, to give room for the more elaborate tongue-muscles required for true speech. And he has raised himself into a semi-erect and finally a fully erect position.

*Extinct Mammals:* 12 Apes and pre-men rarely get preserved as fossils: yet we now have enough fossil remains to demonstrate most of the stages in the process. The most important are the ape-men, of the genus *Pithecanthropus*, who lived in the earliest stages of the Ice Age or Pleistocene period, nearly half a million years ago. Though in many respects intermediate between apes and men, they were definitely on the human side of the divide. The pithecanthropes or ape-men were very variable in brain-size (cranial capacity), and must have been widely distributed, as in addition to the original ape-man found in Java, numerous fossils of the same type, but averaging rather higher in brain-size, were found in China. These have been assigned to a separate species, *P. pekinensis* or Pekin man.

*Extinct Mammals:* 13 Almost as early in time, but more human in character (though with very massive and quite chinless jaw) came Heidelberg man from what is now Germany. And much later, for a considerable period after 100,000 years ago, we find the remains of Neanderthal Man, *Homo neanderthalensis*, the Cave-man of popular legend, who appears to have overlapped with modern man, *Homo sapiens*, in various parts of the world. These, together with reconstructions of them, you can see in the Natural History Museum, and you can read about them in Professor Le Gros Clarke's admirable brief *History of the Primates*. They conclusively demonstrate what Darwin deduced—the zoological Descent of Man from an ape-like primate ancestor, or what the modern evolutionary philosopher would rather call the Ascent of Man from the animal to the human level of evolution.

The rate of cultural evolution has become something like a hundred thousand times as fast as that of biological evolution; for in the 20 thousand years since the end of the Ice Age, the single species *Homo sapiens* has generated almost as much variety and novelty as pre-human life was able to do in the 2000 million years before that time.

You can see some of that variety in the human visitors to the Zoo. There is the variety of racial or ethnic type—black and white, brown and yellow. There is the variety of physique and temperament—stocky and slender, strong and feeble, cheerful and melancholy, brawny and brainy. And there is the variety of class and culture and nationality, revealed in manners and customs, language and accent, dress and adornment.

But to realize the full extent of human variety, one must travel in time and space, must dig into history and into art galleries and museums of antiquities and ethnological collections. That, however, would need another set of photographs, and another book.

JULIAN HUXLEY

## ANIMAL PHOTOGRAPHY

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IT MAY INTEREST people to know a little about animal photography and my way of working. Any competent photographer can take good animal pictures; there is no particular technical knowledge required. Success is more the result of a right approach and attitude of mind. However, one can always learn from the experience of others, and I shall try to sum up what I have learned in many years of animal photography.

I have always been interested in animals. As a matter of fact when I was a boy I wanted to become a biologist. However, circumstances made this impossible and I took up photography instead. Almost twenty years ago I had the good fortune to be working on some films at the London Zoo. This gave me opportunities to enter cages and enclosures and to learn a lot about animals. As I always carry a "still" camera when I work on films, I found myself taking many animal pictures and ever since I have found great fascination in photographing animals.

Very soon I discovered that my most successful pictures were not necessarily those which gave a complete representation of an animal, a perfect record, but they were those which showed some of the animal's character and some expression, its "essential qualities" as Professor Huxley has defined it elsewhere. More often than not these qualities were to be seen in a close-up of the creature's head and many of my best pictures turned out as "animal portraits".

The striking effect which good animal pictures often have is largely due to the fact that the camera can get a much closer and more intimate view of an animal than that obtained by the average visitor to the Zoo or even the naturalist in the field. Furthermore, the photographer can create a picture which is more than a record of an animal by choosing his point of view carefully, by waiting for the most favourable light, and by picking the right moment.

There are various branches of animal photography. My own particular field is perhaps the easiest. So far I have only photographed beasts which are used to human beings, like pets and Zoo animals. I have the greatest respect for the nature photographer and for those who take pictures of animals for scientific records.

Generally speaking, there are two kinds of photographers: those who plan their pictures carefully and arrange their subject to suit their purpose, and there are those who observe and

wait for the right moment. The first group of photographers will find animal photography difficult, because I think that the most essential equipment for all animal photographers is patience. Animals cannot be forced to do things for you. They have a will of their own to which they are entitled; they cannot understand what is wanted from them and no amount of bullying will make them understand. Usually it is therefore a matter of waiting for the right moment, for the right look or movement, for the right position. A certain amount of animal psychology and a little cunning are necessary too, and a large percentage of luck.

The best people to teach you the psychology of Zoo animals are the keepers. After all, they practically live with their charges, have perhaps known them for many years or may even have brought them up from babyhood. If you can get the help of a keeper, half the battle is won. I owe much to the keepers who have helped me to obtain my pictures. They usually knew how to get the animals into the right position for me by putting some tit-bits down, how to produce the right kind of noise to make them look up if I wanted to photograph them that way. They have taken a small animal out of its cage for me if it was tame enough, and put it on a tree-trunk so that I could get a picture against the sky. This sounds easy enough, but if you think that for instance a Bushbaby can jump several yards, you can imagine what a risk they took of the animal escaping up a tree or a building. Only because they knew their animals so well could they take such a risk. The keeper would have known a second or so before the Bushbaby jumped, and would have grabbed it in time. Incidentally, holding a good-sized branch with one of the slightly larger animals such as a Potto or a Loris at arm's length, is quite some physical strain.

Sometimes I have had one or two keepers with iron bars standing next to me to hold off one of the more dangerous beasts when I wanted to poke my lens through the bars. Several times I have been dragged back just in time when an animal has made a dash for me—something one cannot always anticipate through the viewfinder. Polar Bears and some large cats often quite cunningly pretend not to take any notice of you, and then suddenly make a rush for the bars. They can reach out quite a distance between the bars and might claw one badly—that is why there are barriers between the public and the bars of the cages. At Whipsnade Park, the country branch of the London Zoo, there is a particularly cunning Polar Bear who is not only interested in cameras but also specializes in capturing walking-sticks and umbrellas. If somebody tries to push bits of food which have fallen short of the cage with his stick or umbrella, the Polar Bear will studiously look the other way and come steadily nearer. He will then make a sudden grab for the stick and carry it off triumphantly towards his pond, where he will play with it for a long time, throwing it up in the air, catching it in his mouth, diving with it into the water. This is great fun to watch—not for the owner of the stick or umbrella.

Keepers are usually quite fond of their charges; they are proud of them and will go to great trouble for a serious photographer—as far as their time allows. They appreciate being shown the results afterwards so that they know that their efforts have not been in vain.

Zoo animals are used to people looking at them. Some are even too familiar and keep close to the fence, begging for food. This is not much good to the photographer, who must have them at a certain distance from the fence or the bars. I never carry food when I walk through the Zoo. The animals soon smell whether you have anything in your pocket. Many times have I come across an animal in a perfect position, at the right distance for my camera and in good light, when somebody else has arrived at the cage with a paper bag and the animal has run up for the food before I could get my picture. In such a case it usually takes a little time to persuade the kind visitor to throw the food to the right distance, to get the animal away from him and you. Most times the picture is lost and the opportunity gone. However, in Zoos where the animals are kept in large enclosures it is often necessary to attract the animal closer and then one does need some food for them. It is better to let a friend or the keeper carry it so that the animal will not come begging to you.

While some animals may be too familiar, many others remain shy even after long captivity. With those only patience and perseverance can get results. Many animals become shy when their routine is disturbed. I have also come across animals which do not take much notice of ordinary visitors but become alarmed as soon as they spot a camera. I particularly remember an antelope at Whipsnade Park, a Northern Waterbuck, who always seems fairly placid until I arrive with my camera. Then he strikes a threatening attitude, races along the fence, bangs his head against it and snorts wildly. It took several visits to get the picture you see in this book (Plate 60).

It always pays to make only slow movements when you take pictures of animals. All animals have an instinctive fear of quick movements—an unexpected quick move and the animal will rush to the far end of the paddock or cage. The slowness of all movements is especially important if you get permission to enter a cage. This makes animals very nervous, even with the keeper present.

If I see from some distance that an animal happens to be in a favourable position for a picture, I prepare my camera—well away from the cage—and then approach slowly. If it takes no notice at all and I want it to look up I make a slight noise to attract its attention. Most beasts hear much better than human beings and a loud call might again send it to the other end of the cage.

Baby animals are often difficult to photograph because they will instinctively hide behind their mothers, but if you have enough time you often find that their curiosity gets the better of them and they may come out to investigate you.

The tamest "wild" animal I have come across was the Cheetah Prince of the London Zoo, whose picture you can see in Plates 9–10. He took no objection at all to visitors to his cage, and if you wanted his head turned for a different view, the keeper would go and turn the head with his hands. You stood a good chance that Prince would then remain in the new position long enough for you to get your picture. He was taken for walks on a lead, posed with fashion models and was often televised. Alas, he is no more. Another very tame friend of mine is one of the

Giraffes at Whipsnade Park. He will follow visitors to his paddock, sniffing at their camera or nibbling at the camera case, bending his long neck down to do so. It is an unforgettable experience to seem so small beside him; something like Alice must have felt.

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As far as possible I avoid Zoo backgrounds. They either look depressing or incongruous. Cages and bars are never beautiful, and unless you want to show them for dramatic effect they are better avoided. It is surprising how many animals one can photograph at most Zoos without showing obvious Zoo backgrounds. Of course in modern open-air Zoos like Whipsnade Park, Vincennes near Paris, or Hellabrunn near Munich it is easier to achieve an impression of natural surroundings. I try to photograph animals against the sky, against the grass or against rocks. In the more orthodox Zoos it is often best to use selective focus—getting the background out of focus—or to use a dark background, a wall in the shade or the opening of a door. One often has to wait for the sun to be in the right spot.

The background in a photograph is more important than many people realize. So often pictures are spoilt through obtrusive backgrounds—trees grow out of heads, bright patches of light distract the eye, reflections appear on shiny walls. I always try to get the animal away from the background as much as possible. If it is too close to a fence or bush it may merge with the background, after all, that is why animals have protective colouring or patterns on their coats. Getting your model away from the background also helps to get the background out of focus; the animal will stand out much better in the picture. With small animals in smaller cages one can often put something like a blanket at the back to hide the bars or a sheet of cards. This is of course not possible with excessively shy animals, which would be immediately upset by anything strange in their cage.

There are no rules in photography and certainly no rules on how to photograph animals. However from experience I have learned to look out for a few things when I photograph an animal. For instance horses, members of the deer family, canines and many other animals look much better with their ears cocked. If their ears are back they look frightened. If the whole of a four-legged beast is shown, there should be four legs to be seen and not three. I therefore look out for legs masking each other. Caged animals are better photographed on a dull day, otherwise the shadows of the bars make them all look like Zebras. The angle from which the picture is taken should be carefully chosen to avoid distortion, especially if a camera with a lens of short focal length is used. Taking this into account, almost any angle may provide an interesting picture. Very often it is a good idea to try to take at least some of the pictures from the level of the animal, especially if it is a small creature. We usually look down upon small things and by taking the camera down to ground-level it can reveal new loveliness, as for instance I think I have done with my picture of a hedgehog in Plate 123.



So far I have never photographed a dressed-up animal. I find this particular humour very unfunny and somehow degrading to both the photographer and the viewer. We already put too great a human interpretation on the behaviour of animals and on their expressions. If a horse bares its teeth it is not really laughing, if a monkey yawns he may not be sleepy—they want to show their teeth in order to frighten you. Some creatures look sad because their features are built that way, like bloodhounds for instance. Some of course look sad because they have no reason to rejoice in captivity or they may lack attention—monkeys or apes often do. Animals have their own dignity which one ought to respect. Some of the more intelligent ones resent very much being laughed at. However many like to show off and appreciate the interest a crowd takes in them. A perfect example of showing off I saw recently at the Zoo at Hellabrunn, near Munich. There they have a young walrus in a pond together with several much smaller seals. They had a large crowd of people watching their antics: the walrus chasing the seals, splashing the visitors with water when they expected it least or the walrus giving a seal a ride by swimming on its back and holding the seal in its flippers.

At the London Zoo the chimpanzees are famous showmen, clapping their hands after a performance to start the onlookers' applause. Their favourite trick is to take water in the mouth and spray the public, causing great hilarity. Perhaps they do it because they are annoyed at being teased but they do seem to enjoy themselves most of the time if they get a crowd around their cages. Most summers the young chimpanzees have a tea-party in the afternoon, their table manners at least as good as that of human children of the same age. This is a splendid opportunity for good pictures, and not only of chimps—the young visitors can give you good studies of concentration and enjoyment.

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As I have mentioned before, any competent photographer can take animal pictures. The same goes for equipment—any camera can take good animal pictures, but they all have their limitations. Anybody taking up animal photography should use the camera he usually works with.

Personally, I prefer a single-lens reflex camera using  $2\frac{1}{4}$  in.  $\times$   $2\frac{1}{4}$  in. roll film. At present I use an Agiflex camera, made in England, which I find very satisfactory. Occasionally I also take a twin-lens reflex of the same size along on a job, mainly for flash work as the between-the-lens shutter of these cameras is easier to synchronize with flashlight than the focal-plane shutter of my Agiflex.

The main advantage of a single-lens reflex is the interchangeability of lenses and the easy adaptation of these cameras for close-up work with extension tubes. Twin-lens reflexes have lenses of rather short focal length and have to be used with great care to avoid distortion. By using lenses of longer focal length in a single-lens reflex the camera angles are less limited, as there is less danger of exaggerated perspective. For close-ups with a twin-lens reflex, one has to use

supplementary lenses, which further shorten the focal length and make for more distortion. On a single-lens camera only extension tubes are necessary for close-up work.

A choice of lenses enables you to take pictures of animals from varying distances. My aim is usually to get the negative filled as much as possible with the subject I am photographing. This gives a more satisfactory print than an enlargement of part of a negative. By using lenses of longer focal length I can photograph my subject larger without having to wait for it to come close of its own accord, or having to take great trouble to attract it nearer. I have three lenses with my Agiflex: one of 80 mm., one of 105 mm. and one of 165 mm. focal length. While still longer focal-length lenses might be useful to me I would need them only rarely, and one can collect too much equipment to carry around. However longer lenses are certainly necessary for wild life photography.

Another great advantage of the single-lens reflex camera is the fact that you can see exactly what you will get on your focusing screen. The lens can easily be poked through bars or between the wires of cages and you know at once whether it is clear of all obstructions. All too often I have thought I had both the lenses of my twin-lens camera clear of the cage wires, when the animal moved slightly and I moved the camera with it—only to find my picture spoiled because the taking lens became obscured without my noticing.

One disadvantage of both types of reflex cameras is that you have to look down into the camera to watch your subject. You cannot keep your eye on any other creatures which are in the same cage which might make a dash for your camera or your hair. Monkeys have a great talent for doing this if you are not careful.

The miniature camera can do everything that a reflex camera can do and has the further advantage of much greater depth of focus. Personally, I find it easier to get a large good print from a  $2\frac{1}{4}$  in.  $\times$   $2\frac{1}{4}$  in. negative. If a picture will not enlarge to 10 in.  $\times$  12 in. it is not much good to me. However, many wonderful pictures are being taken with miniature cameras. Many more with twin-lens reflexes. The late Miss Ylla, who was the most outstanding animal photographer of our time, used a twin-lens reflex for most of her work and a miniature camera for her great colour pictures of wild life in Africa and India.

I might say a few words about other technical aids to animal photography. A tripod is very rarely wanted, except perhaps when taking very small animals. Even then I find it easier to focus by moving the camera to and fro, rather than have the camera fixed and use the lens-mount for focusing. With most animals a tripod might be rather a handicap. To an animal a tripod looks just like a stick, and many know what a stick can do, and try to escape.

What film to use is again a matter of experience. I use a high-speed panchromatic film—Ilford HP3 or HPS at the moment. As most animals are of a brownish colour, this kind of film gives best detail and texture of the animals' coats. It is however most important to get used to one film and stick to it.

An efficient lens-hood is a most important item of equipment. Light should reach the lens

only from the area which you want to photograph. Light from other directions will only cause flare in the lens. This will reduce the contrast and general quality of your negative, or it might spoil it altogether by causing strong reflections in your lens which will show as bright patches on the picture—images of your lens-iris. Even the most expensive camera will let you down with the sun shining on lens and filter—and how often do I see expensive cameras misused without a lens-hood!

Filters are only necessary if you have blue sky in the picture. They do not help in dull weather, when a subject photographed against a grey sky is rarely successful. The use of a filter would only increase the contrast and make things worse.

I am sometimes asked what animal I consider the most difficult to photograph. Generally speaking I think that the smaller the animal the greater the difficulties. For instance a white mouse is one of the most difficult subjects I have tackled. Not only is the question of focus with such small subjects very difficult, but exposure has to be very accurate in order to preserve detail in the white coat. Also these animals breathe very quickly and their whiskers move rapidly and constantly. Today, electronic flash solves most of these problems. The little Harvest Mouse in Plate 12 was taken with electronic flash. You see it many times magnified in this picture as it is not much larger than a thumbnail—one of the smallest mammals to be found and to me one of the miracles of nature. Just imagine the miniature scale of all the organs in this tiny body, which is organized on very much the same lines as yours or mine, or that of an elephant.

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I hope that some of these technical details and hints may be useful to people interested in animal photography. For me, photographing animals gives great satisfaction and is never dull. There is so much to learn about them too. In any case, they never complain about their portraits.

W. SUSCHITZKY

## NOTES ON THE PLATES

### Colour Plates

#### I KOALA (*Phascolarctos cinereus*)

The Koala, sometimes called Koala Bear from its teddy-bear appearance, looks like a primitive Wombat which has taken to life in the trees. However, its marsupial pouch opens backwards—a rather inefficient arrangement in an arboreal species. Like Wombats, Koalas are tailless. They live exclusively on the leaves of a few species of Eucalyptus.

They seem to have had no enemies before the advent of white men. Thus they have little need of intelligence or alertness, either for securing food or for escaping danger; and they are in fact engagingly stupid and tame. After leaving the pouch, the young one is carried about on its mother's back till about a year old. Mother Koalas are said to smack their young on their behinds when naughty or disobedient. (*Frontispiece: this picture was taken by Julian Huxley.*)

#### II TIGER ([*Felis*] *Panthera tigris*)

The tiger can claim to be the largest of all cats, big males sometimes measuring more than 10 ft. from nose to tail-tip. The tiger is exclusively Asiatic, its east-west range extending from eastern Turkey and northern Persia to the sea of Okhotsk, while to the southward it reaches the Indonesian islands of Sumatra, Java and Bali. Manchurian and Siberian tigers inhabit quite cold areas, and are exceptionally large and long-haired. The sexes are alike, except for the slightly smaller size of the tigress.

Whereas the lion is an animal of open savannahs, the tiger prefers jungles and canebrakes. In such habitats its narrow body

permits easy movement through the dense vegetation, and its stripes help it to avoid detection by its prey. Man-eating tigers, like man-eating lions, are rare: but once an animal has taken to man-eating (usually in old age) it is very dangerous.

The tiger preys mainly on deer, cattle, small buffaloes, wild pigs, and large birds such as peacocks.

#### III GIRAFFE (*Giraffa camelopardalis*)

The Giraffe has the distinction of being the tallest of all living animals, large males reaching a height of 18 ft. The Giraffe and the Okapi, both of them exclusively African animals, are the only survivors of a considerable Family of ungulates which in the Pliocene period existed in a variety of forms over most of the Old World.

The Okapi is an animal of the dense equatorial forest. The Giraffe on the other hand is adapted to life in the open savannahs and game-plains, mostly in the east of the continent. With its huge neck it can reach branches of the thorny trees of the region, that are quite unattainable by other animals, while its long muscular tongue enables it to pluck leaves from among the formidable thorns. Its disruptive colour-pattern blends with the background, while its neck acts as a sort of periscope enabling it to get a view over the flat tops of the thorn trees. If alarmed, it can gallop at surprising speeds up to 30 m.p.h. or more.

There is only one species of Giraffe, but it has differentiated into several subspecies or geographical races, each with a somewhat different colour-pattern.

### Extinct Mammals

#### I THE EARLY EVOLUTION OF HORSES

The first known members of the horse family (*Equidae*), belonged to the genus *Eohippus*, which lived about 50 to 60 million years ago. If they were alive today, they would not be

recognized as horses, for they were no larger than small-medium to fairly large dogs, they had four toes on the front foot and three on the hind, with only the rudiments of hooves, and they possessed much shorter-crowned

and simpler grinding teeth (molars and premolars) than the horses existing today.

By the Middle Oligocene period, over 20 million years later, the ancestral pre-horses, now called *Miohippus*, had become recognizably horse-like. They were still rather small and had three functional, well-hooved toes on each foot, though the middle toe was enlarged relative to the others (which later became reduced to the vestigial splint-bones of modern horses). The grinding teeth were bigger, and the premolars had acquired the more complicated pattern of the molars.

#### 2 SKULL OF *Deinotherium*

*Deinotherium* represents a side-branch of the elephant family, which flourished for over 15 million years, from the Early Miocene, about 25 million years ago, until it became extinct during the Pliocene.

The special feature of the *Deinotheria* was their pair of powerful downwardly-directed tusks in the lower jaw, which must have served for digging up roots and bulbs.

#### 3 SKULL OF A SABRE-TOOTH (*Smilodon*)

The Sabre-tooths (often miscalled Sabre-toothed Tigers) were a distinct family of the Carnivores, with upper dog-teeth (canines) enormously enlarged and flattened from side to side. These served to puncture the skins of the large herbivores on which they preyed, including the Giant Ground-Sloth (E.M. Plate 4). Some specialized forms of Sabre-tooths fed only on the blood of their prey.

This family evolved successfully for close on 40 million years, but became extinct during the Ice Age, apparently owing to extinction of their bulky prey.

#### 4 SKELETON OF THE GIANT GROUND-SLOTH (*Megatherium*)

The Ground-Sloths are an extinct family, related to the true Sloths which live in trees, hanging upside-down from the branches. Both are of South American origin, but the Ground-Sloths penetrated to North America. The latest representatives of the family were exceedingly bulky, some of them bigger than elephants, and became extinct only very

recently; in fact there is some evidence that they were kept in a state of semi-domestication by some Indian tribes.

#### 5 FRONT-VIEW OF THE SKULL OF *Stegodon*

A primitive Mastodon-like elephant with enormous tusks which flourished in the Later Pliocene period, but became extinct with the onset of the Ice Age.

The later-evolved Mammoth was a large elephant adapted to a cold climate, with a humped back and a coat of long black hair. It survived through the entire Ice Age, and only became extinct less than 10,000 years ago; its extinction was almost certainly accelerated by the cave-men of our own species in Magdalenian times, who hunted it for food and depicted it on the walls of their rock-shelters and sacred caves.

#### 6 IRISH ELK (*Megaloceros*)

The so-called Irish Elk was really a Giant Fallow Deer whose enormous antlers are still found (by probing with a long iron rod) in the peat-bogs of Ireland. It was distributed over the north temperate regions of the Old World and seems to have been a frequenter of open woodlands during the later part of the Ice Age. The latest and largest species, standing 6 ft. at the shoulder and with an 11 ft. spread of antlers, was a contemporary of our own species in the Upper Palaeolithic, but persisted only for a few tens of thousands of years. Its final extinction was probably correlated with a drastic change of climate, but may well have been accelerated by human hunting.

#### 7 FRONT VIEW OF THE SKELETON OF A GIANT ARMADILLO (*Glyptodon*)

*Glyptodon* is the typical representative of a family of giant armadillos, which did not protect themselves by rolling up into a ball like some modern ones, but relied on their size and "one-piece" suit of heavy bony armour. The glyptodons originated in South America, but some of them found their way into North America. They all became extinct, together with many other bulky American mammals, during the Ice Age.

8 SKELETON OF *Moropus*, one of the Chalicotheres

These were the animals which upset Cuvier's generalization that claws always went with flesh-eating teeth: the Chalicotheres had claws instead of hooves, but were purely herbivorous, with skull and teeth not unlike those of a horse. Perhaps they scratched up roots with their clawed feet. They thrived through more than 30 million years in the northern hemisphere, but became extinct about the time when the Ice Age set in.

9 SKULL OF THE ARCHAIC HERBIVORE *Uintatherium*

This creature came from the Middle Eocene of North America, about 45 million years ago. It was armed with two small and two larger horns, and had huge tusks in the upper jaw; but its feet were clumsy and its brain small and primitive, and it and all its relatives had become extinct before the end of the Eocene, when more efficient and bigger-brained ungulates were rapidly evolving.

10 SKULL OF *Sivatherium*

A giant Okapi-like member of the giraffe family with large palmate horns, which flourished in Asia in Lower Pliocene times, about 10 million years ago, but then became extinct.

11 FRONT VIEW OF A SKELETON OF *Arsinoitherium*

*Arsinoitherium* was an aberrant and archaic type of herbivore from the Lower Oligocene of Egypt. Note its clumsy and hypertrophied horns.

12 APE-MAN (*Pithecanthropus*)

A reconstruction, in the Natural History Museum in London, of the earliest known hominid, who lived in Java about half-a-million years ago. He had no chin, and a protruding almost ape-like muzzle, and his brain was only about half the size of a modern man's brain, as shown by the receding forehead and small flat brain-case.

13 NEANDERTHAL MAN (*Homo neanderthalensis*)

A reconstruction of Neanderthal man, who survived until the last glacial phase of the Ice Age, perhaps 60,000 years ago. He overlapped with modern man, *Homo sapiens* (as dramatized in William Golding's curious book, *The Inheritors*), and the two species may perhaps have interbred in a few localities. Neanderthal man differed from our own species in lacking a chin, in possessing heavy brow-ridges like an ape, and in not walking completely upright. He was the type of early cave-man, but never left any painting or other evidence of creative art.

Monochrome Plates

1 LION ([*Felis*] *Panthera leo*)

Well into early historic times, the lion ranged from Greece in the west to northern and central India in the east, and south all through Africa. It must have been abundant in North Africa during the Roman Empire, since up to several hundred lions were brought to Italy for single shows in Roman amphitheatres. In northern Syria and Persia, lions survived until the present century. Today, however, lions are confined to tropical Africa, except one pitiful remnant in India north of Bombay.

The lion's tawny colour is an adaptation to open country; but the cubs are spotted, probably indicating that the species is descended from a forest-dwelling ancestor.

Their strength is prodigious: they have been known to jump over a six-foot stockade with a native cow in their mouth.

2 LIONESS

No lioness has a mane; the lion's mane is a secondary sexual character confined to males, serving both as a threat and as a protection in fighting. Curiously enough it is absent in some subspecies or local races, in which both sexes are maneless.

The lioness is not quite so large as the lion, but is still an exceedingly powerful animal, capable of killing large game such as antelopes and zebras.

3 CARACAL (*[Lynx] Caracal caracal*)

The Caracal, sometimes called the Persian Lynx because of its tufted lynx-like ears, is a medium-sized cat rather larger than a fox, found in south-western Asia and many parts of Africa. It lives on small deer and gazelles, hares, and large birds, and in some places has been tamed and trained to chase and catch game. It differs in many ways from the true lynxes, which are more northerly, larger, and live more in forests.

4-5 TIGER (*[Felis] Panthera tigris*)

See note on Colour Plate I.

6 TIGER-CUB

The usual size of a tiger's litter is three or four, but five or six cubs are sometimes produced. Tiger-cubs, unlike lion-cubs, resemble adults in their coloration. The pattern of the ears—black-bordered with a white inner spot—recurs in many other cats. As the photograph shows, even the baby tiger has very powerful feet and claws.

7, 8 LEOPARD (*[Felis] Panthera pardus*)

Leopards, as their cryptic spotted coat indicates, are primarily woodland animals. The species ranges over a large part of the Old World—most of Africa, across Asia from the Mediterranean coast in Syria and Palestine to China and Manchuria, and south to Indonesia. Curiously enough, while the tiger has failed to reach Ceylon, the leopard is well distributed there. It is more variable than the tiger: not only are the differences between geographical races (subspecies) greater, but in some races black individuals are not uncommon.

The leopard is one degree below the lion and tiger in size, and is adapted to prey on somewhat smaller animals. In the New World, where neither lions nor tigers exist, the largest cats are the Puma or Mountain Lion, which resembles the real lion in having a uniform coloration adapted to an open habitat, and the Jaguar, which is a spotted forest animal. Both these species are smaller than lions and tigers.

Like all cats, leopards are playful, and enjoy rolling over into strange positions, as illustrated in one of the photographs.

The Lion, Tiger, Leopard, Snow Leopard and Jaguar are generally put in a separate genus or subgenus, *Panthera*, because of their ability to make roaring noises, and not merely howl, growl, spit or purr.

9-10 CHEETAH (*Acinonyx jubatus*)

The lithe and graceful Cheetah (sometimes erroneously called the Hunting Leopard) differs from almost all other cats in being adapted for running down its prey rather than for stalking and leaping upon it. Its legs are very long; its claws are not fully retractile within a sheath, but help to give it purchase as it runs over hard ground. It is probably the fastest of all land animals: Bourlière states that, starting from rest, it can reach 45 m.p.h. within 2 seconds, and 65 to 70 m.p.h. at full speed! This is considerably faster than the 50 m.p.h. of the fastest antelopes, or the best achievements of greyhounds on dog-racing tracks.

The Cheetah is found wild in Africa and western Asia, including India. It purrs like a cat, and is easily tamed and trained. In India and Persia it has been used for centuries to hunt smaller antelopes like Blackbuck and Gazelles. Recently cheetahs have been employed in Africa to obtain antelopes alive for zoos, and in the U.S.A. to kill coyotes, and tame cheetahs have even been taken on leash through some great Western capitals.

11 ARABIAN SAND CAT (*Felis margarita*)

This small cat is an inhabitant of deserts in south-western Asia, living in holes and only coming out to feed at night. Its pale buff colour helps it to remain undetected against its sandy surroundings.

Though at first sight it has an agreeable pussy-cat face, it is in reality very savage, and when angry emits a horrifying sequence of roaring growls, snarls, groans, and hisses.

12 SERVAL (*[Felis] Leptailurus serval*)

Servals inhabit Africa, especially the savannah and bush-veldt regions. Like cheetahs, they are long-legged and speedy, adapted for running down their prey, but they are considerably smaller, and feed mainly on

small mammals, lizards, guinea-fowl, francolins and other medium-sized birds. The young lie in the grass in a "form" like a hare's until old enough to accompany their mother. Serval fur is used for mantles and cloaks by the chiefs of various African tribes.

### 13 SPOTTED HYENA (*Crocuta crocuta*)

Hyenas are essentially scavengers, feeding on wounded or helpless animals, or on the remains of kills by the great cats. They have weak hind-quarters, but strong fore-legs and immensely powerful jaws, with a pair of huge teeth acting like strong scissors or wire-cutters and capable of shearing through the thigh-bone of an antelope or cow with ease, and of coping with even the largest bones of hippos and elephants.

The Spotted Hyena is spread through Africa south of the Sahara, where it inhabits mainly the savannahs and bush-veldts. It often hunts in packs, and will sometimes attack human children or solitary adults.

The other members of the family *Hyaenidae* belong to the genus *Hyaena*. The common species of this, *Hyaena hyaena*, is smaller and inhabits south-west Asia from India to the Mediterranean, and North and East Africa. Both types of hyena emit weird and blood-curdling sounds, including maniacal "laughter".

### 14 MALAY WILD DOG (*Cuon javanicus*)

The Wild Dogs or Dholes are all Asiatic, the genus *Cuon* ranging from Siberia and Tibet to Singapore and Indonesia, though, like the Tiger, they have not succeeded in colonizing Ceylon. They are extremely dog-like in appearance, but must have a quite different ancestry from the true dogs (*Canis*), for they lack the last pair of lower molar teeth, have seven instead of five pairs of nipples, possess long fur between the pads on their feet, and seem to be quite undomesticable. Their habit of hunting co-operatively in packs enables them to kill prey as large as Water Buffaloes and Nilghai antelopes.

The Malay Wild Dog ranges from Burma through Malaya to Borneo, Sumatra and Java. It differs from the more familiar Indian

Dhole in being light reddish in colour, with white underparts.

### 15-16 TIMBER WOLF (*Canis lupus*)

The Wolf represents the highest development of the true dogs or *Canidae*. It is a widespread species, ranging over a great part of the northern hemisphere, from the subarctic in Greenland and the northern U.S.S.R. through the temperate regions to the subdesert zones of Mexico and India. The Coyote is a smaller and less social North American species of wolf.

The true wolf has evolved into a large number of geographical races or subspecies, differing in size, coloration, and habits. The Timber Wolf is the large subspecies of the forest areas of North America.

The wolf is ancestral to the domestic dog. Many authorities believe it to be the sole ancestor, but some maintain that the Jackal has also made a major contribution to our dogs' genetic make-up. In any case, the almost incredible variety shown by domestic breeds of dog—from toy terrier to St Bernard, from dachshund to greyhound—testifies to the power of selective breeding to mould and transform an organism within the space of a few thousand years.

The wolf is a highly intelligent and adaptable animal, much given to play and games when young. Though it is not a fast runner, being incapable of speeds much above 25 m.p.h., its method of co-operative hunting in packs enables it to catch and kill even large deer and antelopes. That they exercise a salutary biological check on the species on which they prey was shown by the events on the Kaibab plateau in Arizona. Here, in a misguided attempt to protect the deer of the area, wolves were exterminated, and pumas and coyotes nearly wiped out. The result was such an over-multiplication of the deer, from about 4,000 in 1905 to over 100,000 in 1924, that they literally ate themselves out of existence, and died off so rapidly that by 1929 only 10,000 were left.

In the breeding season wolves are less gregarious, and both parents indulge in lone hunting (over a range which may be fifty miles

across!) to provide food for the cubs. The same pair may remain mated for more than one season. In the wild, wolves rarely live longer than twelve years.

As you may read in Konrad Lorenz's book, *King Solomon's Ring*, wolves have a highly developed social organization, with a hierarchy of rank which prevents the pack being disrupted or enfeebled by individualist quarrels. The organization is maintained by a system of visible "sign-signals"—instinctive expressions of different emotional situations, to which other wolves equally instinctively respond by appropriate action. Particularly to be noted is the submissive gesture made by a weaker wolf involved in a fight: this at once induces the stronger animal to abstain from further violence, and so saves a life for the community.

#### 17 FOX (*Vulpes vulpes*)

The Common or Red Fox occurs in a number of subspecies or races spread over the entire northern hemisphere from Canada and northern Eurasia south to the southern U.S.A., North Africa and India; (the New World races are sometimes separated as a distinct species, *Vulpes fulva*).

The fox is a quick grower, reaching sexual maturity at about ten months of age. It breeds in a burrow or "earth", sometimes digging its own, but often taking possession of a badger's or rabbit's burrow. Two vixens have been seen sharing an earth and taking turns in nursing their combined litters. Fox cubs are among the most playful of animals, and to see them at their games is a delight.

Unlike the wolf, the fox hunts by solitary stealth and cunning, not socially in packs. It lives mainly on small mammals and birds, supplemented in summer by insects and fruits. Curiously enough, it hardly ever eats insectivores such as shrews or moles, but concentrates on rodents like voles, mice and lemmings, together with rabbits and leverets.

Small rodents have a population cycle, their numbers fluctuating enormously at more or less regular intervals: in voles and lemmings the average length of the cycle is about three and a half years. Naturally enough, the foxes

that feed on the rodents show the same cycle, increasing as their prey increases, and dying off after the rodent population crashes.

Like a number of other mammals, the fox is polymorphic, with sharply distinct colour-phases. In many areas a small proportion of blacks regularly occur, together with the "cross" types which are heterozygotes (hybrids) between red and black. In Canada, the black phase is the valuable Silver Fox; in Alaska and the Old World a black form has also arisen, but is slightly different and its fur is not so valuable.

It can be shown theoretically that permanent polymorphism can only be maintained if there is a selective balance between the various forms, each enjoying some relative advantage in the struggle for existence, but also suffering from some disadvantage. The delicacy of the balance is shown by the fact that the percentage of black (and cross) foxes varies with latitude, blacks being absent in the southern parts of the species' range (such as Britain), but increasing in frequency towards the north. The frequency also goes up and down with the ups and downs of the population cycle: apparently a character that is advantageous when times are hard becomes less so when life is easy.

#### 18 ARCTIC FOX (*Alopex lagopus*)

The Arctic Fox is also a valuable fur-bearer. As its name implies, it is the most northerly member of the dog family: and as food is scarcer in the arctic than in the temperate zone, it is smaller than the Red Fox. It also has extremely small ears, so as to minimize loss of heat in its cold home.

Like the Red Fox, it is polymorphic, but with only two colour-phases—the normal type, brown in summer and pure white in winter, and the "blue" type which stays bluish-grey all the year round. There are only two phases, because blue is a Mendelian dominant, so that heterozygotes (hybrids) between blue and white appear blue. Here again there is a gradation in frequency of the two types, white becoming more frequent to the north, as one would expect from their being less visible to their prey against a snowy background.

The Arctic Fox lives mainly on lemmings and ptarmigan, though, in some parts of its area at least, the "blues" manifest a greater preference for fish and sea-birds.

19 FENNEC ([*Vulpes*] *Fennecus zerda*)

The Fennec is a delightful-looking creature. It is a desert animal, even smaller than the Arctic Fox, for the reason that its prey is scarcer and smaller, and with a light creamy-yellow coloration serving for concealment in its sandy habitat. In the dry hot desert, its need is not to conserve bodily heat, but to lose it: accordingly the ears are enormous, and serve as very efficient heat-radiators, as well as helping to guide it by sound in its nocturnal hunting. It lives in burrows in the desert regions of Africa and the Middle East.

20-2 POLAR BEAR (*Thalarctos maritimus*)

The Polar Bear's scientific name means *sea-bear*. This is very appropriate, as it is a great swimmer, and lives mainly in and by the Arctic Ocean, though in summer it may penetrate quite a distance inland. Unlike the general run of bears, it is essentially carnivorous, feeding mainly on seals, fish, and stranded whales, though it betrays its omnivorous ancestry by supplementing its diet with seaweed, birds, and berries as occasion offers. It will lurk for hours by a seal's breathing hole in the ice to kill the unwary animal as it comes up for air, and it will dive for fish. There is a tale of a Polar Bear, presented by the King of Norway to his Royal Brother of England in the twelfth century, let out from the Tower at the end of a long rope, and catching Thames salmon.

In relation to its peculiar habits and habitat, it has evolved many peculiarities of structure and appearance. Thus it is white all the year round, to help it stalk seals unobserved; its molar-teeth, no longer required for grinding vegetable matter, are smaller, while its dog-teeth or canines are enlarged the better to tear flesh; and the soles of the feet are hairy as a protection against the cold and slipperiness of ice and snow. It is so different from other bears that it is placed in a distinct genus.

Polar Bears are very playful: it is delightful

to see them playing with bits of wood or other objects in their pool at the Zoo, as beautifully shown in Suschitzky's photographs. But they are also extremely savage and dangerous; and, as with most bears, the male will kill and devour his young if he gets the chance.

A Polar Bear might have altered Britain's destiny: if, in the encounter between the 14-year-old Nelson and a Polar Bear in the Arctic in 1772, Nelson and not the bear had been killed, world history would have been different.

23-4 KODIAK BEAR (*Ursus arctos middendorffi*)

The Kodiak Bear, so-called from its being found only on the large island of Kodiak in the Gulf of Alaska, as its trinomial or triple-barrelled name implies, is not a separate species. It is only a subspecies or geographical race of the most widespread of all bears, *Ursus arctos*, which inhabits the temperate regions of the northern hemisphere, from western Europe to China and Kamchatka, and the North American continent in Alaska and western parts; and south to Syria and Persia in the Old World and Mexico in the New.

The conventional English name for *Ursus arctos* is the Brown Bear; but this is not really satisfactory, since the species has differentiated into a large number of subspecies, including some which are not brown at all like the Syrian, the Isabelline, the Blue and the Manchurian Black Bears, and also the Grizzlies and the typical Brown Bears.

Like foxes, bears may show polymorphism in colour. Thus the Isabelline subspecies of *Ursus arctos* may be reddish, grey, or cream, and in the American Black Bear, *Euarctos americanus*, there is a considerable minority of brown animals.

The Kodiak Bear has the distinction of being the largest of the subspecies of *Ursus arctos*, and indeed the largest of all carnivores. A big male may measure 11 ft. when standing upright and 4 ft. at the shoulder when on all fours, and will weigh well over half a ton. When charging, it makes prodigious bounds and is capable of great speed.

25-9 BROWN BEAR CUB (*Ursus arctos arctos*)

Bears, like most carnivores, are intelligent and also playful, especially when young. But their playfulness and apparent amiability are not to be trusted: they can readily become dangerous and their powerful paws can inflict very serious damage. The "dancing bears" that showmen once paraded over western Europe and can still be seen in India, are broken in by a rope attached to a ring through their nose.

30-1 RED PANDA (*Ailurus fulgens*)

The Pandas are a small group of two genera, each with only one species, apparently related to the Raccoons, but living in a very different region of the earth's surface, and distinct enough to warrant being classed in a Family of their own (*Ailuridae*).

The Red, Lesser or Himalayan Panda, sometimes called the Cat-bear, is extremely attractive both to look at, with its handsome red and white fur, and to watch, with its toy-like playful movements; but any familiarities are dangerous, since it is quick to bite or to strike with its razor-sharp claws. It is rather cat-like in face and also in size, but is almost entirely vegetarian, living mainly on fruit, roots and bamboo-shoots. It inhabits the mountainous area from the Himalayas to southern China.

32 GIANT PANDA (*Ailuropoda melanoleuca*)

The Giant Panda is one of the most curious and interesting mammals. It looks like a bear, but is more nearly related to the raccoons; though a member of the Order Carnivora, it is exclusively vegetarian; and it has achieved a unique evolutionary feat, in developing a substitute for a thumb.

It feeds entirely on young bamboo shoots. In order to handle these, it needs some grasping mechanism in its hands. Since all its fingers had become modified to form a walking foot, its ancestors have transformed a small sesamoid bone (a bone formed within a tendon to give better attachment to the sinews) into the skeleton of a more elongated movable structure, complete with appropriate muscles, capable of grasping the young

bamboos, and holding them while they are being chewed in its powerful jaws.

The rare Giant Panda is as big as a moderate-sized bear, adults weighing up to 200 lb. or so. It lives in the dense bamboo forests of the West Chinese mountains, from the 6,000-ft. level up to 14,000 or 15,000 ft., and was only made known to science during the nineteenth century.

When young, its playful disposition and clownish appearance make it a universal favourite; but the adults become sluggish and (in Zoos at least) seem to spend most of their time dozing.

33 CRAB-EATING RACCOON (*Procyon cancrivorus*)

The Raccoons (*Procyonidae*) are a New World family of medium-sized adaptable carnivores, specialized in a number of different directions.

The Crab-eating Raccoon from South America looks much like its more familiar relative the common Raccoon from the northern New World; it is, however, more aquatic, being able to swim across several miles of water, and has a strange high-pitched whistle.

34 RACCOON (*Procyon lotor*)

The common Raccoon, familiarly called coon, is a characteristic North American mammal. It is a good example of a species which is both generalized and intelligent. It is at home in the trees and in the water as well as on land, and lives on a great variety of food, from small birds and poultry to snails and crayfish, from tortoise-eggs and mice to insects and earthworms. It is very adaptable, and has even taken to raiding the dustbins of Manhattan.

Its specific name *lotor*, "the washer", is derived from its curious habit of washing its food in water before eating it. It uses its hands with great dexterity to grasp and manipulate objects, and some zoologists consider that if selection for intelligence were practised on a strain of domesticated raccoons, they might well surpass dogs in intelligence. The fur is much used in the U.S.A. for men's coonskin coats and caps.

L. F. Whitney and A. B. Underwood have given a good general account of the species in their book *The Raccoon*.

35 PERUVIAN COATI (*Nasua nasua mephitis*)

The Coati or Coatimundi can be described as a raccoon which, instead of having its face flattened in a rather cat-like way, has so elongated its head that its sensitive mobile snout has almost become a trunk or proboscis.

The Coatis are New World animals, ranging from the south-western United States to southern Brazil. They are primarily tree-dwellers, with long (but not prehensile) tails to assist in balancing; they are social and diurnal in their habits, and omnivorous in their diet, eating anything from fruit and insects to lizards and nestling birds. They are intelligent and are often kept as pets in Latin America. Perhaps in correlation with the large size of their nasal cavities, they are very sensitive to smells, and will get extremely excited if given a piece of blotting-paper or cloth soaked in scent.

36 KINKAJOU (*[Cercopithecus] Potos caudivolvulus*)

The Kinkajou is a purely arboreal and nocturnal carnivore inhabiting the tropical forests of the New World and, in spite of its Latin name, quite unrelated to the Potto of Africa, which is a lemuroid. It is the size of a largish cat, with a prehensile tail to aid it in climbing. It is sometimes classified with the Raccoons, but sometimes in a family or sub-family of its own. In any case, it is more vegetarian than any of the true Raccoons, living mainly on fruit, fungi and honey (which it extracts from wild bees' nests with its long tongue), though it is not averse to insects and other small animals and to birds' eggs. It is said to have a passion for alcohol, which is dangerous because when drunk it becomes frenzied and vicious.

37 COMMON SKUNK (*Mephitis mephitis*)

The Skunks, together with the Weasels, Badgers, Rats and others, make up the Weasel family or *Mustelidae*. Many of these animals produce evil-smelling secretions to repel their enemies, but the Skunks are

supreme in this field. So potent is the secretion of their anal glands, which they can squirt to a distance of several yards, that no other animal will voluntarily attack them. Furthermore, instead of being protectively coloured, they advertise their formidable chemical weapons by warning coloration, usually in conspicuous black and white patterns, which they flaunt as they walk unconcernedly about. They sometimes stress the warning further by adopting striking attitudes if threatened: one species stands on its forepaws, with white tail waving aloft. They appear to be immune to snake venom.

Skunks are inhabitants of the New World. They are catholic in their diet, eating any kind of small animal, from mice and frogs to insects and birds' eggs. Skunks of the genus *Mephitis* range from the latitude of Hudson's Bay to southern Guatemala.

38 HOODED SKUNK (*Mephitis macroura*)

Hooded Skunks are found in Mexico and the southern parts of the U.S.A. Their colour-pattern, with white above and black below, is the reverse of the usual countershading of cryptically coloured animals, and serves to produce maximum conspicuousness.

39 SMALL INDIAN MONGOOSE (*Herpestes auro-punctatus*)

Mongoose, like Civets and Genets, belong to the Civet family or *Viverridae*, which on the whole resemble elongated cats, adapted for climbing or for hunting small prey through dense vegetation or in narrow burrows.

The true Mongooses of the genus *Herpestes* are Old World animals, ranging from the Mediterranean to China and south to Indonesia. Kipling immortalized their remarkable snake-killing prowess in his story of Rikki-tikki-tavi; but they feed mainly on small birds and rodents.

They have been introduced into various West Indian and Pacific islands for the purpose of destroying rats and other introduced pests, but have always become serious pests themselves, killing off the indigenous birds and other animals.

They are intelligent and can be tamed.

40 OTTER (*Lutra lutra*)

The subfamily of Otters, *Lutrinae*, consists of Mustelids which have become adapted to an aquatic existence. Their feet are webbed, and they live largely on fish, but with the addition of frogs, water-snails, crayfish and other aquatic animals (the Sea-Otter is an exception: it eats shellfish, crabs and sea-urchins).

The Common Otter ranges all over the subarctic and temperate parts of the Old World, and south to Persia, India and Burma. It is a beautifully agile and playful animal, but bites viciously if threatened.

41 SOUTHERN SEA-LION (*Otaria byronia*)

The Southern Sea-lion is not quite so streamlined as the Californian Sea-lion, but lives in much the same fashion. Like all eared seals, it is polygamous; the males are larger than the females, they come ashore for several weeks during the mating season, and take no food for several weeks. During this period they establish harems for themselves, which they defend against rivals. Walt Disney's film *Seal Island* gives a wonderful picture of a colony of the related Fur Seal in the breeding season.

42-3 CALIFORNIAN SEA-LION (*Zalophus californianus*)

The Sea-lions, Sea-elephants, Seals and Walruses make up a very distinct Suborder of the Carnivora, the *Pinnipedia* or fin-footed carnivores.

The Sea-lions, Sea-bears and the Fur Seals belong to the family of Eared Seals or *Otariidae*. These animals are not so completely modified for an aquatic existence as are the true seals, as they still have small external ears, and their hind-limbs have not been converted into a closely apposed pair of flippers permanently pointing backwards, and of no use on land, but can be brought forward to act as clumsy though serviceable organs of land locomotion, or even brought up to scratch the animals' heads.

The "seals" of circuses are in reality Sea-lions from the Pacific. They are extremely agile and intelligent, and enjoy learning various acrobatic and balancing feats. Their language

consists of barks, of various tones and shades of meaning.

Though the Eared Seals perhaps prefer to sleep on land (Plate 48) they can, like true seals, enjoy a sleep while floating upright, with their head out of water (Plate 43). They are wonderfully fast swimmers, being capable of 20 m.p.h. for short bursts, and can leap out of the water onto rocks several feet up.

44-8 SOUTHERN SEA-LION (*Otaria byronia*)

See note on Plate 41.

49 COMMON SEAL (*Phoca vitulina*)

The name "Common Seal" is really a misnomer since the Grey Seal (next Plate) is commoner on our rocky western and northern coasts: the Common Seal prefers coasts with offshore rocks or sandbanks showing at low tide. While the young of the Grey Seal are born in early autumn, those of the Common Seal are born in the summer.

50 GREY SEAL (*Halichoerus grypus*)

The Grey Seal is the larger of the two species of true seal found round the British coasts, some adult bulls reaching 10 or 11 ft. in length. It is an intelligent and on the whole a gentle animal, whose interesting habits have been well described by R. M. Lockley in *The Seals and the Curragh* and by Frank Fraser Darling in *A Naturalist on Rona*.

The Grey Seal can stay under water for a quarter of an hour: it can even sleep underwater on the sea-bottom, coming up automatically to the surface every five to nine minutes to take a dozen or so breaths of air and then return, still asleep, to the bottom.

They have remarkable mating dances and enjoy aquatic play. The young when born are white: they grow extremely fast on their mothers' rich milk, which contains about 50 per cent of fat, putting on about 3 lb. every twenty-four hours; at three weeks of age they are ready to start their independent life in the sea.

51 MOUFLON (*Ovis musimon*)

The Mouflon is restricted to the mountain forests of Corsica and Sardinia. It is one

among many species of wild sheep from the mountainous regions of the northern hemisphere, from various of which our domestic sheep have been derived.

The male Mouflon has fine horns, but in some wild sheep the horns are truly enormous, measuring over 6 ft. round the outer curve in *Ovis ammon* from the mountains of central Asia. The horns of the female Mouflon are very small, or totally absent.

52 BARBARY SHEEP OR AOUDAD (*Ammotragus lervia*)

The Aoudad is the only African wild sheep, being found in the sub-desert mountain regions round the Sahara. It differs from the true sheep of the genus *Ovis* in having no scent-secreting glands on the face, and in the rams' less spirally-twisted horns (the ewes have much smaller and more slender horns). It has striking fringes of hair on the forelegs, looking rather like knickerbockers, and on the throat.

53 DOMESTIC GOAT (*Capra hircus*)

The goats grade almost imperceptibly into the sheep, so that the separation of the sheep from the goats may in some areas be a difficult task. Typical goats, however, differ from typical sheep in the males having a beard, a powerful and disagreeable smell, and horns which are not curved in an open spiral. While sheep have come to symbolize innocence, the goat has often been the emblem of evil, or supposed to be in league with the Devil.

While wild sheep are found throughout the mountains of the entire northern hemisphere, wild goats are confined to those of the Old World. The finest wild goats are the Markhor of Afghanistan and the Ibexes.

54 NUBIAN GOAT (*Capra hircus*)

The Nubian Goat is the domestic goat of Nubia and Abyssinia. It stands high on its legs, and has a "Roman" profile and enormous pendulous ears.

55 WHITE-BEARDED GNU (*Connochaetes taurinus*)

The Gnus or Wildebeests are among the most curious of antelopes. They are inhabitants of

the game-plains of East and South Africa, in some parts of which they are still found in large herds. They have heavy-looking heads with a convex "Roman" profile and horns rather like a small buffalo's, but the body and the slender legs are somewhat horse-like, and they are extremely agile and speedy. When approached, their characteristic behaviour is to stand tossing their heads, then perhaps pretend to charge, then to prance and curvet and finally to retreat to a distance before repeating the process.

56 ELAND (*Taurotragus oryx*)

The Eland is the largest antelope, reaching the size of a big ox. It and its relatives such as the Bongo and the Kudu are all African, and are generally placed in a separate subfamily, characterized by their twisted horns and their less graceful and more oxlike appearance. Attempts have been made to domesticate the Eland, which is resistant to the nagana disease that kills off domestic cattle in Africa, but their hooves are too small to be of service on any but the hardest ground.

In Plate 56 two young bulls are fighting with locked horns; Plate 59 shows the stripes which give the subfamily the name of Horned Antelopes.

57 WHITE-BEARDED GNU (*Connochaetes taurinus*)  
See note on Plate 55.

58 GREATER KUDU (*Strepsiceros strepsiceros*)

In the Kudus, the twisted horns reach their highest development. The Greater Kudu is an animal of the East African mountains, and ranges up to the tree-line.

59 ELAND (*Taurotragus oryx*)  
See note on Plate 56.

60 NORTHERN WATERBUCK (*Kobus defassa*)

The African genus *Kobus* includes some rather heavily built true antelopes. The Waterbuck have handsome out-curving horns, and coarse heavy hair. They will take to water if pursued, but live in tall grass as well as in reed-beds near water.

61 BLACKBUCK (*Antilope cervicapra*)

Most antelopes live in Africa, where they have radiated out into a vast assemblage of forms, large and small. The Gazelles, on the other hand, are found in the deserts and semi-deserts of Asia as well as Africa; while the Blackbuck, like the Nilghai, is confined to India.

The males have splendid corkscrew-shaped horns, and are handsomely patterned in black and white, while the females are hornless and cryptically sand-coloured. Their extreme speed sometimes enables them to escape even from cheetahs.

62 SCIMITAR ORYX (*Oryx algazel*)

The Oryxes are African and Arabian antelopes characterized by moderate to rather large size and long and sharp horns, which can be dangerous even to lions. The Scimitar Oryx is an inhabitant of the deserts of northern Africa, with particularly beautiful curved horns and large hooves for running on loose sand. Like some other desert antelopes, it can exist without water for considerable periods.

63 CHINESE WATER-DEER (*Hydropotes inermis*)

The Chinese Water-deer, though deer-like in body, is not strictly speaking a deer, since the males have no antlers, but have developed large tusk-like upper canines as weapons in their fights with other males. They also differ from the typical deer in producing up to half a dozen young in a litter. They are small semi-aquatic marsh-dwellers from China and Korea. The young, like those of many other deer, are spotted.

64 RED DEER FAWNS (*Cervus elaphus*)

Red Deer are by nature animals of temperate woodlands: it is only in a few regions, such as Exmoor and the Scottish Highlands, that they have been forced up into the bare moorlands by the spread of human civilization. Even here, their forest origin is revealed by the spotted pattern of the fawns, which is a protective adaptation to blend with the woodland dappling of sun and shadow.

65 RED DEER STAG (*Cervus elaphus*) IN VELVET

The antlers of male deer are among the most extraordinary phenomena in the animal kingdom. Each year the buck grows and later sheds a pair of these branched bony structures, which in big stags may weigh over 20 lbs. During their formation, growth is extremely rapid, and is ensured by the so-called velvet, a coating of skin warm to the touch and richly supplied with blood-vessels, which secretes the solid framework of bone.

Eventually the velvet dies and is rubbed off, leaving the branched weapons of bare bone that we call antlers. After the rutting season a circle of the bone is resorbed at the base, leaving a line of weakness at which the antler eventually breaks and falls off.

Young stags produce simple spikes; but later, one or more branches or points are added each year, until in the finest stags there may be twenty or even more points.

66 REINDEER BUCK (*Rangifer tarandus*) IN VELVET

The Reindeer and its opposite number in the New World, the Caribou, differ from all other deer in possessing antlers in both sexes, and in the antlers having one downward-pointing brow-tine with which, it has been suggested, the animals may scrape the snow away to find the reindeer moss (really a kind of lichen) on which they chiefly subsist. Its large feet are also an adaptation to its northerly habitat, enabling it to spread its weight when walking on snow.

67 FALLOW DEER (*Dama dama*): HEAD OF A STAG

Fallow deer are medium-sized animals, showing in their spotted coat an adaptation to their woodland habitat. The males' antlers are palmate—that is to say, they expand into a broad plate of bone instead of ending in a number of separate points.

68 FALLOW DEER (*Dama dama*)

A young buck with his first growth of antlers, in the shape of a pair of short single spikes.

69 FALLOW DEER (*Dama dama*): DOE AND FAWN

The adults show the same spotted protective coloration as the young.

70-1 AMERICAN BISON (*Bison bison*)

The American Bison, often miscalled Buffalo, was one of the most successful members of the wild ox family or bovines, until its near-extirmination by man during the nineteenth century. Huge herds of Plains Bison once roamed the great grasslands of the North American prairies, and afforded an important element in the diet of the large bears and the Plains Indians. Both the Great Plains subspecies and the Wood Bison of north-western Canada are now rigorously preserved in special sanctuaries.

The bulls have an imposing "cape", "beard" and "leggings" of long black fur, and fight vigorously for the possession of the cows.

72 EUROPEAN BISON (*Bison bonasus*)

The second species of the genus Bison is the European Bison or Wisent. This is much like its New World congener, but the bulls have a less impressive cape and beard.

During the later stages of the Ice Age, the Wisent occurred over most of Europe, and is frequently depicted in Upper Palaeolithic cave-paintings of Aurignacian and Magdalenian times. It was reduced during the nineteenth century to two small groups in Lithuania and the Caucasus, and all but exterminated during the two World Wars of our present century. A small number survive in special reserves and in zoos.

73 CAPE BUFFALO (*Syncerus caffer*)

The true buffaloes are heavily built wild oxen with large massive horns. The Water Buffalo of India and adjacent regions has been domesticated since prehistoric times; but the African Buffaloes of the genus *Syncerus* (so-called because their horns are fused in the middle line to form a bony casque) seem to be untameable.

The Cape Buffalo inhabits the savannahs and bushveldts of eastern Africa. It is a huge and fierce animal, whose cunning makes it extremely dangerous to the hunter. To deal with the coarse vegetation on which it feeds, its tongue has been transformed into a powerful rasp.

74-5 ANKOLE CATTLE (*Bos indicus*, var.)

Man's domestic cattle have been developed from two separate species, both now extinct in the wild state—*Bos primigenius* for those originating in Europe and the Middle East, and *Bos indicus* for those of Indian origin, all of which have a hump on the back.

The most familiar cattle of *indicus* type are the zebus of India, but other breeds have long been established in Africa. Of these, the magnificent long-horned Watusi and Ankole cattle, from Ruanda and western Uganda respectively, are outstanding.

76 YAK (*Bos grunniens*)

The Yak is a large wild ox with enormously long hair and bushy tail, adapted to the high cold plateaus of Tibet and adjacent regions. Wild Yaks were once almost as abundant as American Bison, but are now confined to a few small and remote areas. However, unlike the American Bison, the Yak was domesticated, and still provides one of the most important means of transport in this mountainous region. Yaks are also killed for meat, and they provide the vast quantities of butter used by the Tibetans to flavour their tea and to burn in place of oil in their religious shrines.

Domestic Yaks are smaller and gentler than the wild form, and exhibit much variation in colour and in presence or absence of horns.

77 CHARTLEY OX (*Bos taurus*, var.)

European domestic cattle are given the name *Bos taurus*, but are descended, mainly or entirely, from the formidable Aurochs, *Bos primigenius*, the giant wild ox which figures in the prehistoric cave-paintings of the Upper Paleolithic period, and survived in the Middle East and Europe into historic times.

In Britain two types survive—the Chartley and Chillingham breeds—which resemble their wild ancestor in conformation, though they are smaller and white in colour (the Chillinghams with reddish ears, the Chartleys with black ears). These apparently originated from the enclosure of herds of half-wild forest cattle in parks.

78-80 GUANACO (*Lama guanaco*)

The Guanaco or Huanaco is the ancestor of the Llama and the Alpaca. It is brownish in colour with white underparts, and is still found wild in considerable herds. Its range extends from the high Andean plateaux to the southern tip of the South American continent.

81 LLAMA (*Lama glama*)

The Llama and the Alpaca are the domesticated forms of the wild Guanaco, (and together with the smaller Vicuna) constitute a separate branch of the Camel family, a branch which is now confined to the Andean region of South America.

The Alpaca was bred exclusively for its wool. The Llama, on the other hand, though it provides some wool, was the only beast of burden available to the ancient Incas, and is still used extensively by the Indians of the Andean plateau, even though it cannot carry loads much above 100 lb. in weight. It also provides meat, and a not very satisfactory milk. Many breeds and colour-varieties exist.

Llamas employ a curious and unpleasant means of defence by spitting, which they have inherited from their wild ancestors.

82 ARABIAN CAMEL (*Camelus dromedarius*)

The Arabian or One-humped Camel seems to have originated in the desert regions of the Middle East. It was very early domesticated: Abraham used camels, and Job is said to have possessed a herd of 6,000. Contrary to popular belief, it was not introduced into Africa until well on in the Christian era. Herds of feral or secondarily wild camels exist in various regions where it has been introduced, such as Australia and southern Spain; for a time, they were also in the southwestern states of the U.S.A.

Various breeds of camel exist, some used for carrying burdens, others for riding: the term *Dromedary* should be reserved for fast riding camels, such as are used in the various military camel corps.

Camel flesh is much used as meat; the

humps are a special delicacy. Camel milk is also much used, but apparently never for butter-making.

The male camel in the rutting season protrudes a fleshy fold from his mouth and emits a loud and unpleasant belching roar.

83 BACTRIAN CAMEL (*Camelus bactrianus*)

Camels are popularly associated with hot tropical deserts, but in point of fact the Bactrian species is a long-haired animal adapted to the high cold arid regions of Asia north of the Himalayas. The splay feet of camels serve to spread their weight on snow as well as sand. The camel's hump or humps are fat-storing organs, which, together with the water-storing stomach, enable the animals to go long distances on a very small ration of food and water. It is probable that no truly wild camels of either species remain, though considerable herds have escaped from domestication to become feral and live a free life.

The Bactrian camel is always two-humped. It is much used as a beast of burden, as well as for food and as a supplier of wool.

84-6 GIRAFFE (*Giraffa camelopardalis*)

See note on Colour Plate III.

87 WARTHOG (*Phacochoerus aethiopicus*)

The Warthogs are the wild boars of Africa south of the Sahara. They are now the most abundant of wild swine, in many large areas still reaching a density of over one per square kilometre. They are sturdy animals with huge canine teeth coming out and up from the wart-embellished face. They are capable of speeds up to 30 m.p.h. When running they have a ludicrous look with small tails vertically erected; and on arriving at their burrows, which they either excavate themselves or take over from an Aardvark, they turn round quickly and back in, so that an enemy is faced with the formidable tusks.

88 RED RIVER HOG (*Potamochoerus porcus*)

The Red River Hog is another African wild pig, but lives in forests instead of on open plains and savannahs like the Warthog,

rooting for its food with its powerful snout. It has a fascinating grotesqueness, with its enormously elongated face and tufted ears and its handsome coloration of rust-red, white and black. They appear to be easily tamed: Dr Albert Schweitzer for years had a tame female, which he eventually presented to the London Zoo.

89 BABIRUSA (*Babyrousa babyrussa*)

The Babirusa is confined to Celebes and the neighbouring island of Buru. The males are perhaps the most extraordinary members of the Pig family, with their enormous curved canine teeth resembling horns rather than tusks. The upper pair do not enter the mouth, but grow upward through the skin of the face to curve backward above the eyes. One of their functions is probably to act as a symbol of power and a threat to other males, but they also serve to protect the eyes when the animal is rooting. In this connection it is interesting to note that the boars do most of the rooting, the rest of the family feeding on what he digs up. They are nocturnal animals, and live in moist forest habitats.

90-1 PIGMY HIPPOPOTAMUS (*Choeropsis liberiensis*)

The Hippopotamuses can be regarded as a branch of the ancestral pig stock which has become specialized for an aquatic life. They are now reduced to two species, both confined to Africa. The Pigmy Hippo is less modified from its pig-like ancestry, lacking the enormous size and the exaggerated jaws of the common hippo. It is however more fully aquatic, being unable to live for any length of time on dry land. It can absorb water through its thin skin. It is confined to a few remote pools and rivers of the West African forests.

92-4 HIPPOPOTAMUS (*Hippopotamus amphibius*)

*Hippopotamus* means River Horse; and certainly the heads of hippos projecting from the water look remarkably horse-like. However, the rest of the body at once betrays their common ancestry with the pigs. Male hippos may reach 14 ft. in length and a weight of over two tons. With their huge gape and their

powerful tusks, hippos are formidable animals, and can bite through a man's body or a canoe with ease. Their thick, tough hide, which is used by man to make cruel whips, enables them to spend considerable periods out of water. They feed mainly by night, eating grasses and crops. They are perfectly at home in the water, mating and bringing forth their young there, and able to walk about on the bottom and to stay submerged for quite long periods. They are often attended by a species of fish which plays a somewhat similar role to the tick-birds and cattle egrets that frequent large land mammals, cleaning the animals' skin by eating the organic debris that accumulates on it.

95 BRAZILIAN TAPIR (*Tapirus terrestris*)

The Tapirs are primitive members of the order of odd-toed Ungulates to which the horses belong, though tapirs are more closely related to rhinoceroses. They are superficially rather pig-like in general appearance, but with a flexible snout or incipient proboscis with which they pluck vegetation. Tapirs were widespread in Miocene times, but have now become restricted to two widely separated areas, in Malaya and South America. The Brazilian Tapir is one of the most prized sources of meat for the forest Indians. Like various other forest animals, it has a protective spotted pattern when young.

96-7 MONGOLIAN WILD HORSE (*Equus przewalskii*)

This is the only living wild species of horse. Wild horses of similar type were widespread during the Ice Age, and are often represented in the cave-paintings of the Upper Paleolithic hunters, for whom they were a valuable source of meat. Today, Przewalski's Wild Horse is confined to a few areas in eastern Siberia and Mongolia: the other historically known species, the Tarpan, survived in the Dnieper area until less than a hundred years ago.

98 AFRICAN WILD ASS (*Equus asinus*)

There are several species of wild ass, inhabiting the drier regions of the Old World, from Mongolia and Tibet through Afghanistan

and Persia to North Africa and Somaliland. Xenophon, during his famous march, noted the numbers and the extreme swiftness of the wild asses or Onagers of the upper Euphrates region.

The African Wild Ass appears to be the ancestor of our domestic donkeys. It differs from other species in its grey rather than fawn colour and its more prominent crest-like mane.

99-100 COMMON ZEBRA (*Equus burchelli*)

The Common Zebra is the most abundant species of the striped horses or zebras of the eastern and southern parts of the African continent. Its stripes are a form of disruptive camouflage, causing it to stand out less prominently against the background. It is a widespread species with several geographical subspecies. One of them, the Quagga of South Africa, which was striped only on head, neck and shoulders, has now been exterminated by white men. Common Zebras are still abundant on the game-plains of East Africa, down to the north of the South African Union: they are one of the lion's chief sources of food.

Plate 100 shows the East African sub-species.

101-2 WHITE RHINOCEROS (*Ceratotherium simum*)

The Rhinoceroses, like the Tapirs, are survivors of a once-abundant primitive group of odd-toed Ungulates. The White Rhinoceros is not really white, but grey. It is the largest Rhinoceros, and the third largest land animal, being exceeded in bulk only by the Elephants. It has two horns, the anterior one sometimes reaching several feet in length. Unlike the African Black Rhinoceros, it is an inoffensive animal, whose square upper lip is adapted to browsing on grasses and small shrubs.

103-4 GREAT INDIAN RHINOCEROS (*Rhinoceros unicornis*)

The other rhinoceroses have a prehensile triangular upper lip with which they pluck their vegetable food. The Indian Rhino likes moisture, and lives mainly on reeds and long

grasses. Its immensely thick hide is thrown into pleats, giving the animal an armoured appearance. Like the African Black Rhinoceros, it is much persecuted for the sake of its horn, which is supposed by many Asian peoples to act as an aphrodisiac. Rhinos are veritable living fossils, which reached their heyday in the Pliocene, over 10 million years ago. The long-haired Woolly Rhinoceros lived alongside Upper Paleolithic man in the cold climate of Ice Age Europe.

105 MANATEE (*Trichechus manatus*)

The Manatees and Dugongs are the sole surviving representatives of the order Sirenia or Sea-Cows. This, the only group of vegetarian aquatic mammals, reached its maximum development in the Miocene period, about 25 million years ago. They appear to be of ungulate stock, considerably more specialized for aquatic life than are the carnivore seals, possessing a paddle-like tail and fore-flippers for swimming, but with no external trace of hind-limbs.

The Manatee's fleshy upper lip is split into two mobile halves beset with strong curved bristles, so that it can act as a grasping organ for plucking the aquatic vegetation on which it lives. The female has a pair of teats on the chest, and suckles its young while standing upright with its head and shoulders out of water: it is this habit which caused the animals to be called mermaids by some early travellers.

There are three species of *Trichechus*, two from the eastern coasts of the Americas from Florida to the Amazon, another from West Africa. Both, but especially the African species, frequent rivers as well as estuaries and the sea. They are inoffensive and apparently stupid, though sometimes inquisitive.

106-8 AFRICAN ELEPHANT (*Loxodonta africana*)

The African Elephant is the largest living land animal, old bulls having been recorded with a shoulder height of 12½ ft. and a weight of over six tons. The longest tusk measured 11½ ft. along the curve, the heaviest weighed

226½ lb.—an extraordinary size for a single tooth (though some extinct elephants had much larger tusks). Its gestation period is about twenty-one months. The chief function of the huge ears of the African elephant is probably to provide extra surface to dissipate body heat.

Elephants will sometimes pluck fruit or leaves with their trunks, sometimes shake fruit down, or will uproot whole trees. Like many other herbivores, they use special salt-licks to satisfy their need for mineral salts. They are capable of speeds up to 20 or even 25 m.p.h. over short distances. They travel in herds, making use of well-trodden "elephant roads", and are very fond of bathing.

(In Plate 108 the African Elephant is on the left.)

#### 108-9 INDIAN ELEPHANT (*Elephas maximus*)

*Maximus* is a misleading specific name, for the Indian Elephant is considerably smaller than the African, with record tusks weighing only 150 lb. It is put into a different genus because of the very distinct structure of its molar teeth, which have narrower and more numerous grinding ridges than the African elephant.

It is only recently that African elephants have been domesticated, but the Indian species has been tamed since time immemorial. Its intelligence and its manipulative ability in handling logs are outstanding. In India elephants are often in the service of temples, and are much used in processions and also for tiger-shooting.

(In Plate 108 the Indian Elephant is to the right.)

#### 110 ROCK HYRAX (*Procavia* [*Heterohyrax*] *sp.*)

The Hyraxes are an isolated group of small herbivorous mammals which, in spite of their rabbit-like appearance, appear to be more closely related to the elephants than to any other group. With their small size and nails like small hooves, they have retained many characteristics of the primitive ungulates of the Early Tertiary, 30 or 40 million years ago.

The best-known Rock Hyrax is the Coney of the Bible, but numerous other species exist in Africa south of the Atlas mountains. The photograph shows a West African species from Nigeria.

#### 111 BELGIAN HARE (*domesticated Oryctolagus cuniculus*)

The Belgian Hare is not really a hare, but a breed of domestic rabbit, which owes its name to its large size and rather long legs. It is bred mainly for eating.

#### 112 ANGORA RABBIT (*domesticated Oryctolagus cuniculus*)

The Angora Rabbit, on the other hand, has been bred for its fur, which may reach 6 in. in length. The most valuable fur is white, from albino stock.

#### 113 GREY SQUIRREL (*Sciurus carolinensis*)

The tree-squirrels are rodents specialized for an arboreal life, using their long tails to balance themselves as they climb and leap about the branches, and their hands for manipulation.

The Grey Squirrel is the commonest of several North American species. It was introduced into Britain towards the end of last century, and after stabilizing itself, rapidly spread to become a serious pest. Though less attractive than our indigenous Red Squirrel with its bushy tail and tufted ears, it is in no sense a "tree-rat", as many people call it. Like many other squirrels, it is polymorphic, with two sharply distinct colour-phases.

#### 114 MALABAR SQUIRREL (*Ratufa indica*)

The squirrels of the genus *Ratufa* are the most striking of the *Sciuridae*, with their large size and striking colour pattern. The Malabar Squirrel, as its name implies, inhabits southern India.

#### 115 CAPYBARA (*Hydrochoerus capybara*)

The Capybara is the largest living rodent, adult males weighing over 200 lb. It is confined to tropical South America, where it lives in

herds in moist areas. It is intelligent and domesticable.

116 ALPINE MARMOT (*Marmota marmota*)

The Marmots are heavily-built ground squirrels which live in burrows. The Alpine Marmot is the most characteristic mountain mammal of Europe: its warning whistle is familiar to all mountaineers. In autumn it accumulates a store of dry grass in its burrow, preparatory to hibernating.

The Prairie-dogs are small marmots of the North American prairies.

117 PATAGONIAN CAVY (*Dolichotis patagonica*)

The Patagonian Cavy, like the Guinea-pig and the Capybara, is a member of the *Caviidae*. This is an exclusively South American family of rodents, which has radiated out into various directions. The Patagonian Cavy or Mara has adopted a way of life rather like that of the Hares and Jack-rabbits. It is a long-legged and speedy runner, inhabiting the open treeless prairies of South America, feeding by day, and making its home in burrows which it digs itself. The white rump-patch serves the same purpose as the rabbit's white scut, acting as a guiding signal to others of the species when alarmed. The tail, no longer needed for this purpose or for balancing or as a fly-whisk, has been reduced to a comic-looking black button.

118 GUINEA-PIG (*domesticated Cavia cutleri*)

The Cavies of the genus *Cavia* are small tailless members of the South American family *Caviidae*, sheltering in burrows or crevices or under leaves. One species from Bolivia lives in large "towns" of numerous burrows, very much like the Prairie-dog of North America. The domestic guinea-pig is derived from the wild *Cavia cutleri*, which was the only animal besides the Llama domesticated by the Incas. Only one young is born at a time, but in a very advanced stage of development. The Incas used them for food, while we employ them mainly as valuable laboratory animals, though also as pets. Many varieties and breeds have been

developed by selection in the domestic guinea-pig.

119 TREE PORCUPINE (*Coendou prehensilis*)

The Tree Porcupines, as their name implies, are porcupines which have taken to an arboreal life. In relation to this, their quills have become shorter, and they have developed powerful prehensile tails. They inhabit the tropical forests of Central and South America. They are inquisitive and intelligent, and make interesting pets.

120 CRESTED PORCUPINE (*Hystrix cristata*)

The Porcupines are a widespread group of two distinct families, one in the Old World, the other in the New. They all have some spines, but in the Old World rat-porcupines these are few and small. The maximum development of the spines into formidable quills is found in the Great Crested Porcupines of Africa south of the Sahara. Like Skunks, Crested Porcupines are harmless inoffensive animals when left alone, relying on their weapons to protect them against attack. They give warning of their dangerous properties by their conspicuous coloration and by rattling their quills to the accompaniment of threatening growls and stamps of the feet. The quills of the newborn young are small and soft, and only harden and elongate later. The Great Crested Porcupine may reach a length of over 2 ft. 6 in. It lives on roots, bark, fruits and coarse greenery, and has extremely powerful jaws and gnawing teeth.

121 HARVEST-MOUSE (*Micromys minutus*)

Harvest-mice are among the smallest mammals, though somewhat larger than some of the Shrews. In weight, they run about five to the ounce, or about seven to an ordinary house-mouse. Their small size enables them to climb stems and twigs too slender to support a field-mouse, and their partially prehensile tail is a further help. They build pretty globular nests in growing corn or on thistles.

122 WHITE RATS (*Rattus norvegicus*, var.)

The common rat of this country is the Brown Rat, *Rattus norvegicus*, which is a serious pest.

Domesticated breeds of Rats, especially standardized albino strains, are much used for scientific experiments. They start breeding when rather over three months old, and rarely survive to the age of two years.

123-4 HEDGEHOG (*Erinaceus europaeus*)

The Hedgehog is the largest of British insectivores. It is distributed over most of Europe, and eats a wide variety of food, including fruit and insects, birds' eggs and toadstools. The spines of the young at birth are naturally soft, and only harden later. Hedgehogs when alarmed or attacked defend themselves by rolling themselves tight into an almost unassailable prickly ball. They hibernate, but may emerge on warm days during the winter.

125 INDIAN FRUIT-BAT (*Pteropus giganteus*)

The large tropical Fruit-bats are often called Flying-foxes because of their fox-like muzzles. They feed largely on fruit, and may do great damage to orchards. They roost by day in large colonies, most species in trees, but some in caves: at nightfall they set out in great streams to find food.

The photograph shows how the leathery wings are folded, and how the animal hangs upside-down by the claws of its toes and of one finger.

126 TWO-TOED SLOTH (*Choloepus didactylus*)

The Sloths are edentates, living entirely on foliage and fruit in the tropical forests of South America. They are unique among mammals in spending most of their life hanging upside-down. Their huge strong claws, curved like umbrella-handles, act as hooks to secure their hold on the branches. They are normally very slow in all their movements (hence their name of Sloth), but can strike very fast if threatened. They are also unique in having their hairs modified so as to serve as miniature gardens for microscopic algae: the resultant green colour is highly protective in their leafy habitat.

127-8 GIANT ANTEATER (*Myrmecophaga jubata*)

The Giant Anteater of the forests of tropical America is one of the most peculiar animals,

a primitive type which has managed to survive by becoming extremely specialized for living on termites. It walks on the knuckles of its fore-feet, so as not to blunt the powerful claws, which are needed to rip open the strong walls of termite nests: the narrow elongated muzzle is then stuck into the nest, and the enormously long and sticky worm-like tongue is employed in licking up the termites. The huge bushy tail serves as an umbrella when the animal is asleep, but seems also to be used to brush termites together preparatory to devouring them. The Great Anteater is well capable of defending itself even against a Jaguar.

129-30 TAMANDUA (*Tamandua tetradactyla*)

The Tamandua or Lesser Anteater is a smaller and less exaggerated version of the Giant Anteater, adapted to life in the trees instead of on the ground. In relation to its arboreal habits, it has a powerfully prehensile tail, with which it can suspend itself while opening tree-termite nests and devouring their inmates.

Like the Giant Anteater, Tamanduas are exclusively tropical New World animals, and carry their young on their backs.

131-3 THREE-BANDED ARMADILLO (*Tolypeutes conurus*)

The Armadillos, together with the Sloths and the American Anteaters, belong to the order *Edentata*. These are very primitive placental mammals, which managed to survive in the first instance by being left isolated from competition in South America, and then by adopting very specialized habits of life.

The Armadillos specialized in bony armour, which in the living forms is jointed. This enables some species, including the Three-banded to roll up into a tight ball, safe from almost any enemy. Armadillos are great diggers, living mainly on the insects they find in the earth.

The Three-banded Armadillos are exclusively South American; but their Nine-banded relatives (*Dasyppus*) have penetrated as far north as Texas.

134 ECHIDNA (*Tachyglossus aculeata*)

The Echidnas or Spiny Anteaters are one of the two surviving genera of egg-laying mammals, which have managed to survive because isolated from placental competition for over 60 million years in the Australian region. The common Spiny Anteater of the Australian continent is specialized for a diet of termites; like the placental Anteaters of South America, it has powerful claws and a narrow elongated snout with long sticky tongue to poke into the termite nests it has opened. The Spiny Anteaters have lost all their teeth in the course of evolution. They protect themselves by digging themselves in until only their sharp spines protrude above the surface of the ground. The eggs are laid into a shallow hair-lined pouch which develops afresh every breeding season, and are gummed on to the hair by a sticky secretion. They hatch in the pouch, and then live on the milk which oozes out through the mother's hair.

135 WOMBAT (*Phascolomys ursinus*)

Among marsupials, the Wombats correspond more or less in build and way of life with the Woodchucks among placentals, though they reach a larger size. They are lumbering creatures, making very large burrows, and using their rodent-like teeth to eat roots and coarse herbage.

136-7 WALLABY (*Wallabia sp.*)

Wallabies are essentially small Kangaroos, without the Kangaroos' remarkable speeds of up to 30 m.p.h. and their amazing leaping powers (over 30 ft. in one bound). With the Kangaroos, they are the chief native herbivores of Australia, and in some parts of Western Australia are so abundant that their numbers have to be kept down to ensure grazing for sheep.

138-9 FLYING PHALANGER (*Petaurus australis*)

Several arboreal members of the Australian marsupial family of phalangers have taken to "flying", or rather gliding, from tree to tree. Sometimes the tail only is flattened to provide a gliding surface; but usually folds of skin are developed between fore- and hind-limbs.

When these are in action, the whole underside of the animal is converted into a flat plane. The giant Gliders of the genus *Scolobates* may reach 3 ft. in length and can cover well over a hundred yards in a single glide.

The Flying Phalangers too are fine gliders, but not capable of such long distances. They are beautiful little animals, with silky fur and a rather squirrel-like head: they can inflict a nasty bite, but can be tamed.

140 SLOW LORIS (*Nycticebus coucang*)

The Lorises, Pottos and Bushbabies constitute a distinct family of the primitive lemur-like Primates.

The Slow Loris is an Asiatic animal, ranging from India to Indonesia. It gets its name from the extremely deliberate movements with which it ventures out in the trees at night in search of food, gripping the branches with its opposable thumbs and big toes. It is an omnivore, but much addicted to large insects. It will sometimes eat while hanging upside-down by its feet.

141 BOSMAN'S POTTO (*Perodicticus potto*)

Pottos are lorisoids from the African forests. Their West African vernacular name, "Softly softly", well describes their usual movements. They too are nocturnal omnivores, eating insects, fruits, and birds. They have a peculiar defensive weapon in the shape of the sharp spines of their neck-vertebrae, which protrude through thin places in the skin; these can inflict a nasty wound when the animal butts backwards at an intruder.

142 ANGWANGTIBO (*Arctocebus aureus*)

The Angwangtibo is a lorisoid found in the forests of West Africa from eastern Nigeria to the mouth of the Congo. It resembles the Pottos, but is smaller and has a more elongated muzzle.

143-4 BUSHBABIES (*Galago spp.*)

The Bushbabies or Galagos differ from other lorisoids in being specialized for active leaping from bough to bough instead of slow careful climbing. In relation to this habit, they are small and light, with long tails with

which they can balance and even steer themselves while in the air. They are all African, and like the other lorisooids are omnivorous, but with a rather greater preference for fruits and vegetable matter. In captivity they thrive on mealworms, which they hold like miniature sausages in their tiny hands.

Plate 143 shows the Moholi Bushbaby (*Galago senegalensis*); Plate 144 the Bushy-tail species (*Galago crassicaudatus*).

145 MONGOOSE-FACED LEMUR (*Lemur mongoz*)

The true Lemurines are found only on Madagascar and the adjacent Comoro Islands. The stock must have been isolated there for at least 20 million years, during which time it has radiated out into a large number of types, the most successful and abundant of which is the genus *Lemur*. This is characterized by a dog-like muzzle, moderately large size, and long bushy tail.

The Mongoose or Mongoose-faced Lemur is a smallish arboreal lemur, confined to the northern half of Madagascar.

146 SPIDER MONKEY (*Ateles geoffroyi*)

The Spider Monkeys are so-called because of their long spidery arms with which they swing themselves through the forest. Like all the members of the family *Cebidae*, the highest group of New World monkeys, but unlike any from the Old World, they are equipped with prehensile tails which serve as a very efficient fifth limb.

They live in large social groups, and eat mainly foliage and fruit.

147 PINCHÉ MARMOSET (*Oedipomidas oedipus*)

The Marmosets constitute a primitive family of New World primates, so primitive that some authorities call them Half-Monkeys. They lack the prehensile tail of the higher New World monkeys, and have claws instead of nails on all their toes except the hind big toe. They are all small, and rather squirrel-like in their way of life, feeding on insects, fruits and seeds. They often have striking patterns and adornments. Unlike most primates in which only one young is born at a time, Marmosets usually produce twins. They are

unique among mammals in the fact that the males carry the young, handing them to the female to be suckled.

The Pinchés are the most bizarre of the Marmosets, with exaggerated plumes of fur and very long and very bushy tails. They are confined to the forested western flanks of the Andes in Colombia and northwards into Central America.

148 COMMON MARMOSET (*Hapale penicillata*)

The Marmosets of the genus *Hapale* are long-legged and capable of leaping considerable distances from bough to bough. They inhabit the equatorial forests of eastern South America south of the Amazon.

The photograph clearly shows the clawed fingers, and the striking tufts of light-coloured hair on the sides of the head.

149 RHESUS MONKEY (*Macaca mulatta*)

The best-known macaque is the Rhesus, the common monkey of India, and the species most used in many important branches of scientific research. The Bandar-Log of the *Jungle Book*, with their restless chattering nature, mischievous but never able to concentrate for long, were Rudyard Kipling's idea of the Rhesus monkey people. Monkeys in India do a great deal of damage, but as they are regarded as sacred, they are rarely killed. As with most monkeys, the adult males are aggressive quarrelsome animals, considerably larger than the females.

150 DIANA MONKEY (*Cercopithecus diana*)

The Guenons or Cercopitheques are a large genus of monkeys from the forest regions and savannahs of Africa. They are characterized by striking colour-patterns, whose main function appears to be one of threat, conferring impressiveness on their possessors: as with birds, related species tend to have sharply distinctive patterns. In some the facial pattern is striking, with a white nose or a coloured beard, but in the Diana Monkey from West Africa the face is entirely black and stands out vividly against the white "shirt-front" of chest and upper arms and the white band across the forehead.

151 DRILL (*Mandrillus leucophaeus*)

The genus *Mandrillus* includes the Drill and the Mandrill, which may be characterized as forest baboons. Like the true baboons, they are terrestrial not arboreal creatures, but they live on the floor of the West African forests, never venturing out into the open savannahs. The males are very powerful and vicious, much larger than the females, and have curious bare ribbed cheeks. In the Mandrill these are coloured a brilliant blue, in striking contrast with the bright red nose, while in the Drill they are a shiny leathery black. The face-pattern serves as a threat or warning to rival males: in the Drill the warning is enhanced by the ivory-white of the gums which the male reveals when he snarls.

152 BABOON (*Papio sp.*)

The baboons are tailed monkeys which have left the trees for the ground. In relation to this, they are bulkier than any purely arboreal monkey, their tails are shorter, and they have developed long dog-like muzzles. They are intelligent but fierce creatures, scouring the open plains-country of Africa in large social groups in search of food and prey. The males have a thick cape of long hair; they are much bigger and fiercer than the females, and fight violently. Baboons have an elaborate social organization, dominated by the more vigorous males.

The females carry their young when small. If a baboon baby dies, the mother will often refuse to be parted from it, and will continue carrying the corpse until it is a mere shrivelled mass of fur and bone.

153-4 GIBBONS (*Hylobates spp.*)

Gibbons are true anthropoids or tailless apes, which are now purely arboreal, and are accordingly much smaller than the semi-terrestrial other anthropoids. They are specialists in what is technically known as brachiation, or swinging from branch to branch by their elongated arms alone, using their feet if necessary to carry food. When on the ground, they run on their hind legs, balancing by lifting their long arms in alternation. They

are in some ways anatomically rather more primitive than the large apes.

They live in small troops in the tropical forests of south-eastern Asia. Like the Howler Monkeys of South America, they have extremely powerful voices, and indulge in amazing whooping choruses at dawn and sunset. They are clean and intelligent and are often kept as pets.

There are two genera and five recognized species of gibbon, ranging from Assam through Malaya to Indonesia.

Plate 153 shows the Silvery Gibbon; Plate 154, the Dark-Handed Gibbon (*Hylobates agilis*).

155-6 CHIMPANZEE (*Pan troglodytes*)

The Chimpanzee is the most familiar of the large anthropoid apes. It is an inhabitant of the tropical forests of Africa, and still fairly abundant in some areas. It shows a range of variation—in feature, skin-colour, size, and temperament—approaching that of our own species.

157 ORANG-UTAN (*Pongo pygmaeus*: previously called *Simia satyrus*)

Some time during the Pliocene, our ancestors diverged from the other anthropoids. The future men, by adopting an erect posture and a fully terrestrial life, with hind-limbs specialized solely for locomotion and fore-limbs for manipulation, were able to exploit the resources of the open country. The others, still using their fore-limbs for walking and their hind-limbs for grasping even when semi-terrestrial in habit, remained confined to the tropical forests of the Old World.

Today there are only two areas where large anthropoids are found—equatorial Africa and Indonesia. The Indonesian great ape is the Orang-utan (the Malay word for Man of the Woods). Orang-utans are very much caricatures of men, with their philosophic expression, their fat paunch, and their short bandy legs. They are more arboreal than either chimps or gorillas. Old males of certain races develop bare fleshy folds or flaps round the face.

158-9 GORILLA (*Gorilla gorilla*)

Gorillas are the largest of apes and of all primates, old males of the mountain subspecies weighing up to 35 or 40 stone. The males are much bigger than the females, and have large bony crests on the skull for the attachment of the muscles needed to work the immensely powerful jaws.

Gorillas have a very different temperament

from Chimpanzees, brooding and introverted instead of excitable and inquisitive. They seem to have greater powers of concentration than any other animal. Like the other large apes, they build "nests" or sleeping platforms for themselves, and live in smallish groups which seem to be extended families, comprising one old male, several females, and young ones up to the age of sexual maturity.

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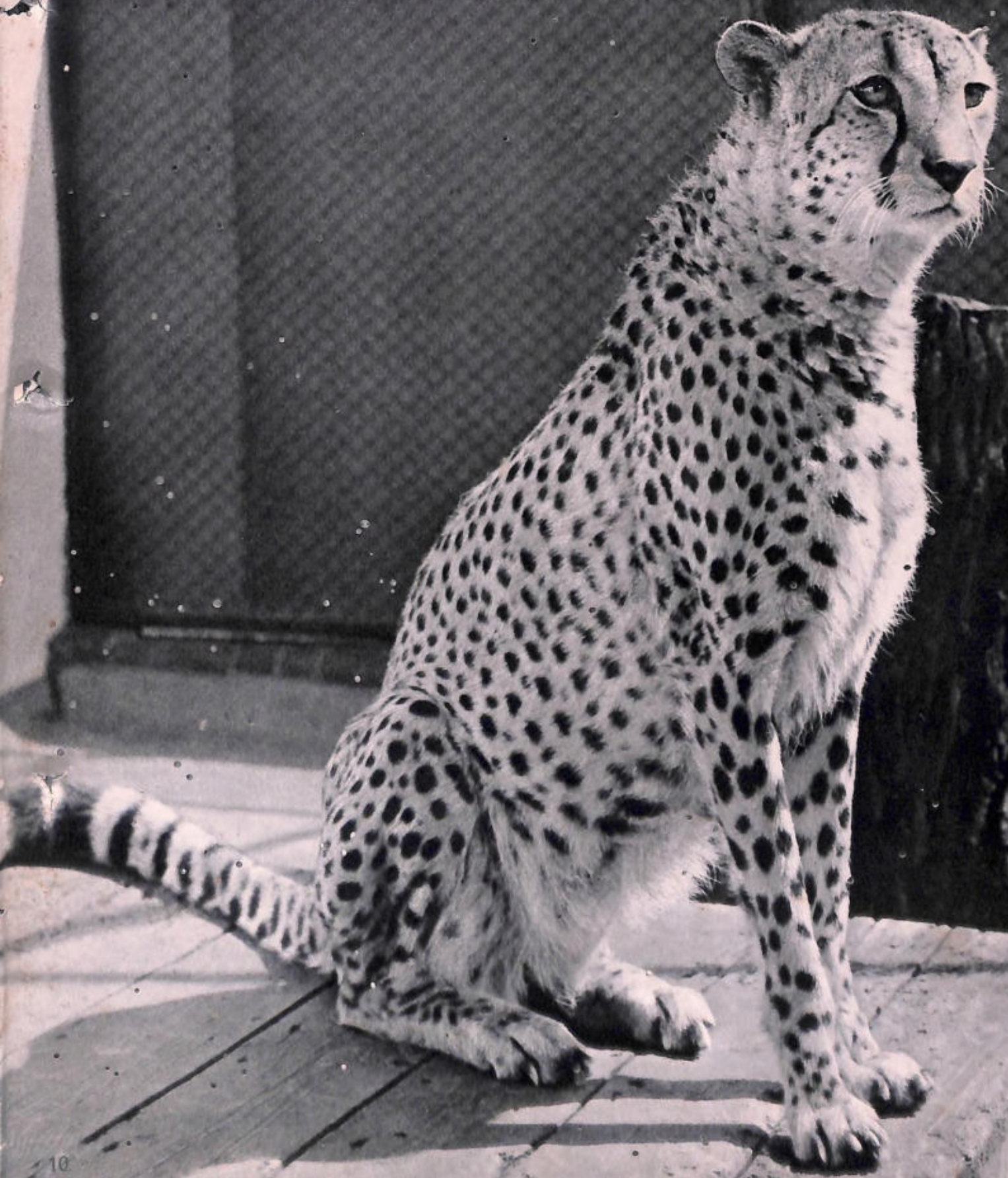
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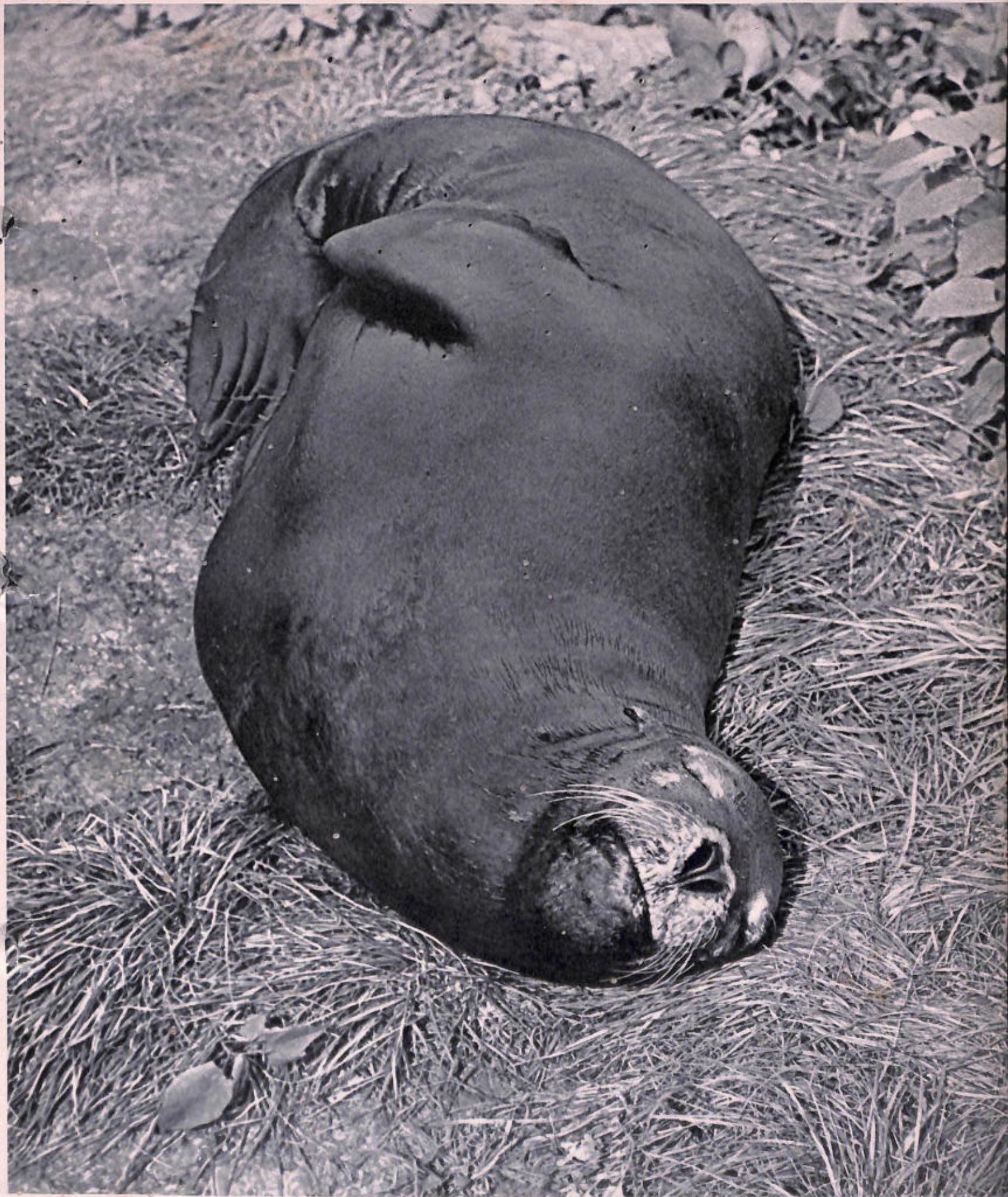
























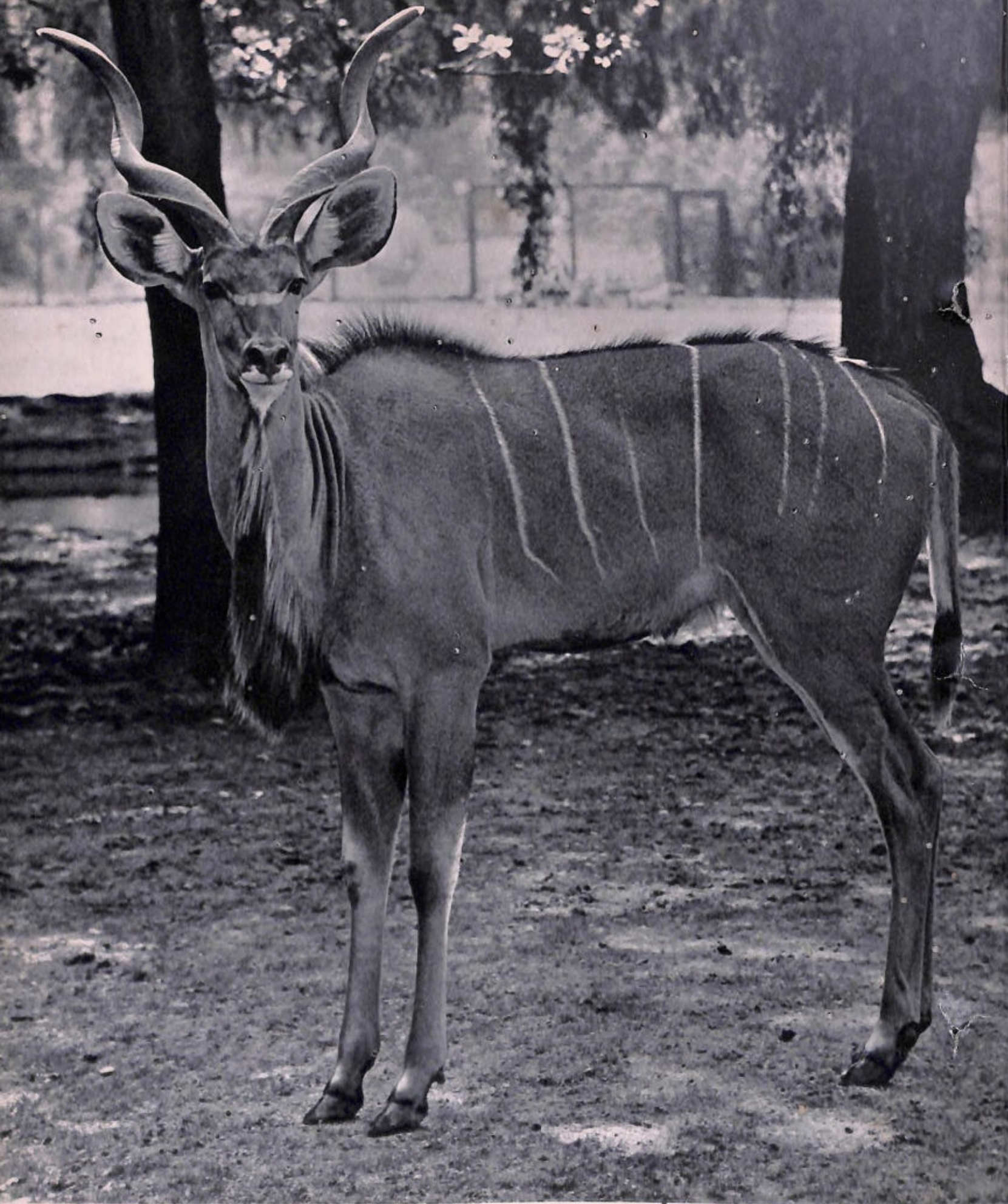


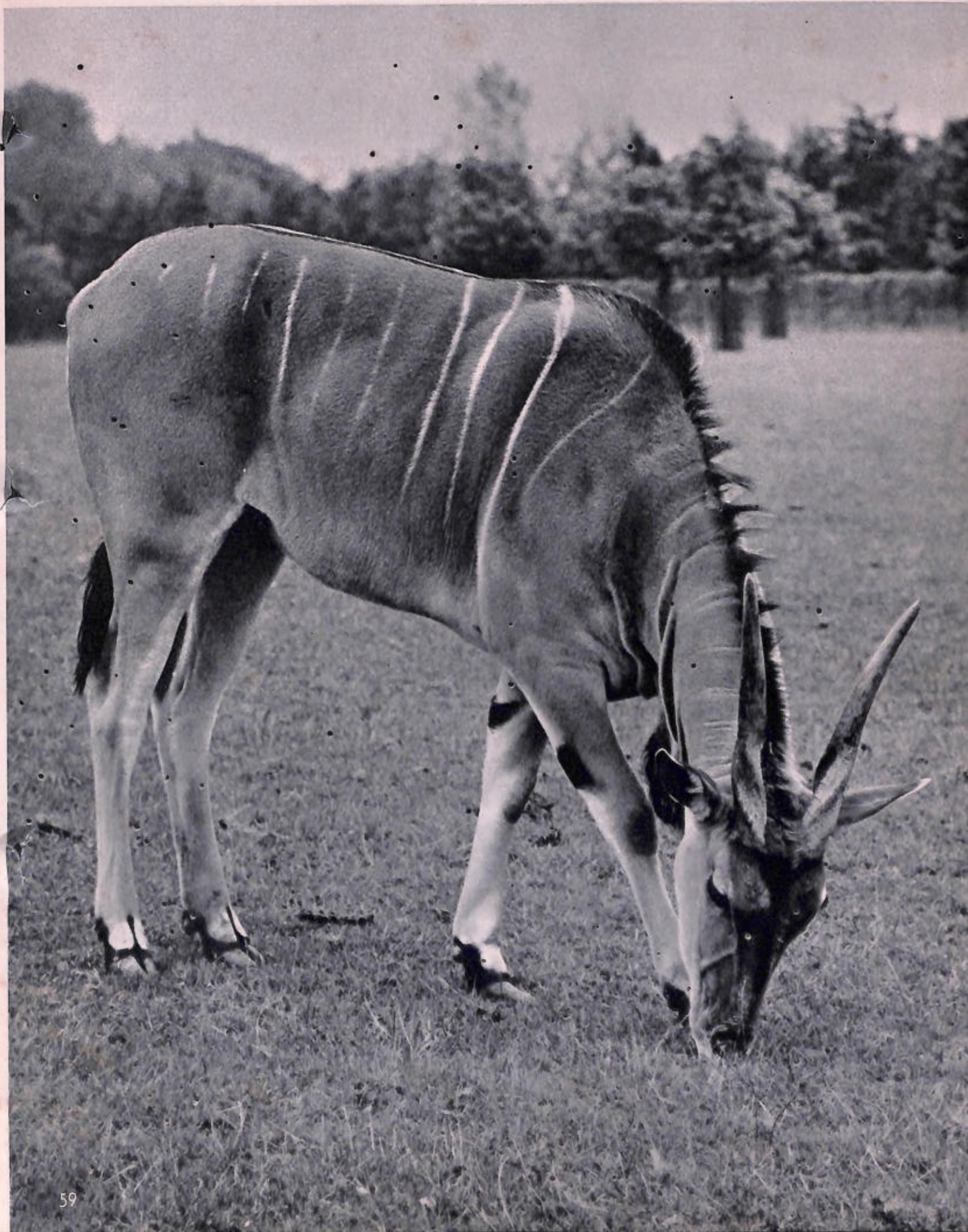


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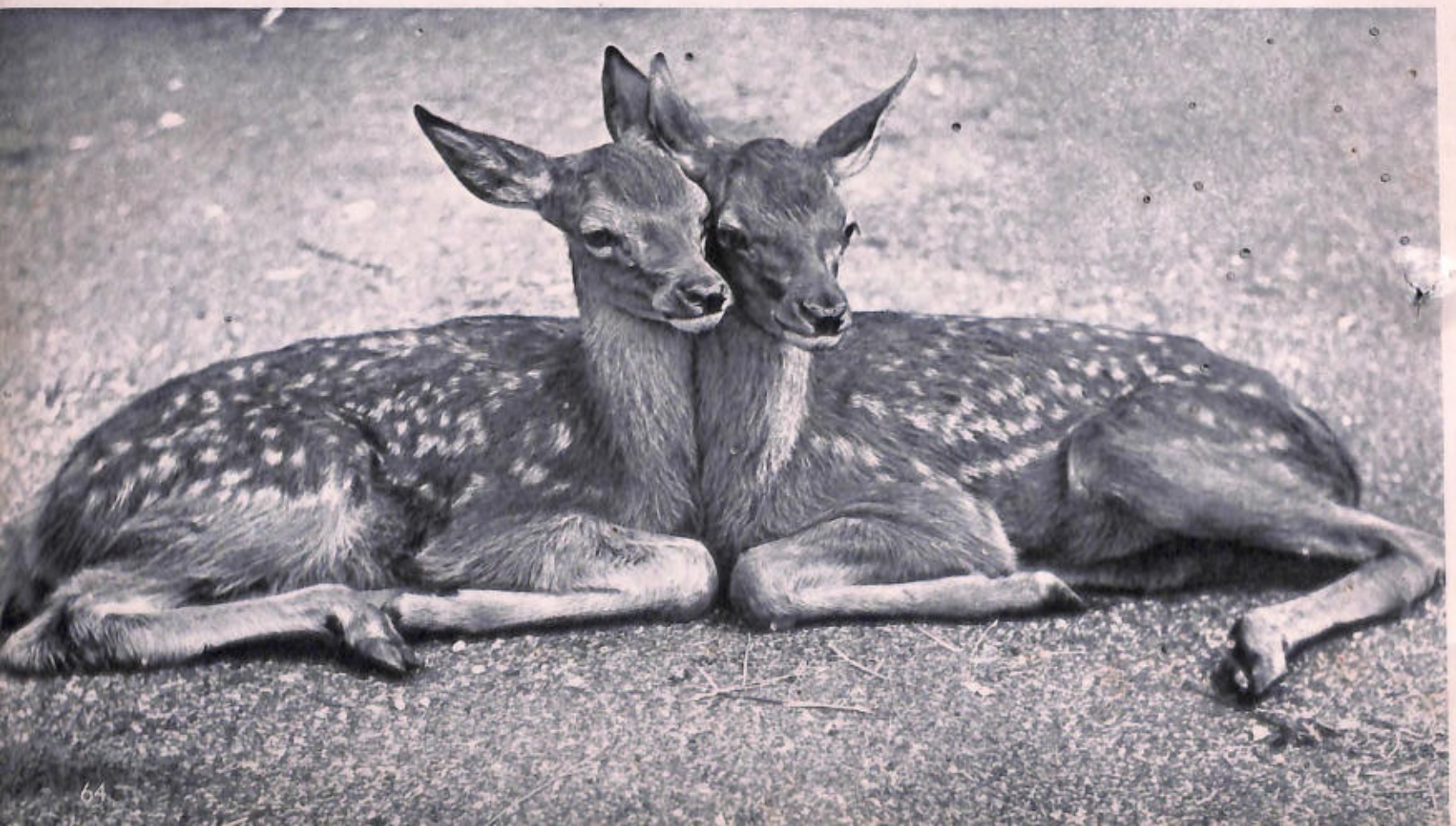
















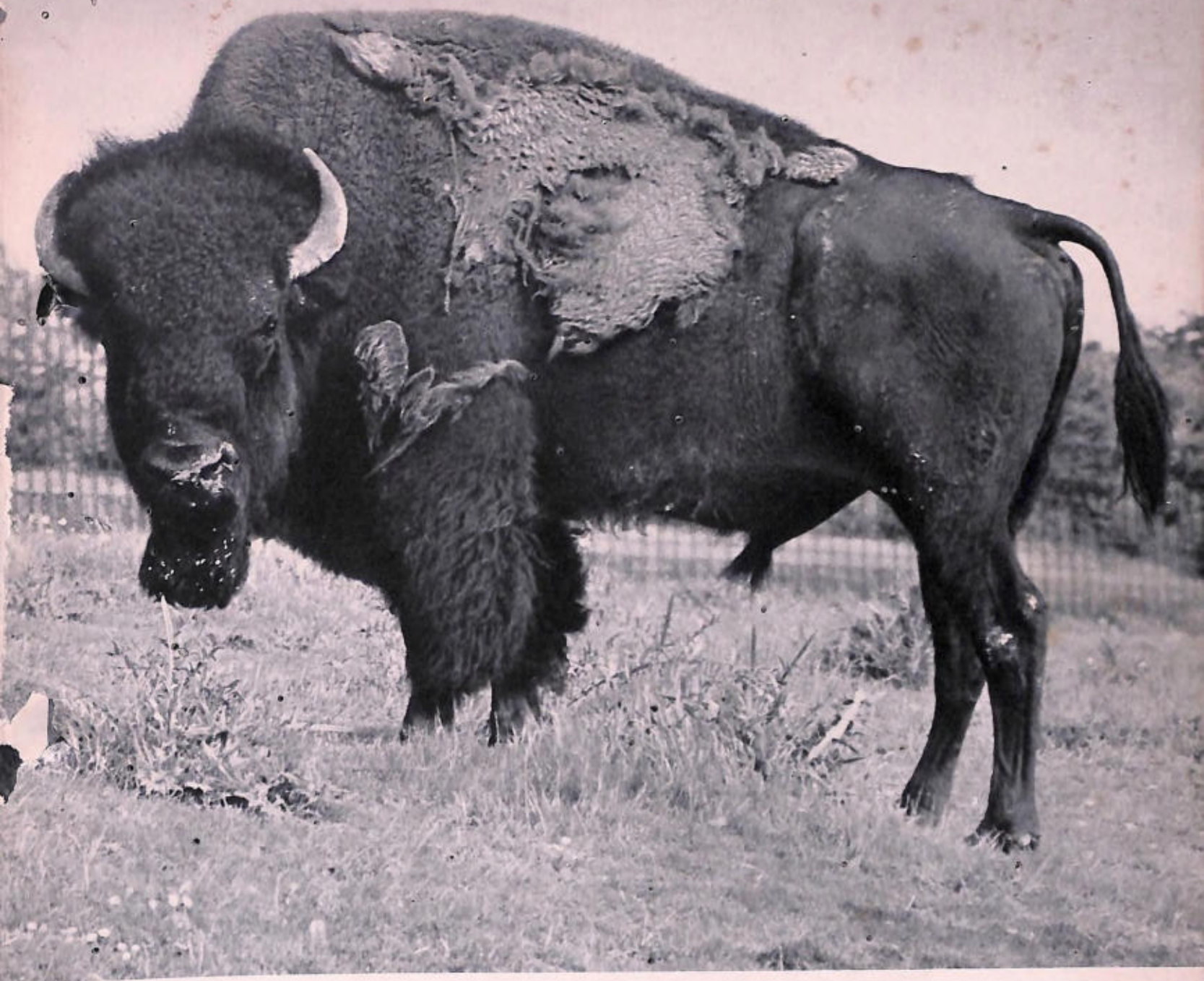






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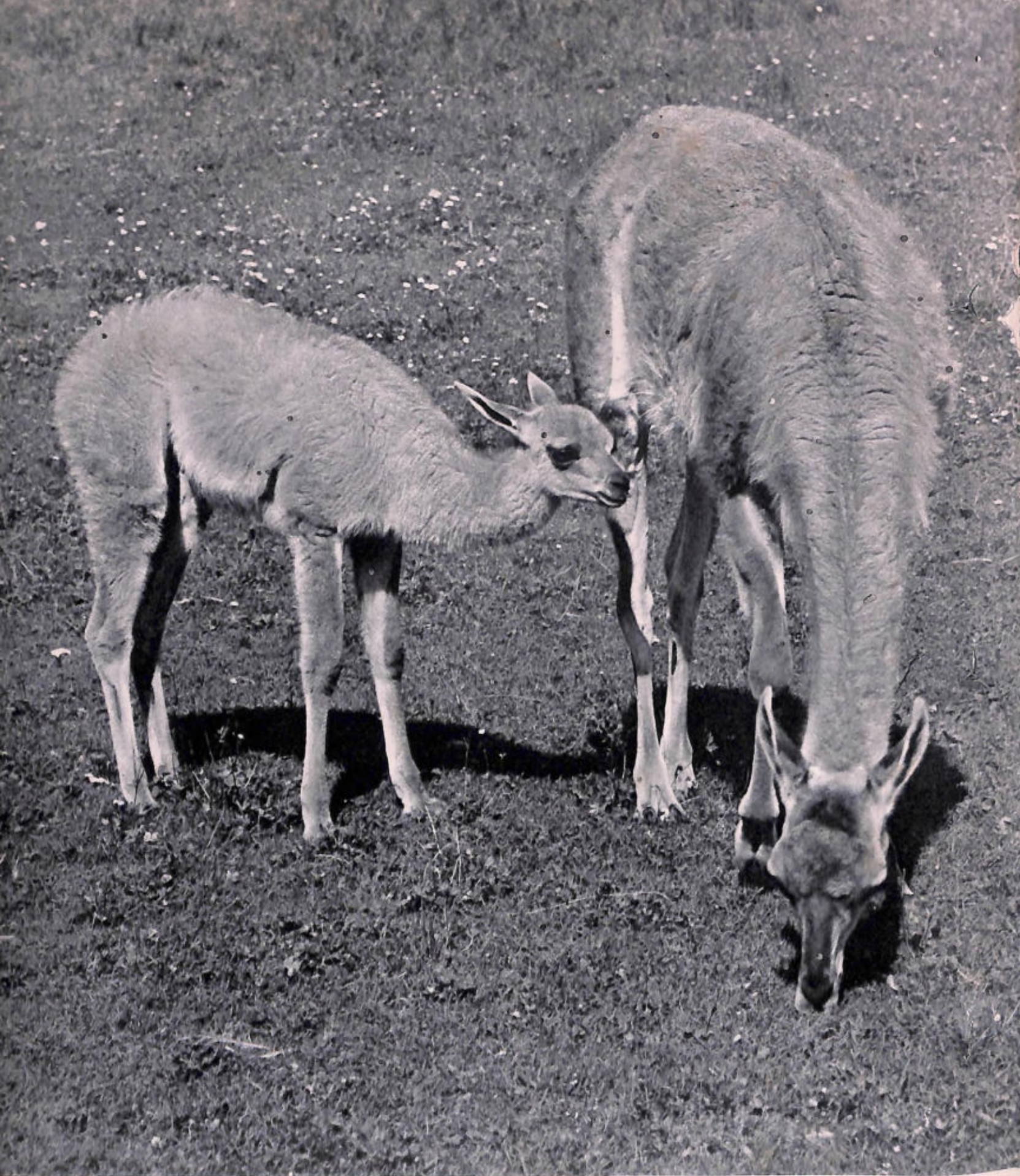
















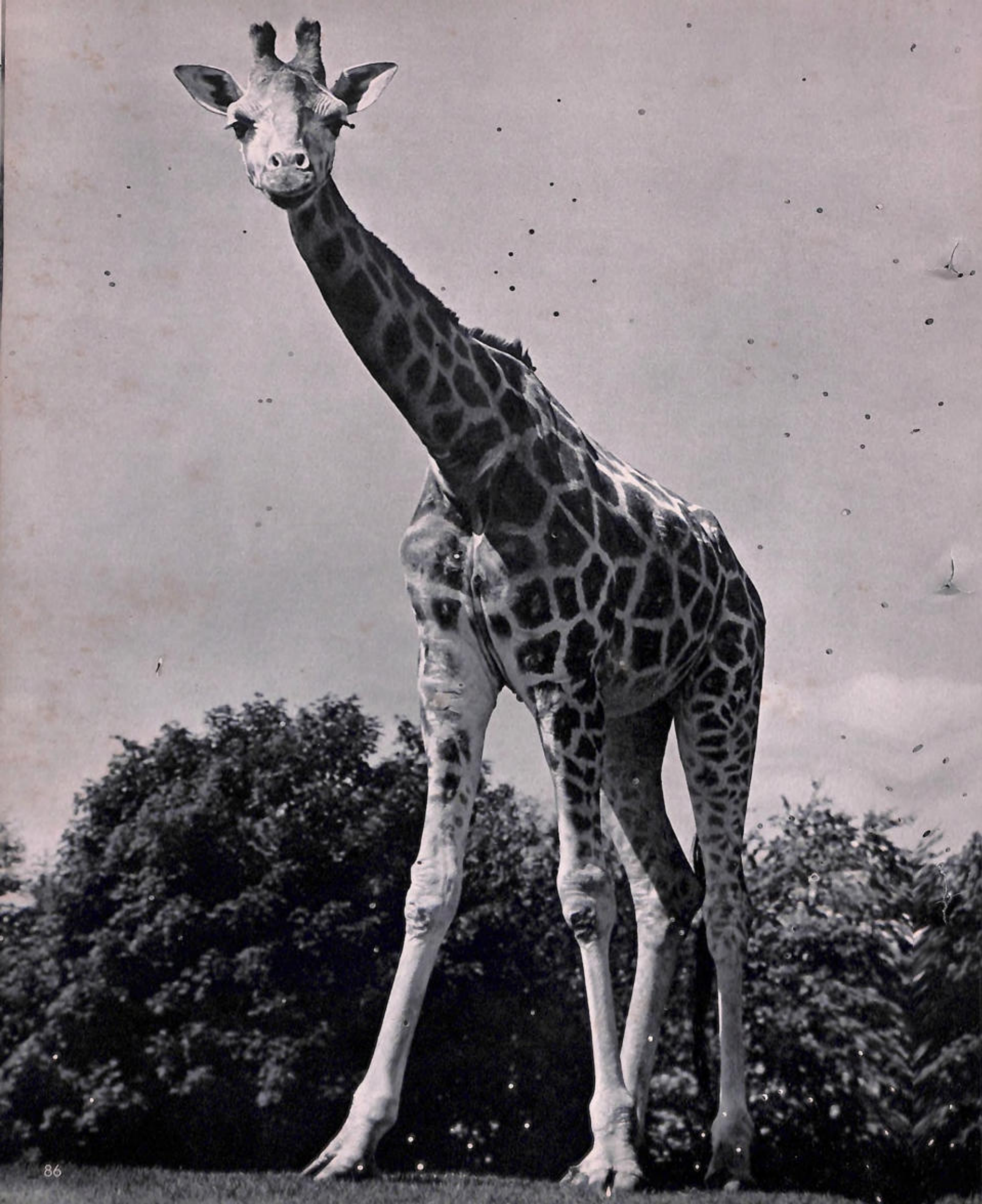


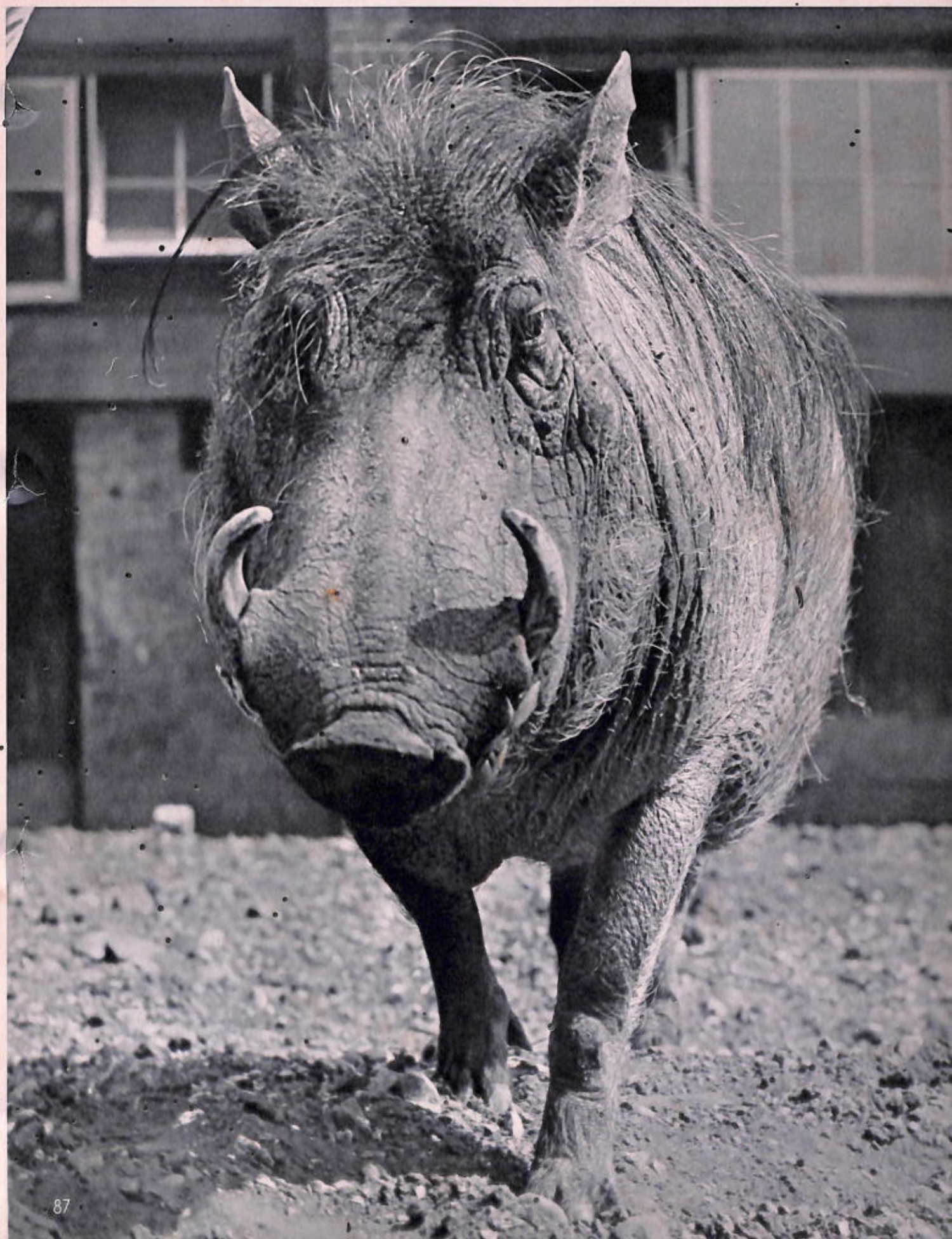




















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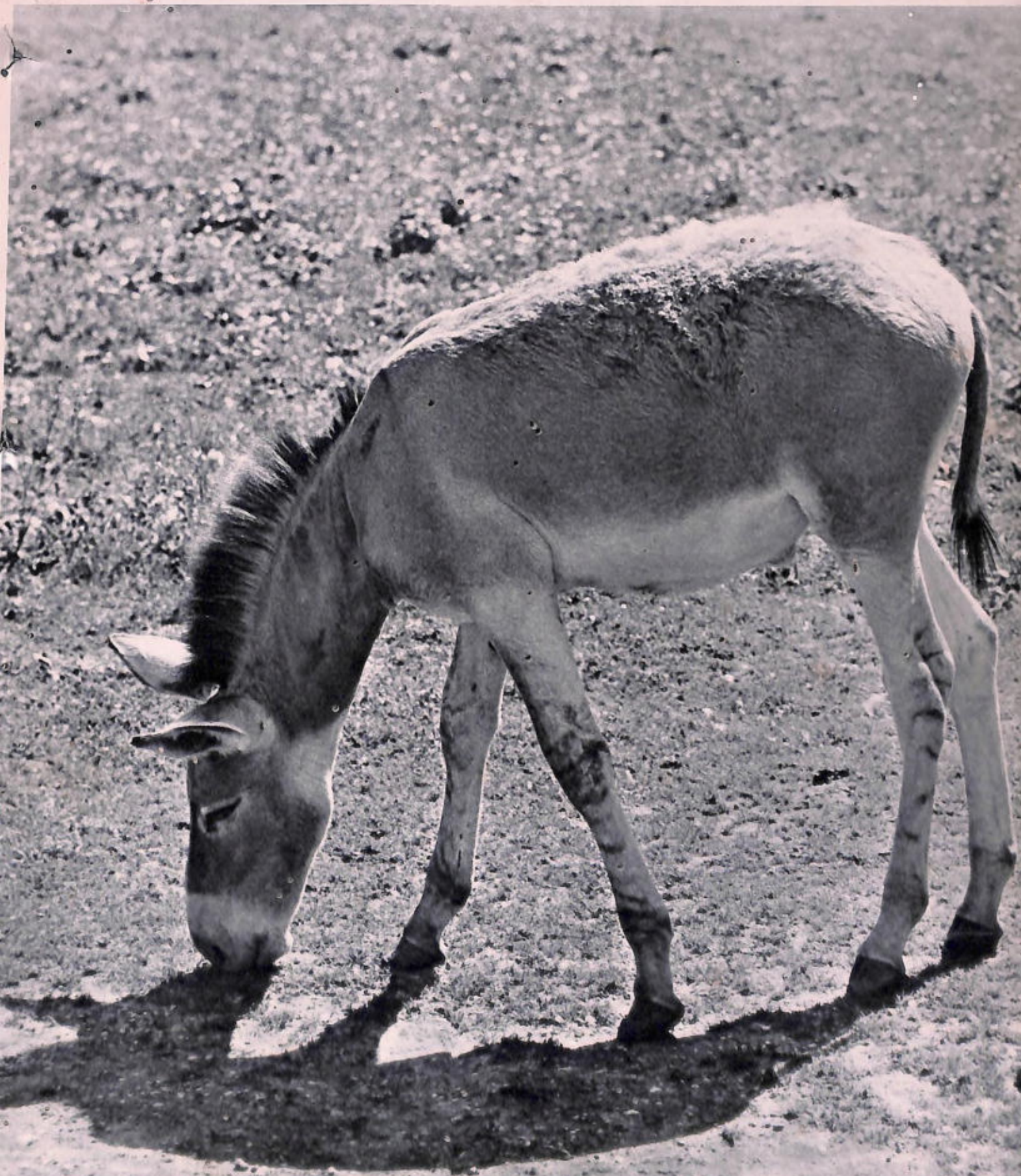


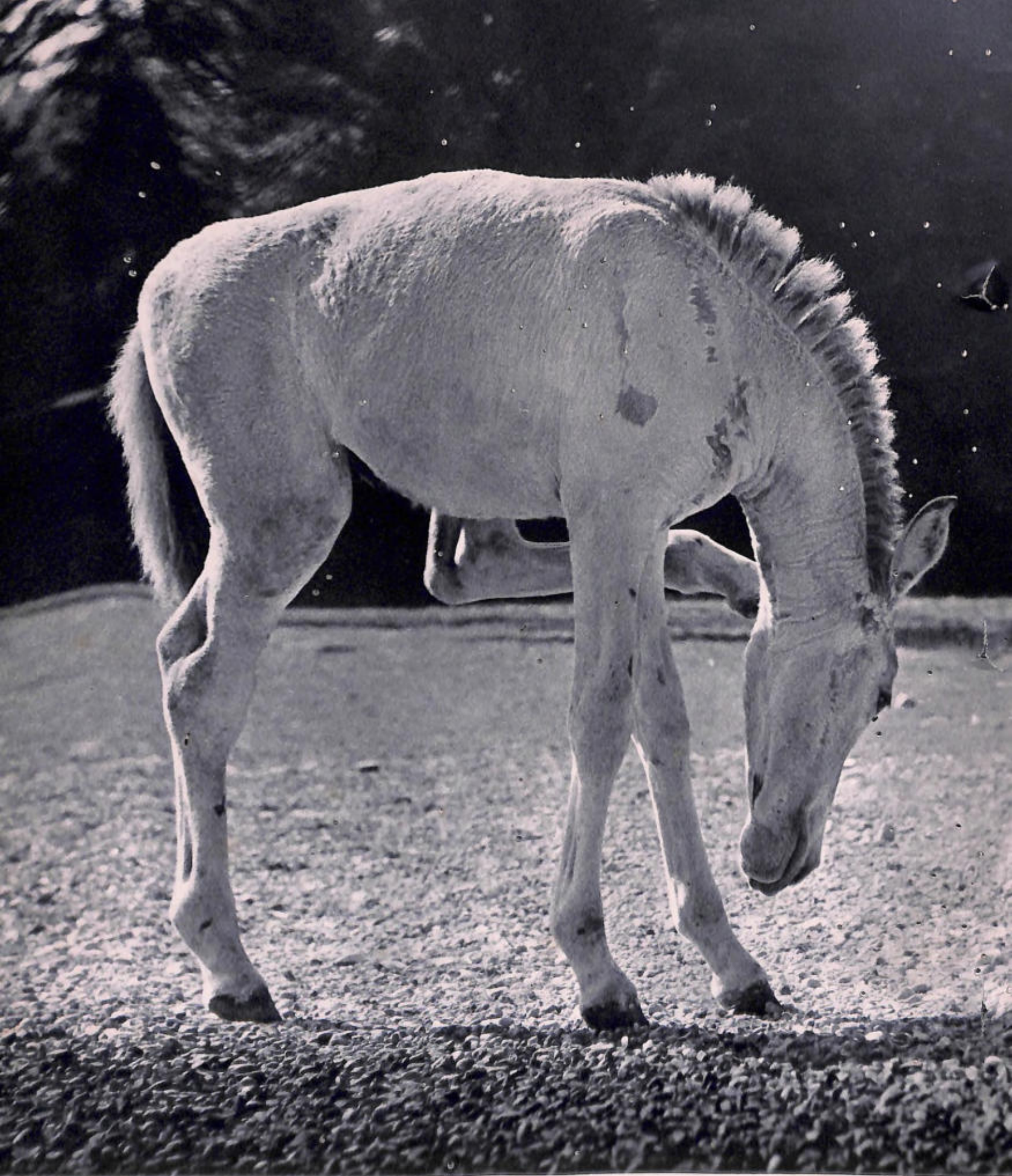
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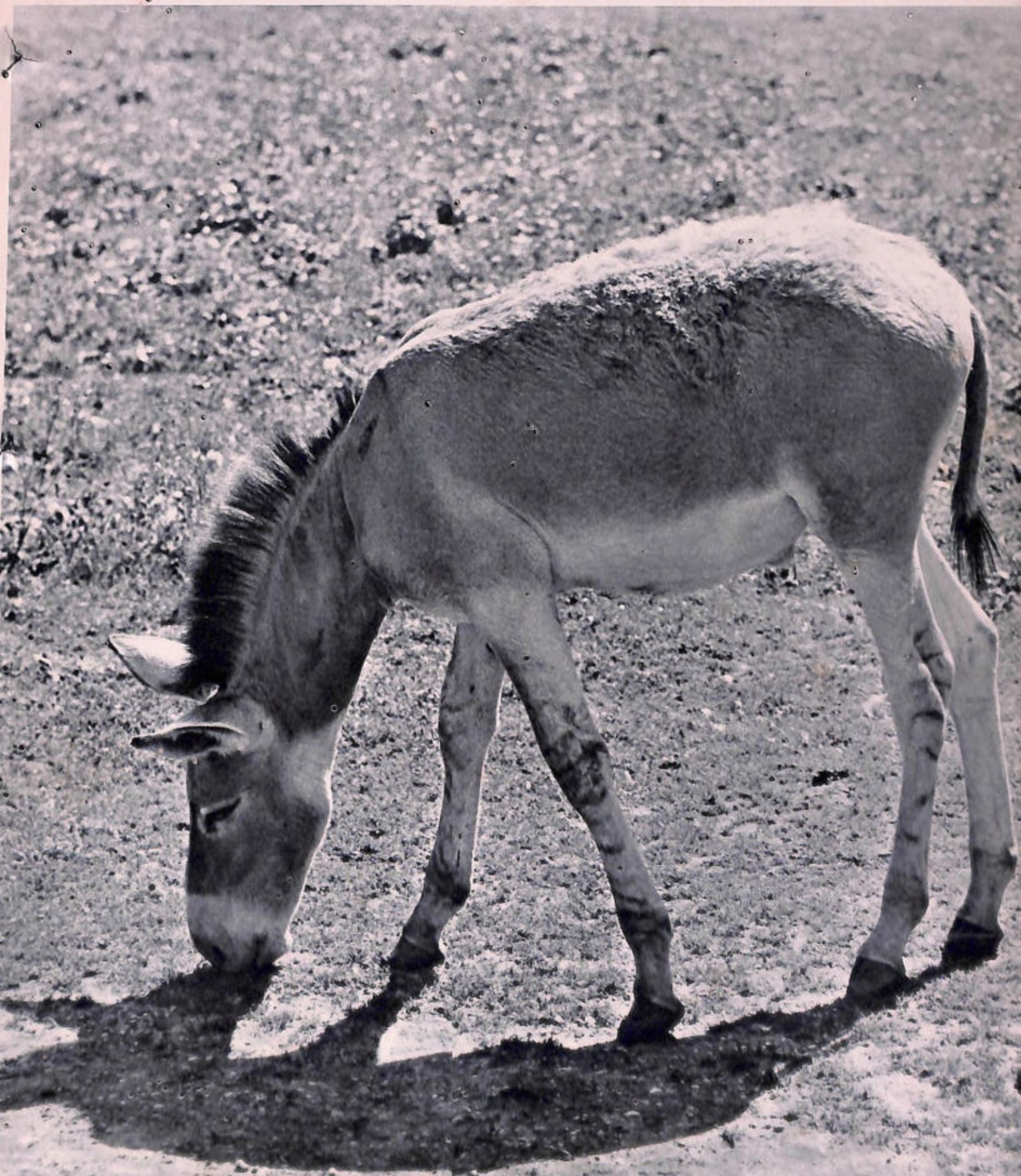


















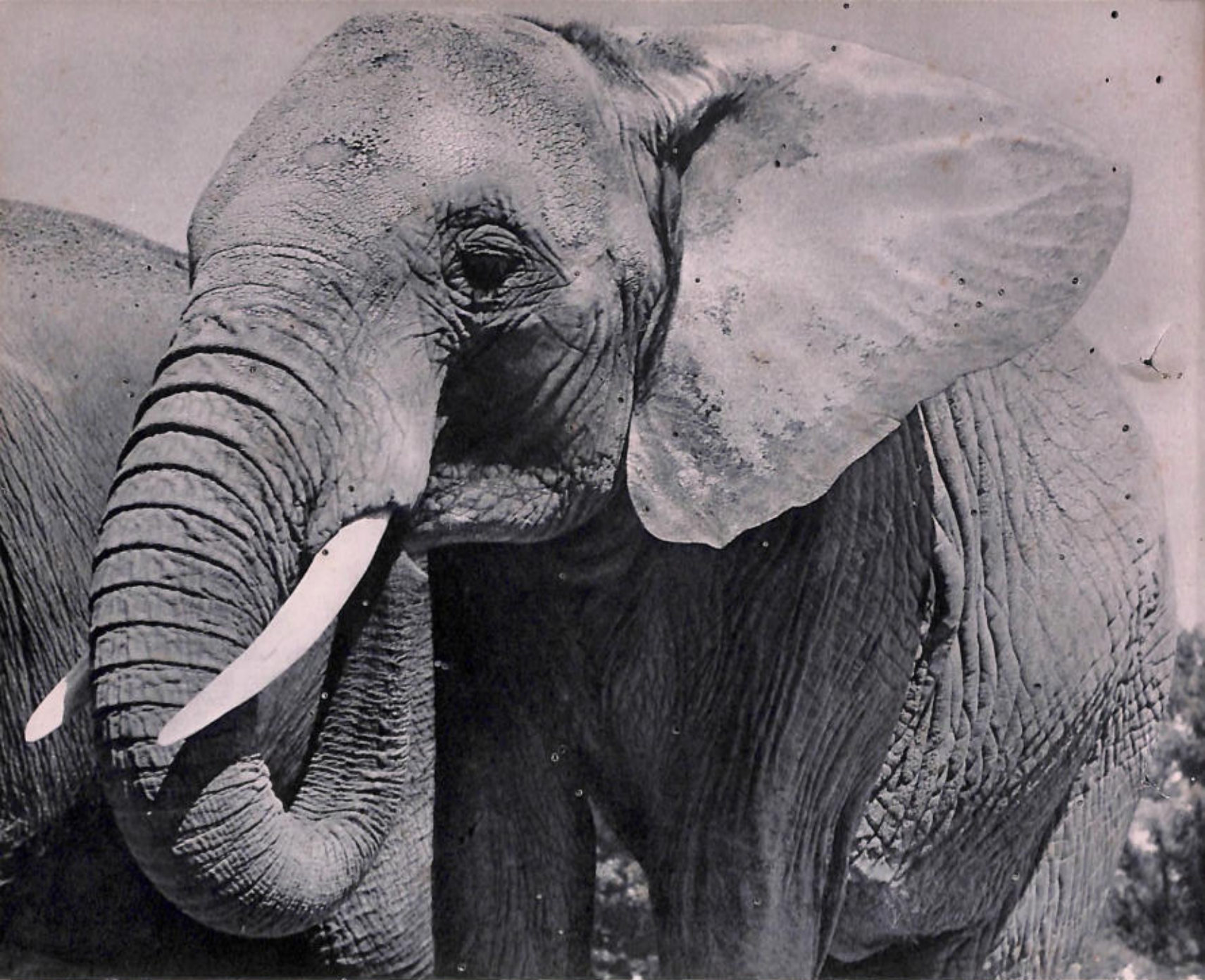






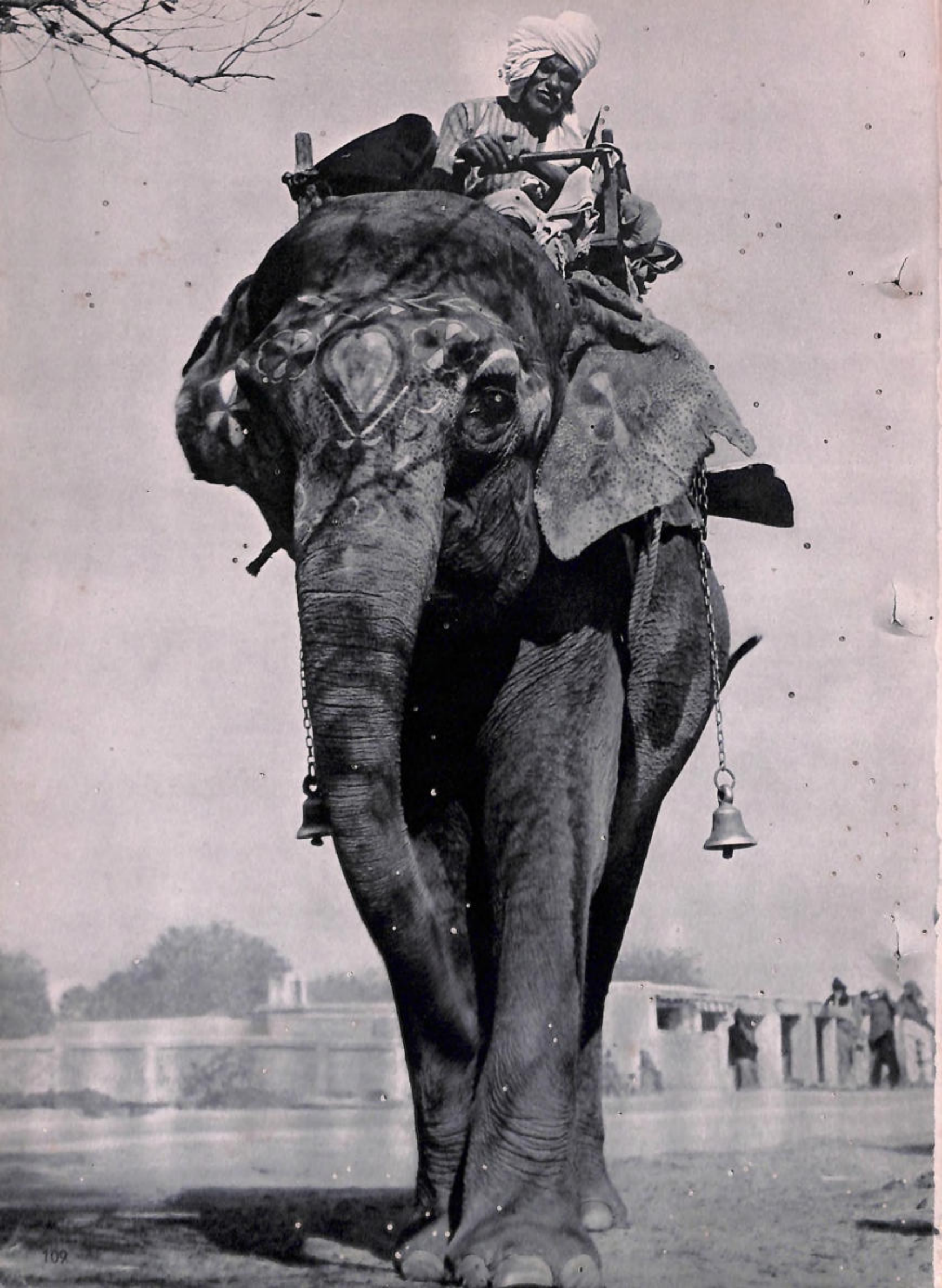












































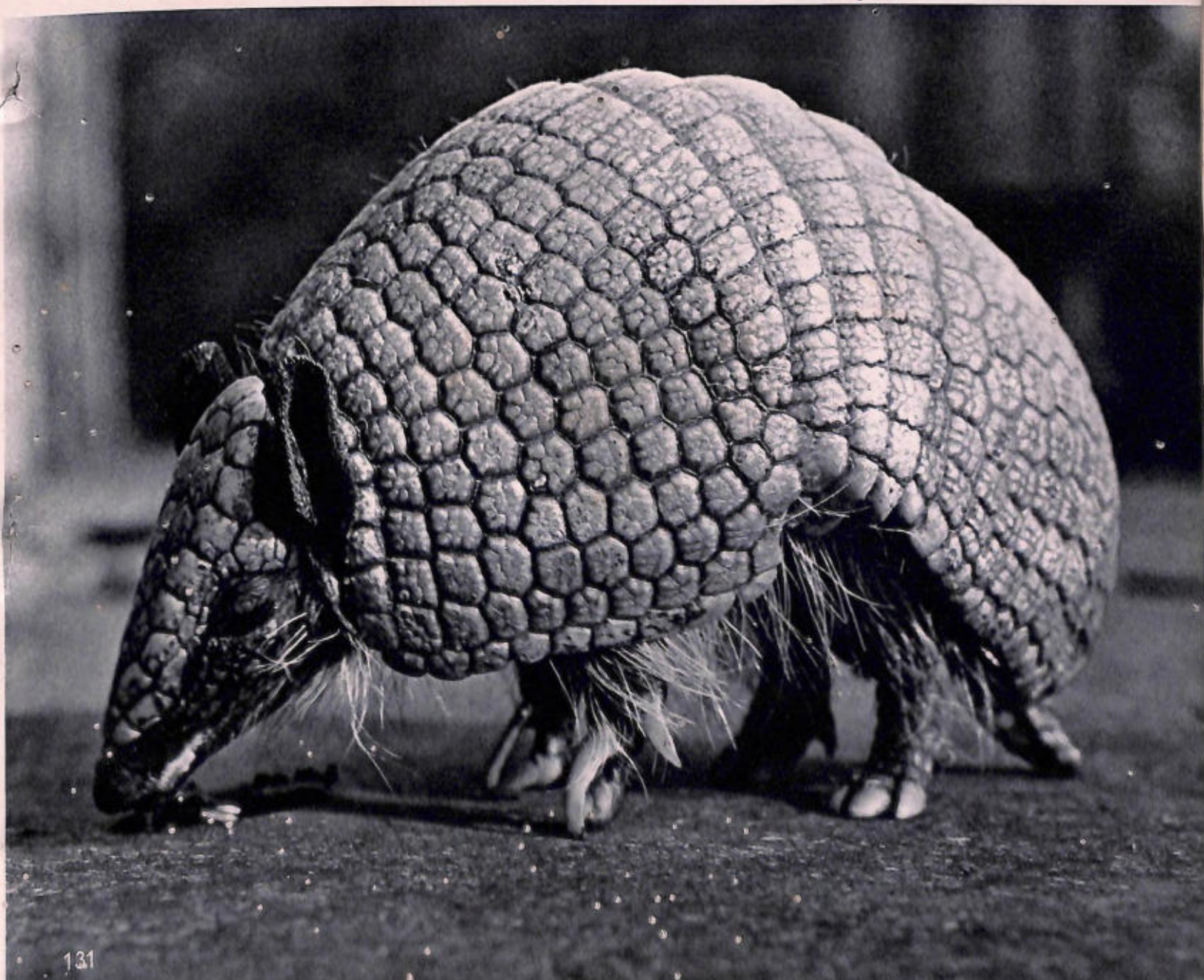


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