CHAPTER 1

Typical Human, Typical Animal?

Reconceptualising the Animal – an Introduction

A REVOLUTION HAS RECENTLY TAKEN PLACE IN BEHAVIOURAL biology. Its consequences are far-reaching, both for our self-image as humans and for our relationship with animals. Just a few decades ago, behavioural science was guided by two key dogmas: animals cannot think, and no scientific statements can be made about their emotions. Today, the same discipline holds both ideas to be false and posits the very opposite: animals of some species are capable of insight – they can recognise themselves in a mirror and exhibit at least a basic sense of self-awareness – and they have rich emotional lives that seem to be startlingly similar to those of humans. Situations that lead to strong emotional responses in humans, whether positive or negative – for example, when we fall in love or lose a partner – seem to have the same effect on our animal relatives.

Indeed, the transformation of the concept of the animal in modern behavioural biology has been so fundamental that it amounts to a paradigm shift. And since it has long since become untenable to distinguish between *Homo sapiens* as driven by reason and animals as driven by instinct, the question arises: what actually differentiates humans from animals? How much of ourselves is present in them?

The general perception of these differences has also changed in parallel to developments in the life sciences. A few decades ago, if biology students had been presented with photos of a goldfish, a chimpanzee, and a human, and asked to sort them into two categories of their own devising, more than 90 per cent would have put the human in the first category and the 'animals' in the second. If biology students today are asked the same question in their first semester, the result is completely different: over 50 per cent group humans and chimpanzees into one category and the goldfish into another. Apparently, humans and animals have grown closer to one another in the public imagination, too.

This has been confirmed by the death of a third dogma: for decades, it was taught that animals behave for the good of their species, generally never killing members of their own – known as 'conspecifics' – and often helping them to the point of self-sacrifice. Today we know that this is not the case. Rather, animals do everything to ensure that copies of their own genes are passed to the next generation with maximum efficiency and, when necessary, they will also kill conspecifics. Clearly, they are not, as Jane Goodall had once famously hoped, 'like us, but better'.

The border between humans and animals is also beginning to blur in other areas. Certain aspects of the social environment can cause stress for both humans and animals, while other similar factors can alleviate it. Both have their thinking, feelings, and behaviour shaped by similar interactions between genetics and environment. Indeed, animal behaviour does not develop in a fixed manner: environmental influences, socialisation, and learning can alter an animal from the prenatal phase through adulthood. Like humans, animals ultimately appear individualised upon closer inspection, which is why behavioural biology now takes animal personalities into account.

This book will demonstrate how and why the scientific understanding of animal behaviour has changed so fundamentally. It will focus on a group of animals to which, biologically speaking, we also belong: mammals, whose approximately 5500 species populate the most diverse range of habitats on our planet. Lions and zebras inhabit the savannah, gorillas and orangutans inhabit the tropical rainforests, fennecs live in deserts, polar bears live in the arctic, moles live underground, bats have taken to the skies, and whales and seals have taken to the water.

Humans have much in common with all these creatures. For one, our genes: we share about 99 per cent of them with our closest relatives, bonobos and chimpanzees. Brain structure is also nearly identical across all mammals: the so-called 'ancient' parts of the brain in particular – like the limbic system – show similarities down to the last detail. A human's fear response at the sight of a snake, for instance, may likely be controlled by the exact same neuronal process as in a chimpanzee or a squirrel monkey. Our physiological regulatory systems, too, are strikingly similar. The same hormones enable all mammals to cope with stressful situations, adapt to changing environments, or reproduce. In fact, the production of the sex hormones testosterone and oestradiol, the stress hormones adrenaline and cortisol, or the 'love' hormone oxytocin is not unique to humans; rather, these hormones occur in the same form in a wide variety of species, from bats to rhinoceroses to dolphins.

However, such similarities across genes, brain structure, and the endocrine system do not automatically imply similarities concerning thoughts, feelings, and behaviour. To better understand these traits, we need to look at specific studies in both animals and humans. In the case of animals, such studies take place within the field of behavioural biology, which was aptly defined by one of the fathers of the discipline, the Nobel Prize winner Nikolaas Tinbergen, as 'the study of behaviour by biological methods'.

THE STUDY OF BEHAVIOUR BY BIOLOGICAL METHODS

This definition can very simply be illustrated by the relationship between a general knowledge of animals and a knowledge of behavioural biology: a knowledge of animals is certainly required to study behavioural biology, but it is not in itself sufficient to draw scientific conclusions about animal behaviour. Thus, the terms are by no means synonymous. Not everyone who interacts with animals and makes statements about their behaviour is a behavioural biologist, although people who have close contact with animals may have an excellent knowledge of their behaviour. My grandmother, for example, was always right about our dog – if she warned he was about to bite, one did well to take it seriously. But this was not knowledge in a scientific sense: it was intuition acquired through experience, and, if I had asked her how she knew these things, she would have answered, 'I can just tell.' Experiential or intuitive knowledge can, of course, be just as true as scientific knowledge. But it does not have to be, so it is very hard to decide when it is valid and when it is not. Take, for example, the characteristics of certain animals that have made their way into the vernacular: we speak of the thieving magpie or the silly goose; we compare a clumsy person to a bull in a china shop, or a person stuck in their habits to an old dog who cannot learn new tricks. Whether these attributes are accurate to these animals or not can ultimately only be clarified through behavioural studies, which have indeed frequently shown them to be prejudices.

How, then, is knowledge characterised in behavioural biology? As with any type of scientific knowledge, it must be possible to convey the methods and procedures by which it was acquired. This was not the case with my grandmother's knowledge of our dog – it is not enough for someone to sit in front of a group of animals, be affected by their behaviour, and describe his or her subjective impressions of it. In a legitimate behavioural study, the researcher must first list and define the specific behaviours of the animal species under study in what is known as an ethogram. Then, data is collected on these behaviours using an appropriate method: if the researcher were studying animal social life, for instance, he or she would record how often and for how long each animal exhibited socio-positive behaviour (that is, friendly behaviour towards other members of the group), how often each animal initiated or was the target of aggressive behaviour, how often each animal positioned itself next to certain others in the group, and which males paired with which females. These observations used to be collected by hand, but behavioural data is now recorded and analysed with sophisticated software, as is the statistical evaluation of the results.

Let's stay with the topic of mammalian social life for a little while longer. The history of research in this area also shows how crucial it is to use the right method of data collection. A few decades ago, when the first of such studies were being conducted in animals' natural habitats, scientists often used the *ad libitum* method: they observed all the animals in a group simultaneously and recorded all behaviours that they noticed. However, this method introduced a huge problem that has long been known to perceptual psychology: humans tend to focus their attention on what is loud and distinctive, neglecting events that occur quietly and unobtrusively. In many mammalian societies, male behaviour – especially in interactions with conspecifics – is more expressive and louder than female behaviour, as confrontations with other males are often marked by conspicuous vocalisation. If researchers apply the *ad libitum* method to these interactions, they will inevitably collect significantly more data on males than females. This perceptual bias may have contributed to the fact that males have long been described as dominant and tone-setting in many mammalian societies, while females have been characterised as passive and inferior.

After this procedural error was recognised, researchers began to replace the *ad libitum* method with what is known as focal-animal sampling, in which each animal in the group is observed for the same amount of time regardless of what it is doing, thus ensuring that all are given the same amount of attention. The data collected using this method has contributed significantly to the revision of our concept of the female role in mammalian societies: we know today that females are by no means passive, but rather tend to interact in subtler yet no-less-influential ways. Recent behavioural biology textbooks reflect this insight, teaching that it is often the females in primate societies who make the most important decisions for the group.

While animal societies like those of primates are organised into fixed groups of several adult males and females, there is a great diversity in the social life of mammals: many species, like tigers, live solitary lives, while others, like certain zebras, organise themselves into harems, and elephants, who constitute the strongest matriarchy in the animal kingdom, present close, sometimes lifelong, bonds between the females of a group. Such long-term bonds between males are found in a few species, such as the cheetah. In the saddle-back tamarin, a small South American species of monkey, harems of one female and two males regularly occur. Interestingly, the favoured lifestyle of humans – monogamy – rarely occurs in non-human mammals: no more than 3–5 per cent of species organise themselves into pairs. (One that does is the North American prairie vole.) None of our closest biological relatives – bonobos, chimpanzees, gorillas, or orangutans – live monogamous lives.

Given this great variety of species, habitats, and lifestyles, studies in behavioural biology must not only be conducted using a sound methodology but the results must also be reproducible. If a research group in

Berlin shows that bees can orient themselves to the position of the sun, for example, then this result must also be obtainable by researchers in London or Tokyo.

The importance of reproducibility is wonderfully illustrated by a certain well-known historical case study. Shortly before the First World War, a man named Wilhelm von Osten caused quite a stir with his horse, Clever Hans. Hans could seemingly do basic arithmetic – addition, subtraction, and division – and indicate the correct answers to problems by stomping on the ground or nodding his head. The public was amazed, but scientists quickly began to doubt that a horse was capable of such a mental feat. Wilhelm von Osten agreed to an investigation, and indeed, the first study showed that Clever Hans was able to solve basic equations even if they were given to him by strangers. However, as the study continued, it was revealed that Clever Hans could no longer solve a problem if no one present knew the solution. The horse, it turned out, was able to pick up on the smallest nuances in the body tension of the person who gave him the mathematical problem to deduce when he should stop stomping or nodding. Clever Hans had extraordinary sensory perception – but he could not do arithmetic.

Nevertheless, he has had a lasting impact on research. Today it is generally accepted that displays of animal cognition can only be scientifically verified through so-called blind studies, during which the experimenter does not know the solution to the task given to the animal. Unconscious assistance, which must be eliminated in any legitimate study, is known as the 'Clever Hans effect'. Wilhelm von Osten was certainly no charlatan – he was firmly convinced of his horse's cognitive abilities. Even today, many pet owners attribute outstanding cognitive abilities to their dogs or cats, claiming things like: 'My dog understands every word I say.' Whether this is really the case, however, cannot be judged from everyday experience alone. Clever Hans has certainly taught us that.

The basic behavioural biological method is therefore known as the process of objectively and reproducibly recording animal behaviour. Depending on the study, however, techniques from neighbouring disciplines may also be used. Researchers rely on state-of-the-art satellite technology to determine the position of birds during migration, for example; they divine the stress state of animals by measuring their hormone levels; they determine paternity or kinship with the help of molecular genetics. Such techniques allow scientists to gain insights that would not be possible through behavioural observation alone, which can often be misleading. For example, songbirds have long been considered in the public imagination as the epitome of fidelity. But paternity verification through genetic fingerprinting has revealed a very different picture: a large part of the offspring found in these birds' nests often do not come from the males who occupy them and feed the young there. Evidently, songbirds are not as monogamous as humans might like to believe.

A SHORT HISTORY OF BEHAVIOURAL BIOLOGY

Since their earliest days of existence, humans have taken an interest in the animals that surround them: in how to escape them, hunt them, or even just enjoy their presence. The cave paintings at Altamira and Lascaux, which are among the oldest works of art in human history, are a Stone Age testimony to the human–animal relationships of this early period. Through breeding, we have been domesticating what were once wild animals for thousands of years: sheep, pigs, cattle, and goats have lived among us for about 10 000 years, while dogs may have been man's faithful companions for as long as 30 000 years.

Greek philosophers began to contemplate the nature of humans vis-à-vis animals about 2500 years ago. Aristotle famously saw the animal's lack of reason as a fundamental difference between the two, and this distinction is still anchored in much of society's consciousness today: many still believe that humans alone possess reason while animals can only follow their instincts.

The first examples of empirical scientific and experienced-based observation of animal behaviour can be found in the Middle Ages. In the thirteenth century, Emperor Frederick II, known to his contemporaries as *stupor mundi*, 'the wonder of the world', wrote *De Arte Venandi cum Avibus/The Art of Hunting with Birds*, which can be considered the first scientific book of western ornithology – or, some may argue, of behavioural biology. As early as the sixteenth century, naturalists such as Konrad Gesner, Carl von Linné, and Jean-Baptiste de Lamarck were describing and systematising animals and plants, including many species from the parts of the world only recently visited by Europeans. These writings include numerous descriptions and contemplations of animal behaviour, but general consensus does not consider behavioural biology to have truly emerged as a discipline until the middle of the nineteenth century.

The father of behavioural biology (and many other related disciplines) is the British naturalist Charles Darwin. In *On the Origin of Species*, first published in 1859, Darwin lays out the basic features of his theory of evolution, which we still hold to be true today. He understood evolution to be two things: first, the process by which species change over time, based on the premise that they do not exist in a static state but rather are altering their appearance and behaviour constantly. The second feature is the descent from common ancestors. Eight to ten million years ago, for example, there were no humans or chimpanzees on our planet. There did exist, however, a certain species of ape, now extinct, from which both humans and the chimpanzee derive. Through his studies, Darwin not only proved that evolution exists, but also recognised the major driving force behind evolutionary change: natural selection.

What does this key concept mean? Darwin recognised that all organisms have a nearly unlimited ability to reproduce – many more offspring can be created in a single generation than there are parents. But this enormous potential is not realised; rather, the size of a population remains more or less constant, meaning that the majority of offspring perish. Only a few survive to sexual maturity, and even fewer subsequently reproduce. Therefore, Darwin posits, there must be steep competition for survival and scarce resources such as food, habitats, and mates: what he termed the struggle for existence. Which animals survive is by no means left to chance. Individuals who are better adapted to their environment through hereditary advantages – for example, they find food or mates more easily or are more likely to escape predators – are more likely to survive and successfully reproduce than their less-capable conspecifics. The genetic makeup that allowed certain individuals to survive is then successfully passed on to the offspring, while the genetic makeup that caused others to perish is lost. Through this process of natural selection, animal species become constantly better adapted to their environment.

One chapter of *On the Origin of Species* is devoted exclusively to animal behaviour. In it, Darwin states that instincts and the behaviours they control, just like all other characteristics of an organism, are modified through natural selection and therefore continually adapted to the environment. He thus anticipates a central theme of behavioural ecology, an important discipline of contemporary behavioural research: the adaptation of behaviour to ecological conditions. He further describes the similarities that appear between the instincts of closely related species that are present even when they live in separate parts of the world. Both South American and European species of thrushes, for example, line their nests with mud. That closely related species share more common behaviours in their ethogram than distantly related ones would become a central dogma of comparative behavioural research decades later.

In 1872, Darwin published another book: *The Expression of the Emotions in Man and Animals*. In it, he argues that certain facial expressions – especially those that reflect basal emotions such as joy, sadness, or anger – exist independently of culture and are thus innate. Furthermore, he says, some animal species may possess emotions comparable to those of humans, which they express using similar faces. The book became a bestseller shortly after it was published, although it did not catch on in the scientific community and, for a long time after, was virtually forgotten. Then, in the 1960s, the biologist Irenäus Eibl-Eibesfeldt revisited Darwin's theses and founded human ethology, a subdiscipline of behavioural biology that attempts to comprehend emotions as innate features of human behaviour. Indeed, Eibl-Eibesfeldt was able to identify universal similarities in human facial expressions when he compared feelings such as joy, sadness, or disgust among different ethnic groups across Africa, South America, and Asia.

At the time, animal emotions had not been a topic in behavioural biology for well over a century – the idea that humans and animals shared certain emotions had long been considered politically incorrect. But in the last decade or so this has changed dramatically. Today, emotions are a central field of research in behavioural biology, and perhaps in this context we will see a Renaissance of Darwin's long-forgotten work.

For about half a century after Darwin, the majority of biologists were not specifically interested in animal behaviour: research tended to focus on systematics, physiology, and developmental biology. Only then did the field we now call behavioural biology begin to emerge through the writings of the researchers Konrad Lorenz, Nikolaas Tinbergen, and Karl von Frisch.

Karl von Frisch studied sense perception: how animals calibrate themselves to their environment and communicate with one another. He was the first to prove that fish can hear and bees can see colour, and that they orientate themselves with the help of a solar compass. von Frisch became known primarily through his investigations into animal communication, in which he discovered the so-called ‘waggle dance’ used by individual bees to tell hive-mates the direction and distance of a food source. von Frisch was also the first scientist to study animal behaviour through a logical sequence of related experiments.

While von Frisch is a key figure in behavioural biology (or ethology or animal psychology, as it was also called in its early days), the emergence of the discipline was even more influenced by the researchers Konrad Lorenz and Nikolaas Tinbergen. Through their work, it was first accepted that behaviour can be studied in the same way that anatomy, morphology, or physiology can, and observation of animal behaviour was established as a serious scientific method. In a series of classic studies, Lorenz described the behaviour of various duck species down to the smallest possible units, which were termed ‘fixed action patterns’. These relatively stereotyped behaviour patterns are exhibited by all members of the same species, at least those of the same age and sex: one could say that the courtship behaviour of a mallard in Berlin is the same as that of one in Beijing. Lorenz’s comparison of fixed action patterns across different species such as mallards, Meller’s ducks, pintails, shovelers, teals, wigeons, or mandarin ducks in turn showed that the more closely certain species were related, the more fixed action patterns they shared. Thus, comparative ethology was born.

Through observing ducks and geese, Lorenz also recognised that these animals have no innate knowledge of their species’ appearance – rather, they only learn to recognise each other through what is known as imprinting. In a specific window of time shortly after hatching, chicks will become fixated on whatever moves and makes noise in their vicinity. In their natural habitat this is usually the mother, whom the chicks then