# *Contents*

# *Foreword*

Charles Darwin said he had wanted to keep his musings about "man" for himself. Publication of the revolutionary thoughts that he had written in his notebooks about the human animal would only reinforce the prejudices against his theory, he feared.

We should be immensely grateful that he overcame his reluctance, and gave us *The Descent of Man,* a book that continues to provoke new insights for many branches of science. *The Origin of Species* barely mentions our species at all, alluding to us only in the vaguest terms: "light will be thrown on the origin of man and his history."

*Descent* made up for this omission, in 1871, over a decade after *Origin*. The book starts out demonstrating the anatomical continuity between us and other animals. Nowadays, few readers will find this shocking, but then Darwin continues applying the same logic to mental continuity. In doing so, he took the opposite view from Alfred Wallace—his contemporary and codiscoverer of evolution by natural selection. In an 1864 essay, Wallace had argued that humans are physically a species of ape, but that our intelligence could not possibly have been produced by the same mechanism of natural selection that had produced our bodies. The

noble human mind hints at intervention, Wallace suggested, by some higher being.

Echoes of his position can still be found today in the social sciences and humanities, where it is quite common to hear academics adhere to evolutionary logic while at the same time stressing a radical break between humans and other animals in the cognitive domain. Even the up-and-coming field of evolutionary psychology cannot resist this temptation, and manages to keep its textbooks mostly free of hairy cousins. Inasmuch as this approach tries to dissociate human evolution from continuity among all life forms, it is dramatically at odds with Darwin's message in *Descent*, which is that humans are animals in *both* body and mind.

As a primatologist, the parts that interest me most are those in which Darwin compares human and animal behavior. In one of his notebooks, he had claimed "He who understands baboon would do more toward metaphysics than Locke" (M Notebook, 16 August 1838). In *Descent*, Darwin spends considerable time reviewing whatever he knew about animal altruism and kindness, relating how primates are loyal to their friends (see the incident with the zookeeper who is saved by a small monkey, pp. 163–64), or how a blind pelican keeps a full belly thanks to its companions, p. 163. Not all of these stories should be taken literally, though, as Darwin often received them secondhand. But they helped Darwin make the case that animal social instincts may have provided the basis for the evolution of human morality. He stressed continuity, as in my favorite quote from *Descent:* "...any animal whatever, endowed with well-marked social instincts, the parental and filial affections

being here included, would inevitably acquire a moral sense or conscience, as soon as its intellectual powers had become as well, or nearly as well developed, as in man."

This is typical of Darwin. Instead of shying away from the most challenging topic, he faces it head on. Morality is often proposed as that which sets humans apart, but such thinking was alien to Darwin. If we consider that much of the continuing opposition to evolutionary theory probably derives from people fearing "moral decay," and if we were to accept that we are mere animals, it is all the more relevant to read what Darwin himself had to say about morality. He did not see it as something coming from God, but from a need to survive. He saw humans as moral to the core of their being.

The parts of *Descent* in which Darwin speculates about moral evolution are often cited since they imply so-called group selection, a highly controversial topic. Darwin argued that if the members of certain tribes are endowed with loyalty to the group and a tendency to help each other, their tribe will likely supplant other tribes, resulting in these qualities being passed on to the next generation. Biologists have been debating group selection for the last few decades, but it is generally agreed that provided the people within a tribe are genetically related, Darwin's argument holds.

At the time of writing, Darwin did not know about genes, let alone DNA. He obviously knew about the inheritability of characteristics, and about the need for males and females to

contribute, but not that maternal and paternal traits in fact stay segregated in the genome. A host of issues remained irresolvable because of the assumption that the characteristics of both parents are blended together in their descendants. But this lack of knowledge did not prevent him from proposing a second mechanism of evolution, sometimes considered equally important as natural selection, which is selection of sex-specific characteristics. Here the selection is not on how traits assist survival in a particular environment, but on how they affect mate choice.

Darwin had been worried about the fact that some animals possess traits that seemed extremely costly or risky. How does the male peacock get around with that enormous tail, and why do male Babirusa pigs have upper tusks that curve back over their snout and seem useless for digging or fighting? From a survival perspective, these traits were stupid. They seemed to mock Darwin's theory according to which every trait has its own utility—otherwise it would not be there. He told his children: "The sight of a feather in a peacock's tail, whenever I gaze at it, makes me sick!"

Darwin's deceptively simple solution that females may prefer males with the most extravagant ornamentation ran into immense opposition from scholars who did not wish to give females such an important role in the origin of male traits, and others who saw adornment and embellishment as morally corrupt, utterly frivolous, and perhaps even harmful for the species.

Darwin's ideas about humans as animals, about morality as an

evolutionary product, and about bodily beauty being a turn-on for the other sex made *Descent* an incredibly radical book for its time. Even in modern times, not all of its implications have fully sunk in yet. For anyone with an interest in human evolution, there is only one logical starting point and it is this exposé of humanity's place in the larger scheme of nature. The current concise edition has made reading this otherwise somewhat lengthy book a much less daunting task, and will help readers absorb its central and most profound points.

—Frans de Waal

# *A Note on the Text*

Darwin originally published *The Descent of Man* in 1871, correcting and revising it in subsequent editions. The 1879 edition is the basis of the Penguin Classics edition published in 2004. The editors of the Penguin edition, Darwin historians Adrian Desmond and James Moore, corrected many inconsistencies in fonts and spelling and translated many of the passages Darwin had quoted from other languages. They also added a magisterial introduction of their own. This abridged version is drawn from the Penguin edition, with separation marks indicating where portions of *The Descent of Man* have been omitted.

# THE DESCENT OF MAN, AND SELECTION IN RELATION TO SEX

# 1

## Editor's Introduction

The history of science is rife with fateful meetings. The astronomer Tycho Brahe hires a young assistant named Johannes Kepler, who will go on to discover in Brahe's observations the law of planetary motion. A bright but aimless British physicist named Francis Crick is introduced to a boisterous young American biologist named James Watson. The two soon discover they share a curiosity about a strange molecule called DNA. And on a warm afternoon in the early spring of 1838, the young Charles Darwin climbed into an orangutan's cage.

The sight of a living ape was a new sensation at the time in England. Europeans only knew of apes through vague accounts from travelers returning from Africa and Indonesia. Beginning in 1835, however, chimpanzees and orangutans began to appear at London's Zoological Gardens. Face to face, the apes inspired uneasy fascination. Queen Victoria declared them "frightful, and painfully and disagreeably human."

The first ape to come to London, a chimpanzee named Tommy, was put in a sailor's suit. The second, a female orangutan named Jenny, was put in a dress. Both were taught to eat with spoons. Yet

the humanlike qualities of these apes did not cause most observers to question the uniqueness of humans. An article about Jenny's humanlike behavior stressed that "in nothing does it trench upon the moral or mental provinces of man." After all, it was agreed, God had separately created man and orangutan and every other species on Earth in their current form. He had endowed each species with its own combinations of traits, all of which displayed His handiwork. One need only look at the complex barbs of a feather or the muscles of the human hand to see the work of a Creator. An orangutan's ability to eat with a spoon was just a distraction from that great truth.

A few people, however, harbored some doubts. Charles Darwin was one of them. In 1838, those doubts had not yet flowered into a full-blown theory of life. Darwin was only twenty-nine at the time, and would not publish his first account of evolution for another twenty-one years. But his doubts were already deep enough to lure him into Jenny's cage.

Historians have long wondered how the seeds of evolution were planted in Darwin's mind. They were probably already there in his youth, but they remained dormant for years. His grandfather, the physician Erasmus Darwin, wrote a long poem called "Zoonomia" in the 1790s, in which he argued that life had changed over vast stretches of time, with new kinds of creatures emerging from old ones. This transformation would later become known as evolution. Charles Darwin learned more about evolution as a teenager, when he traveled to Edinburgh to study medicine. Surgery and autopsies appalled him. His fondness for nature was already becoming plain,

as he explored tidal pools instead of sitting through lectures. Darwin soon found a mentor in the Scottish naturalist Robert Grant. Grant taught Darwin not only about natural history, but about evolution as well.

Grant had been deeply influenced by Darwin's grandfather, as well as by the more recent work of the French naturalist Jean Lamarck. Lamarck argued that two laws of nature gradually changed life over time. Simple life forms perpetually came into existence, and they were all driven toward greater degrees of perfection. Species also adapted to their particular environments through experience. Giraffes stretching to reach leaves, Lamarck suggested, might acquire longer necks. The giraffes could then pass down their longer necks to their offspring, Lamarck believed.

While Grant and a few other naturalists embraced Lamarck, most scholars viewed him with scorn. Lamarck was challenging a fundamental tenet of Christianity, and he even dared to suggest that human beings were also the product of evolution. Lamarck speculated how an ape much like orangutans or chimpanzees might gradually stand upright and begin to speak, and thus become human.

Despite the influence of his grandfather and Grant, Darwin doesn't appear to have taken evolution seriously as a young man. Rejecting medicine, he began preparing to join the clergy. At the University of Cambridge he read the influential 1802 book *Natural Theology* by the Reverend William Paley. Paley asked his readers to imagine walking across a heath and coming across a watch. By its

sheer complexity, his readers would know someone had made it. Paley argued that eyes and feet and other traits showed similar signs of design. Darwin admired Paley's rhetoric, although he was not a terribly serious student of theology. In his free time, Darwin hunted for beetles in the countryside.

In 1831, as Darwin was finishing up at Cambridge, he received a rare invitation. Robert FitzRoy, the captain of HMS *Beagle*, was searching for a well-educated gentleman to join him on a voyage around the Earth. Darwin accepted, and became the *Beagle*'s unofficial naturalist. The voyage lasted five years, during which time Darwin explored Amazon jungles, climbed the Andes, and prowled Pacific islands few Europeans had ever seen. He gathered much of the raw material that he would later use to develop his own theory of evolution.

But Darwin was not yet an evolutionist. On the voyage of the *Beagle* he simply made observations—of mountains, of coral reefs, of giant tortoises—and sought natural explanations for how they came to be. One of his best guides was a newly published book he had brought along on the voyage, called *Principles of Geology*. The author, a British lawyer-turned-geologist named Charles Lyell, argued that mountains and valleys and other geological features were not the result of Noah's flood or some other sudden catastrophe. Instead, the surface of the planet was the product of a long series of gradual changes. Rain gradually wore down canyons. Mountains inched up out of the sea. Darwin saw ample evidence on his voyage to support Lyell's theory of an ancient, slowly changing Earth.

Lyell also discussed evolution in *Principles of Geology*. He sketched out Lamarck's arguments, describing how an orangutan supposedly "is made slowly to attain the attributes and dignity of man." But Lyell rejected Lamarck. He pointed out the recent discovery of ibises mummified for thousands of years in Egypt. If Lamarck were right, one would expect to see a difference between the mummified birds and living members of their species. No such difference had been found. Yet Lyell did not believe that all life was created at Earth's dawn. He proposed that new species were separately created over the course of Earth's history.

This argument did not make sense to Darwin. After his return to England in 1837, he began to carefully describe the fossils, birds, plants, and other specimens he had gathered on his travels. He recorded his ideas in a series of notebooks. The notebooks document his embrace of evolution. Just as geology showed evidence of a slowly changing Earth, living species showed evidence of a slow transformation. How else to explain fossil rodents and anteaters in South America that were giant versions of the mammals that Darwin saw on his visit? Darwin had discovered new species of finches on the remote Galapagos Islands, with beaks so different from one another he had not realized at first that they were finches at all. It was hard to reconcile those finches with the idea of special creation. Perhaps an ancestral finch had given rise to new species, Darwin thought, each with its own adaptations.

In his notebooks, Darwin sketched a tree, each branch a species joined in kinship with other species. Above the tree he wrote, "I think."

Humans, Darwin immediately recognized, might also belong on one of those branches. Hence his fascination with Jenny the orangutan. In the similarities between orangutans and humans Darwin saw signs of kinship, of a shared ancestry. On March 28, 1838, Darwin rode to the London Zoo and paid a visit to Jenny, who was weathering the British climate in the heated giraffe house. As a wealthy guest, Darwin was allowed to enter the cage itself. In a letter he wrote four days later to his sister Susan, he described what he saw:

> ...the keeper showed her an apple, but would not give it [to] her, whereupon she threw herself on her back, kicked & cried, precisely like a naughty child.—She then looked very sulky & after two or three fits of pashion, the keeper said, "Jenny if you will stop bawling & be a good girl, I will give you the apple.—She certainly understood every word of this, &, though like a child, she had great work to stop whining, she at last succeeded, & then got the apple, with which she jumped into an arm chair & began eating it, with the most contented countenance imaginable.

Darwin watched Jenny gaze at herself in a mirror. She used bits of straw like tools. Her face contorted much as a child's would. Others might believe they were vastly different from an orangutan, but Darwin didn't. He decided that much of that difference was a superficial matter of clothes and manners. His mind raced back to the people he had encountered on his voyage aboard the *Beagle*. He had met naked Indians in Tierra del Fuego.

But he had also met Fuegans who had traveled to England and taken up the customs of Western civilization.

"Let man visit Ourang-outang in domestication," he wrote in his notebook, "hear [its] expressive whine, see its intelligence when spoken [to]; as if it understand every word said—see its affection.—to those it knew.—see its passion & rage, sulkiness, & very actions of despair; let him look at savage, roasting his parent, naked, artless, not improving yet improvable & let him dare to boast of his proud preeminence."

Darwin kept his notebooks private. His dangerous thoughts about human origins would stew in his mind for more than three decades. He would finally share them with the world thirty-three years later, with the publication of his 1871 book, *The Descent of Man, and Selection in Relation to Sex.*

*The Descent of Man* is one of the most important books in the history of biology, but it is also one of the most baffling. A reader can be forgiven for wondering why the book exists at all. Twelve years earlier, Darwin had introduced the world to his theory of evolution with *On the Origin of Species by Means of Natural Selection*. An account of how evolution produced humans would have made a splendid final chapter. And yet Darwin scrupulously avoided almost any mention of humans in the *Origin of Species*. When Darwin finally did turn his attention to mankind and wrote *The Descent of Man*, he produced a sprawling book that seems arranged to frustrate any attempt to read it all the way through.

Darwin buries the skeleton of his argument under fleshy folds of esoterica—the length of European shinbones, the habit rabbits have of stamping their feet in fear, lizard snouts, peacock feathers, the Egyptian custom of knocking out their front teeth. In fact, even the title of the book is misleading, because most of *The Descent of Man* is not in fact about man at all. Darwin dedicates more than half of the book exclusively to the courtship of animals.

For all these frustrations, *The Descent of Man* marks a turning point in the history of science. It represents the first effort to trace the origin of human nature to a biologically realistic account of evolution. Darwin argued that the same natural processes that produced iris petals and scorpion tails also produced humanity's noblest features, such as language and morality. Of course, like any book, *The Descent of Man* was the product of its time. It is deeply tinted by the prejudices and assumptions of Victorian England. Its picture of humanity is in some ways disturbingly obsolete. And yet more than 130 years later it remains a living document. How many other books from 1871 appear regularly in the footnotes of papers published in the latest issues of scientific journals?

This abridged edition will, I hope, give readers new to *The Descent of Man* an appreciation of its importance. Each excerpt I have selected represents one of the book's major themes. To introduce them, I discuss the intellectual background to Darwin's arguments and then compare his ideas to the current understanding of human nature. The notion that Jenny the orangutan shared a common ancestor with a Victorian gentleman, for example, was outrageous in 1838, but today the evidence is

overwhelming. Darwin made his original case by comparing the anatomy and behavior of humans and apes. Today scientists can compare humans and apes on the molecular level and put Darwin's hypothesis to the test. If orangutans were kin to humans, you'd expect that their DNA would preserve traces of that kinship. And indeed it does. Human DNA bears distinctive sequences shared only by orangutans, gorillas, chimpanzees, and bonobos. Jenny and Darwin were two cousins in a cage.

To understand the peculiar nature of *The Descent of Man*, it's essential to understand two things: Darwin's own view of human nature, and his struggle to present evolution to the public. Together, they made *The Descent of Man* such a paradox of a book.

Looking back from the twenty-first century, we must work hard to understand Darwin's conception of what it means to be human. Darwin viewed humanity with a mix of egalitarianism and elitism. Is this a contradiction? Perhaps, but it was one that Darwin shared with many of his peers.

Darwin's egalitarianism made him a passionate opponent of slavery. England outlawed trading in slaves in 1807, two years before Darwin was born, but slavery itself would not be outlawed in British colonies until 1833. Darwin grew up in an abolitionist household, and his experiences in South America during the voyage of the *Beagle* only hardened his disgust for slavery: In Brazil, slave families would be cruelly separated, and the ears of fugitives lopped off. This brutality was often justified on the basis

of race: Europeans supposedly were inherently superior to other humans. Racism also underlay the vicious treatment of Indians in Argentina, where European settlers slaughtered families and took their land.

Evolution, to Darwin's mind, directly challenged justifications for this cruelty. Africans were not subhumans, fit only for slavery. All humans shared a common ancestry—not from Adam, but from apes. Africans, Fuegans, and Englishmen were no more different from one another than breeds of pigeons. In fact, many of the qualities that supposedly elevated humans above animals could be found among the beasts, such as Jenny.

Once Darwin recognized *that* humans and other species had evolved, he had to figure out *how* they did so. He did not reject Lamarck entirely, but he was soon captivated by a new concept, which he dubbed natural selection. It came to Darwin as he read an essay by the clergyman Thomas Malthus about the growth of human population. Malthus argued that the population of a country, if left unchecked, would rapidly explode, and warned that it would outstrip the country's food supply. The only reason that human history was not one long famine was because human populations were kept in check by diseases, catastrophes, and the like.

Darwin realized that Malthus's ideas had a huge importance with respect to animals and plants. The world could easily be overrun by flies or roses or toadstools or any other species if the population of that species could grow without check. Many

individuals in each species must therefore die without offspring. Darwin realized that certain traits might determine whether an individual reproduced more than others. A thick coat of fur might allow one fox to weather a winter better than a more lightly attired one, and survive to produce more kits. Over the course of generations, the thick-furred foxes would become more and more common. Natural selection could not only alter life but also wipe it out. If two species competed for the same types of food, one might eventually drive the other to extinction.

Darwin's discovery of Malthus was a crucial moment in the history of science, one that would ultimately give rise to the modern understanding of biology. It's easy to forget, however, that Malthus was much more interested in people than in animals or plants. He championed a bleak sort of politics. Welfare was counterproductive, Malthus argued, because it only worsened the suffering from population growth. Darwin acquired a similarly bleak view of natural selection among humans. He was wary of welfare for the poor, since it removed the improving powers of hardship. And when two peoples met—such as the English and the Aborigines of Australia—they competed like two species. In Darwin's day, a number of cultures were dwindling in the face of European expansion, and Darwin fully expected them to disappear. Thus Darwin's view of human nature was a mix of abolitionist equality and a Victorian capitalist view of industrial society. He was hardly the only Victorian gentleman to hold both views at once.

In the early 1840s Darwin worked furiously to flesh out a theory

of evolution by natural selection. He found that it could account for a vast range of patterns in nature, from the distribution of species to the relationship between fossils and living animals. He amassed evidence of the common ancestry of different species, evidence such as homologies—structural similarities between different organs: bat wings and human hands, for example.

Darwin translated his notebooks into a long formal description of the theory, but he did not immediately publish it. He knew that it would shock many of his colleagues, particularly in its implications for human origins. He shared the full details with only a few people, including his wife, Emma, and the botanist Joseph Hooker. Darwin's instincts proved sound. Shortly after Emma and Hooker learned about his theory, England began buzzing about a new book about evolution.

In 1844, a Scottish journalist named Robert Chambers anonymously published *Vestiges of the Natural History of Creation*. Chambers declared that life evolved according to natural laws. As lofty as humans might be, they had evolved just as any other animal had. *Vestiges* sold tens of thousands of copies, but it also triggered a furious backlash from England's scientific elite. Adam Sedgwick, Darwin's old geology teacher at Cambridge, declared that if the book were true, "religion is a lie; human law a mass of folly and a base injustice; morality is moonshine."

*Vestiges*'s harsh reception did not force Darwin to abandon his theory. He set out to succeed where Chambers had failed. Instead of presenting a compelling mechanism by which life evolved,

Chambers offered a fanciful stew of speculation. Darwin redoubled his efforts to make the case for evolution by natural selection. He gathered vast stores of information, sending letters around the world. He spent years studying barnacles, which had undergone extreme evolutionary transformation from their shrimplike ancestors. He published a massive two-volume monograph on barnacles that was both a zoological tour de force and a gold mine of insights about evolution. He also looked for signs of evidence of evolution in humans. In the expressions in the faces of his children, Darwin saw echoes of Jenny.

Darwin did not return to his natural selection manuscript for another decade. When he did, he was able to infuse it with all that he had learned in those years. His ideas about natural selection had become more subtle and complex. The reproductive success of an animal, he realized, also depended on one animal finding another animal. Here, too, there might be inequality. Strong males might be able to fight off weaker ones for the opportunity to mate with females. Females might be attracted to handsome males more than ugly ones. Attractive males would father more offspring, and their traits would become more common over the generations.

In 1856 Darwin dubbed this process sexual selection. He wondered if sexual selection might be the source of nature's extravagance, from warthog tusks to peacock tails. It might have even produced the differences between human races. Europeans became white and Africans became black thanks only to different conceptions of beauty. Sexual selection might have also produced the differences between men and women, as men competed for the

opportunity to mate, and women chose from their prospective suitors.

By 1858 Darwin's book had reached 250,000 words, with no end in sight. But his glacial pace was interrupted in 1858 by a letter from the Far East. Alfred Russell Wallace, a naturalist who had supplied Darwin with some bird skins for his research, had been thinking about a theory of evolution. It was strikingly similar to Darwin's; Wallace even drew inspiration from Malthus as well. In his letter to Darwin, Wallace described his theory in detail. Once Darwin got over his shock, he arranged for Wallace's paper and a short summary of his own work to be read at a June meeting of the Linnean Society. Suddenly his ideas were public, but not in the way he had carefully planned. He struggled to write a scientific paper to expand on the Linnean talk, but it swelled up to book length. He decided that a book it would be: *The Origin of Species*.

The book ended up far shorter than Darwin's unpublished tome. But he still managed to squeeze in an awesome amount of natural history. His friend and public champion, Thomas Huxley, called *The Origin of Species* "a mass of facts crushed and pounded into shape, rather than held together by the ordinary medium of an obvious logical bond." Darwin had compiled that mass of facts to meet every objection he could imagine, and also to show how universal a process evolution was—to show how deeply evolution had left its mark on every corner of life.

One of those corners, Darwin knew, was our own species. His storehouse of natural history included a great deal of information

on human evolution. But in *The Origin of Species*, he constrained himself to just a few fleeting mentions of humans. Darwin hinted at the evolution of human races and then coyly announced, "I may add that some little light can apparently be thrown on the origin of these differences, chiefly through sexual selection of a particular kind, but without here entering on copious details my reasoning would appear frivolous." Near the end of the book, he cryptically predicts, "Light will be thrown on the origin of man and his history."

Darwin's omission was a conscious, tactical maneuver in a campaign to win the public over to evolution. It would be hard enough to persuade his readers that animals or plants evolved. To add humans to evolution's list of accomplishments might instantly turn them away. "I thought that I should thus only add to the prejudices against my views," he later wrote.

Darwin was probably right. Most of the attacks launched against *The Origin of Species* in the 1860s sooner or later came around to the question of man's place in nature. Richard Owen, the greatest British anatomist of the nineteenth century, tried to refute evolution by finding a part of the human brain with no counterpart in apes. In 1860, Owen attended the most famous debate over Darwin, at Oxford University. Bishop Samuel Wilberforce delivered a furious attack on *The Origin of Species* and ended it by turning to Thomas Huxley and asking him whether he descended from an ape on his mother's or father's side. Jenny's ghost cast a long, worrisome shadow.

While others argued over man and ape, Darwin planned his next project after *The Origin of Species*. It would be a sprawling trilogy, packed with all the information he'd had to leave out of his first book on evolution. Originally, he hoped to include his material on human biology. But his plans, as they often did, went awry. The material on domesticated animals and plants proved massive enough to warrant a book of its own, which Darwin published in 1868. He became distracted by orchids, which proved a hothouse illustration of evolution's remarkable power to reshape life. And then his health took a serious turn for the worse, leaving him exhausted and unable to work for long stretches.

While Darwin was distracted from human evolution, others gave it their full attention. Archaeologists were discovering arrowheads and pottery shards and other evidence of an ancient period of human existence that they dubbed "prehistory." Huxley was organizing devastating attacks against Owen, showing that human brains were not so profoundly different from primate brains after all. Anthropologists tried to quantify the differences between the races. Some argued that the races had a single human origin, while others argued that each race must have evolved separately from primate ancestors. To Darwin's horror, the multiple-origins camp proved willing to use evolution to defend slavery.

Darwin kept abreast of these developments, but it was Wallace who finally pulled him into the debate over human evolution. In the late 1860s Darwin began to discuss his theory of sexual selection with Wallace. He explained how it could have driven the

evolution of features in both animals and humans. Wallace only saw the need for one kind of selection: natural. Darwin argued that in birds, bright males and drab females were evidence of the choosiness of females. Wallace argued that the plumage of the two sexes helped each to survive—drab females, for example, being better camouflaged from predators as they sat on their nests. Over the course of their exchange, Darwin searched for more evidence he could provide to Wallace for sexual selection—evidence he would later present in *The Descent of Man*.

Darwin and Wallace debated sexual selection in the spirit of friendly competition. But suddenly the argument turned ugly. Wallace decided that once the very simplest features of humans had emerged—crude communication, tool-making, and so on—natural selection could not have driven those faculties to become as powerful as they are today. There would simply be no advantage to full-blown language, morality, and all the other things humans prided themselves in. Wallace was growing increasingly interested in séances and the supernatural, and he became convinced that human nature transcended nature itself. While our distant primate ancestors might have evolved by natural selection, Wallace concluded, supernatural forces took control of humanity's progress.

Darwin told Wallace that he was "dreadfully disappointed." Unlike Wallace, Darwin saw nothing in human nature beyond the scope of evolution. Morality had its counterpart in the selfless behavior of animals. Human language was just a particularly elaborate form of communication. Humans were different in

degree from animals, not in kind.

Darwin could no longer rely on others to put man in his proper place. He would have to do it himself. By 1867 Darwin was referring to his "book" on man. Its final form reflected the complex history of Darwin's ideas about humans. He began by assembling evidence that humans had evolved, showing all the anatomical links to other species. He then argued that man's mental faculties also had precedents in the natural world. Darwin offered explanations for the differences between human races, but in order to do so, he had to introduce readers to sexual selection. Like so many of his other projects, this introduction got the better of him, and it came to dominate the book. At the end of *The Descent of Man*, Darwin combined all of his arguments into a single vision of humanity as the product of evolution, through both natural and sexual selection.

In March 1870 Darwin sent the manuscript to his long-time publisher, John Murray. Murray fretted that the book would stir up controversy and convinced Darwin to abandon his original title, *The Origin of Man*. Such tweaks notwithstanding, it remained dense with provocation, taking on all of religion's most cherished assumptions. The book certainly attracted some tough criticisms, but nothing compared to the uproar that had met *The Origin of Species*. It sold well and deeply penetrated the public discourse. Darwin began to appear in cartoons as half man, half ape.

Today thousands of scientists follow Darwin's path, investigating the evolutionary origins of human nature. They dig

up fossils, they hunt for traces of history in our DNA, they search for humanlike behavior in primates and other animals. Yet human evolution remains a deeply controversial subject. In a 2007 survey, 48 percent of Americans stated that God created humans in their present form in the past 10,000 years. Opponents of evolution claim, like Adam Sedgwick did 163 years ago, that believing in evolution corrupts morality. Human evolution also underlies fierce debates over what is "natural" about human nature. In 2006, for example, Harvard University president Lawrence Summers aroused a storm of protest by suggesting that there were more male engineering professors than female ones because of biological differences between the sexes. Shortly afterward, Summers resigned. Evolutionary biologists are shedding light on such controversial issues, although they are a long way from providing definitive answers. In the biological world, nothing surpasses human nature in mystery. But scientists do not react to the mystery by throwing up their hands; they think of new experiments to run.

*The Descent of Man* is important not just as a scientific milestone, but as a cultural artifact. Darwin was a man of his time, and as controversial as his theory of evolution was, he left certain assumptions of Victorian England unchallenged. Men were intellectually superior to women, he assumed; Victorian monogamy was natural for our species, despite the wide range of other marital systems found in other cultures; and Europeans were in many ways the pinnacle of human development. One cannot ignore these aspects of *The Descent of Man*. Yet one must also bear

in mind that science has always been an imperfect, all-too-human endeavor. But science also allows humans to reach deeper and deeper insights about the world, and about ourselves.

# *Introduction*

THE NATURE OF the following work will be best understood by a brief account of how it came to be written. During many years I collected notes on the origin or descent of man, without any intention of publishing on the subject, but rather with the determination not to publish, as I thought that I should thus only add to the prejudices against my views. It seemed to me sufficient to indicate, in the first edition of my 'Origin of Species', that by this work 'light would be thrown on the origin of man and his history', and this implies that man must be included with other organic beings in any general conclusion respecting his manner of appearance on this earth. Now the case wears a wholly different aspect. When a naturalist like Carl Vogt ventures to say in his address as President of the National Institution of Geneva (1869), 'personne, en Europe au moins, n'ose plus soutenir la création indépendante et de toutes pièces, des espèces,' ['nobody, in Europe at any rate, would nowadays dare to support the idea of the separate and independent creation of every species'] it is manifest that at least a large number of naturalists must admit that species are the modified descendants of other species; and this especially holds good with the younger and rising naturalists. The greater number accept the agency of natural selection; though some urge, whether with justice the future must decide, that I have greatly

overrated its importance. Of the older and honoured chiefs in natural science, many unfortunately are still opposed to evolution in every form.

In consequence of the views now adopted by most naturalists, and which will ultimately, as in every other case, be followed by others who are not scientific, I have been led to put together my notes, so as to see how far the general conclusions arrived at in my former works were applicable to man. This seemed all the more desirable, as I had never deliberately applied these views to a species taken singly. When we confine our attention to any one form, we are deprived of the weighty arguments derived from the nature of the affinities which connect together whole groups of organisms—their geographical distribution in past and present times, and their geological succession. The homological structure, embryological development, and rudimentary organs of a species remain to be considered, whether it be man or any other animal, to which our attention may be directed; but these great classes of facts afford, as it appears to me, ample and conclusive evidence in favour of the principle of gradual evolution. The strong support derived from the other arguments should, however, always be kept before the mind.

The sole object of this work is to consider, firstly, whether man, like every other species, is descended from some pre-existing form; secondly, the manner of his development; and thirdly, the value of the differences between the so-called races of man. As I shall confine myself to these points, it will not be necessary to describe in detail the differences between the several races—an

enormous subject which has been fully discussed in many valuable works. The high antiquity of man has recently been demonstrated by the labours of a host of eminent men, beginning with M. Boucher de Perthes; and this is the indispensable basis for understanding his origin. I shall, therefore, take this conclusion for granted, and may refer my readers to the admirable treatises of Sir Charles Lyell, Sir John Lubbock, and others. Nor shall I have occasion to do more than to allude to the amount of difference between man and the anthropomorphous apes; for Prof. Huxley, in the opinion of most competent judges, has conclusively shewn that in every visible character man differs less from the higher apes, than these do from the lower members of the same order of Primates.

This work contains hardly any original facts in regard to man; but as the conclusions at which I arrived, after drawing up a rough draft, appeared to me interesting, I thought that they might interest others. It has often and confidently been asserted, that man's origin can never be known: but ignorance more frequently begets confidence than does knowledge: it is those who know little, and not those who know much, who so positively assert that this or that problem will never be solved by science. The conclusion that man is the co-descendant with other species of some ancient, lower, and extinct form, is not in any degree new. Lamarck long ago came to this conclusion, which has lately been maintained by several eminent naturalists and philosophers; for instance, by Wallace, Huxley, Lyell, Vogt, Lubbock, Büchner, Rolle, &c.,[1] and especially by Häckel. This last naturalist, besides his great work,

'Generelle Morphologie' (1866), has recently (1868, with a second edit. in 1870), published his 'Natürliche Schöpfungsgeschichte', in which he fully discusses the genealogy of man. If this work had appeared before my essay had been written, I should probably never have completed it. Almost all the conclusions at which I have arrived I find confirmed by this naturalist, whose knowledge on many points is much fuller than mine. Wherever I have added any fact or view from Prof. Häckel's writings, I give his authority in the text; other statements I leave as they originally stood in my manuscript, occasionally giving in the foot-notes references to his works, as a confirmation of the more doubtful or interesting points.

During many years it has seemed to me highly probable that sexual selection has played an important part in differentiating the races of man; but in my 'Origin of Species' (first edition, Chapter 6) I contented myself by merely alluding to this belief. When I came to apply this view to man, I found it indispensable to treat the whole subject in full detail.[2] Consequently the second part of the present work, treating of sexual selection, has extended to an inordinate length, compared with the first part; but this could not be avoided.

I had intended adding to the present volumes an essay on the expression of the various emotions by man and the lower animals. My attention was called to this subject many years ago by Sir Charles Bell's admirable work. This illustrious anatomist maintains that man is endowed with certain muscles solely for the sake of expressing his emotions. As this view is obviously opposed to the

belief that man is descended from some other and lower form, it was necessary for me to consider it. I likewise wished to ascertain how far the emotions are expressed in the same manner by the different races of man. But owing to the length of the present work, I have thought it better to reserve my essay for separate publication.

# 2

## Evidence for Human Evolution

The human body works, and works very well. Our eyes can capture exquisitely detailed images; our immune systems can fight off a practically infinite number of pathogens; our hands are nimble enough that with enough training surgeons can repair ruptured blood vessels and broken brains. In the early 1800s, when Charles Darwin was first learning about biology, such finely adapted traits were seen as evidence of God's handiwork. Only a supernatural Creator could produce structures so well-suited to their tasks.

This view of life was not an ignorant, prescientific delusion. In fact, many of the greatest figures of the scientific revolution in the 1600s believed that their discoveries about the workings of the human body were proof of God's design. With the scientific revolution God became a chemical and mechanical engineer. Natural theology, as this school of thought was known, survived into the early 1800s and was embraced by leading researchers such as Charles Bell, one of the great neurologists of the nineteenth century. In addition to his pathbreaking work on the anatomy and diseases of the nervous system, Bell also published *The Hand, Its Mechanism and Vital Endowments as Evincing Design.*

Only by recognizing the power of previous explanations of the human body can we appreciate how important Darwin's breakthrough was. Darwin's assault on natural theology was like a pincer movement, describing the mechanism of natural selection and offering example after example of human biology that made little sense except as evidence of evolution. In *The Descent of Man*, the evidence comes first. Darwin wants to show the many ways in which man, in his words, "still bears in his bodily frame the indelible stamp of his lowly origin."

In order to persuade his readers of this genealogical connection, Darwin must overcome the powerful notion that the human body is exquisitely well-engineered. To do so, he points out the many rudimentary features of the human body—the stump of a tail at the bottom of the spine, for example, or the lanugo, the hair that grows over the entire human fetus before falling out before birth. These traits make eminent sense if seen as vestiges of primate ancestors. They make little sense if seen as the handiwork of a designer.

In the twenty-first century, the human body continues to reveal more of its imperfections. Along with vestigial tails and fleeting lanugos, scientists are discovering molecular rudiments in the human genome. The most striking examples come from the human nose. Darwin noted that humans have a weak sense of smell compared to other mammals, but in his day scientists knew little about the mechanisms that make smell possible. Scientists now know that each olfactory nerve in the nose is studded with receptors that can grab odor molecules. Each kind of receptor is

encoded by a separate gene. Its unique structure allows it to grab certain molecules. The combined information gathered by olfactory receptors lets us discriminate among a vast range of subtle smells.

Other animals carry their own olfactory receptor genes, and by comparing ours to theirs, scientists have reconstructed the history of smell. Over millions of years, mutations have accidentally produced extra copies of many olfactory receptor genes. Additional mutations altered the structure of those copies, changing their responses to odor molecules. As a result, we carry families of related olfactory receptor genes. Genes belonging to those same families can be found in chimpanzees, mice, and other mammals.

These families alone are powerful evidence of our common heritage with other animals. But even more powerful is the fact that many of the olfactory receptor genes in the human genome don't work. They have been hit by crippling mutations that prevent an olfactory receptor gene from being successfully translated into a working protein. These disabled genes are called pseudogenes. The human genome contains 388 working genes for olfactory receptors, and 414 pseudogenes. By contrast, a mouse has 1,037 working genes, and 354 pseudogenes.

By comparing the human and mouse genomes, scientists have reconstructed the rise and fall of olfactory receptor genes. All of the genes, broken or functional, in both mice and men, originated in an ancestral set of 754 functional genes. Those genes made

receptors in the nose of a small mammal that lived approximately 100 million years ago. In the lineage that produced today's mice, many of those original genes were duplicated, and most of those duplicates still work today. In the lineage leading to humans, on the other hand, many more of the ancestral genes became pseudogenes. We carry some new duplicates of the ancestral genes, but far fewer than mice do. Many pseudogenes have disappeared altogether from the human genome.

The way scientists today understand evolutionary loss is different in some important ways from the way Darwin thought of it. Darwin envisioned a Lamarckian process by which disuse caused a structure to atrophy and then gradually shrivel away over generations. But careful studies of human genes have helped make today's biologists more Darwinian about evolutionary loss than Darwin himself. As species evolve new habits, some of their genes become unnecessary. Mutations that disable them are not eliminated by natural selection, because animals with those mutations suffer no penalty. In the case of smell, our loss of genes occurred as our primate ancestors made a profound sensory shift. Instead of relying mainly on smell for finding food or picking up signals from other members of their species, they came to rely more on eyesight. As they became more visual, they probably no longer needed a big repertoire of olfactory receptors. A mutation that struck one of the genes did not affect their reproductive fitness, and so it was not eliminated by natural selection. For mice, evolution took a very different path. Smell has remained important for mice over tens of millions of years. Losing a gene

could make a mouse less fit. New olfactory receptor genes made them more fit and were thus favored by natural selection. Thus mice and men ended up with their very different collections of olfactory receptor genes.

In Darwin's day, many people scoffed at the notion that humans descended with other primates from a common ancestor. Many still do today. Olfactory receptor pseudogenes are a powerful antidote to illusions of human uniqueness. Humans' olfactory receptor genes are much more similar to those of chimpanzees than to those of mice. By the time the ancestors of humans and chimpanzees split about six million years ago, many olfactory receptor genes had turned to pseudogenes. The same pseudogenes can be found in both humans and chimpanzees. It would be hard enough for natural theologians to explain why most of the genes for smelling in humans are broken. It would be impossible to explain why chimpanzees and humans would be broken in the same way.

## CHAPTER 1:

## *The Evidence of the Descent of Man from some Lower Form*

He who wishes to decide whether man is the modified descendant of some pre-existing form, would probably first enquire whether man varies, however slightly, in bodily structure and in mental faculties; and if so, whether the variations are transmitted to his offspring in accordance with the laws which prevail with the lower animals. Again, are the variations the result, as far as our ignorance permits us to judge, of the same general causes, and are they governed by the same general laws, as in the case of other organisms; for instance, by correlation, the inherited effects of use and disuse, &c.? Is man subject to similar malconformations, the result of arrested development, of reduplication of parts, &c., and does he display in any of his anomalies reversion to some former and ancient type of structure? It might also naturally be enquired whether man, like so many other animals, has given rise to varieties and sub-races, differing but slightly from each other, or to races differing so much that they must be classed as doubtful species? How are such races distributed over the world; and how, when crossed, do they react on each other in the first and succeeding generations? And so with many other points.

The enquirer would next come to the important point, whether man tends to increase at so rapid a rate, as to lead to occasional

severe struggles for existence; and consequently to beneficial variations, whether in body or mind, being preserved, and injurious ones eliminated. Do the races or species of men, whichever term may be applied, encroach on and replace one another, so that some finally become extinct? We shall see that all these questions, as indeed is obvious in respect to most of them, must be answered in the affirmative, in the same manner as with the lower animals. But the several considerations just referred to may be conveniently deferred for a time: and we will first see how far the bodily structure of man shows traces more or less plain, of his descent from some lower form. In succeeding chapters the mental powers of man, in comparison with those of the lower animals, will be considered.

*The Bodily Structure of Man*—It is notorious that man is constructed on the same general type or model as other mammals. All the bones in his skeleton can be compared with corresponding bones in a monkey, bat, or seal. So it is with his muscles, nerves, blood-vessels and internal viscera. The brain, the most important of all the organs, follows the same law, as shewn by Huxley and other anatomists. Bischoff,[1] who is a hostile witness, admits that every chief fissure and fold in the brain of man has its analogy in that of the orang; but he adds that at no period of development do their brains perfectly agree; nor could perfect agreement be expected, for otherwise their mental powers would have been the same. Vulpian[2] remarks: 'Les différences réelles qui existent entre l'encéphale de l'homme et celui des singes supérieurs, sont bien minimes. Il ne faut pas se faire d'illusions à cet égard. L'homme est

bien plus près des singes anthropomorphes par les caractères anatomiques de son cerveau que ceux-ci ne le sont non-seulement des autres mammifères, mais même de certains quadrumanes, des guenons et des macaques.' ['The real differences that exist between the brain of man and that of the apes are very minimal. We should not have any illusions about this. In the anatomical characteristics of his brain, man is much closer to anthropoid apes than these are to other mammals, and not only to them but even to some quadrumanes, guenons and macaques.'] But it would be superfluous here to give further details on the correspondence between man and the higher mammals in the structure of the brain and all other parts of the body.

It may, however, be worth while to specify a few points, not directly or obviously connected with structure, by which this correspondence or relationship is well shewn.

Man is liable to receive from the lower animals, and to communicate to them, certain diseases, as hydrophobia, variola, the glanders, syphilis, cholera, herpes, &c.;[3] and this fact proves the close similarity[4] of their tissues and blood, both in minute structure and composition, far more plainly than does their comparison under the best microscope, or by the aid of the best chemical analysis. Monkeys are liable to many of the same non-contagious diseases as we are; thus Rengger,[5] who carefully observed for a long time the *Cebus Azarae* in its native land, found it liable to catarrh, with the usual symptoms, and which, when often recurrent, led to consumption. These monkeys suffered also from apoplexy, inflammation of the bowels, and cataract in the

eye. The younger ones when shedding their milk-teeth often died from fever. Medicines produced the same effect on them as on us. Many kinds of monkeys have a strong taste for tea, coffee, and spirituous liquors: they will also, as I have myself seen, smoke tobacco with pleasure.[6] Brehm asserts that the natives of northeastern Africa catch the wild baboons by exposing vessels with strong beer, by which they are made drunk. He has seen some of these animals, which he kept in confinement, in this state; and he gives a laughable account of their behaviour and strange grimaces. On the following morning they were very cross and dismal; they held their aching heads with both hands, and wore a most pitiable expression: when beer or wine was offered them, they turned away with disgust, but relished the juice of lemons.[7] An American monkey, an Ateles, after getting drunk on brandy, would never touch it again, and thus was wiser than many men. These trifling facts prove how similar the nerves of taste must be in monkeys and man, and how similarly their whole nervous system is affected.

Man is infested with internal parasites, sometimes causing fatal effects; and is plagued by external parasites, all of which belong to the same genera or families as those infesting other mammals, and in the case of scabies to the same species.[8] Man is subject, like other mammals, birds, and even insects,[9] to that mysterious law, which causes certain normal processes, such as gestation, as well as the maturation and duration of various diseases, to follow lunar periods. His wounds are repaired by the same process of healing; and the stumps left after the amputation of his limbs, especially

during an early embryonic period, occasionally possess some power of regeneration, as in the lowest animals.[10]

The whole process of that most important function, the reproduction of the species, is strikingly the same in all mammals, from the first act of courtship by the male,[11] to the birth and nurturing of the young. Monkeys are born in almost as helpless a condition as our own infants; and in certain genera the young differ fully as much in appearance from the adults, as do our children from their full-grown parents.[12] It has been urged by some writers, as an important distinction, that with man the young arrive at maturity at a much later age than with any other animal: but if we look to the races of mankind which inhabit tropical countries the difference is not great, for the orang is believed not to be adult till the age of from ten to fifteen years.[13] Man differs from woman in size, bodily strength, hairiness, &c., as well as in mind, in the same manner as do the two sexes of many mammals. So that the correspondence in general structure, in the minute structure of the tissues, in chemical composition and in constitution, between man and the higher animals, especially the anthropomorphous apes, is extremely close.

*Embryonic Development*—Man is developed from an ovule, about the 125th of an inch in diameter, which differs in no respect from the ovules of other animals. The embryo itself at a very early period can hardly be distinguished from that of other members of the vertebrate kingdom. At this period the arteries run in archlike branches, as if to carry the blood to branchiae which are not

present in the higher vertebrata, though the slits on the sides of the neck still remain (*f*, *g*, fig. 1), marking their former position. At a somewhat later period, when the extremities are developed, 'the feet of lizards and mammals', as the illustrious Von Baer remarks, 'the wings and feet of birds, no less than the hands and feet of man, all arise from the same fundamental form'. It is, says Prof. Huxley,[14] 'quite in the later stages of development that the young human being presents marked differences from the young ape, while the latter departs as much from the dog in its developments, as the man does. Startling as this last assertion may appear to be, it is demonstrably true.'

As some of my readers may never have seen a drawing of an embryo, I have given one of man and another of a dog, at about the same early stage of development, carefully copied from two works of undoubted accuracy.[15]

After the foregoing statements made by such high authorities, it would be superfluous on my part to give a number of borrowed details, shewing that the embryo of man closely resembles that of other mammals. It may, however, be added, that the human embryo likewise resembles certain low forms when adult in various points of structure. For instance, the heart at first exists as a simple pulsating vessel; the excreta are voided through a cloacal passage; and the os coccyx projects like a true tail, 'extending considerably beyond the rudimentary legs'.[16] In the embryos of all air-breathing vertebrates, certain glands, called the corpora Wolffiana, correspond with, and act like the kidneys of mature fishes.[17] Even at a later embryonic period, some striking

resemblances between man and the lower animals may be observed. Bischoff says that the convolutions of the brain in a human foetus at the end of the seventh month reach about the same stage of development as in a baboon when adult.[18] The great toe, as Prof. Owen remarks,[19] 'which forms the fulcrum when standing or walking, is perhaps the most characteristic peculiarity in the human structure', but in an embryo, about an inch in length, Prof. Wyman[20] found 'that the great toe was shorter than the others; and, instead of being parallel to them, projected at an angle from the side of the foot, thus corresponding with the permanent condition of this part in the quadrumana'. I will conclude with a quotation from Huxley,[21] who after asking, does man originate in a different way from a dog, bird, frog or fish? says, 'the reply is not doubtful for a moment; without question, the mode of origin, and the early stages of the development of man, are identical with those of the animals immediately below him in the scale: without a doubt in these respects, he is far nearer to apes than the apes are to the dog'.

Fig. 1. Upper figure human embryo, from Ecker. Lower figure that of a dog, from Bischoff.

*a*. Fore-brain, cerebral hemispheres, &c.
*b*. Mid-brain, corpora quadrigemina.
*c*. Hind-brain, cerebellum, medulla oblongata.
*d*. Eye.
*e*. Ear.
*f*. First visceral arch.
*g*. Second visceral arch.
H. Vertebral columns and muscles in process of development.

J. Anterior
K. Posterior
} extremities.

L. Tail or os coccyx.

*Rudiments*—This subject, though not intrinsically more important than the two last, will for several reasons be treated here more fully.[22] Not one of the higher animals can be named which does not bear some part in a rudimentary condition; and man forms no exception to the rule. Rudimentary organs must be distinguished from those that are nascent; though in some cases the distinction is not easy. The former are either absolutely useless, such as the mammae of male quadrupeds, or the incisor teeth of ruminants which never cut through the gums; or they are of such slight service to their present possessors, that we can hardly suppose that they were developed under the conditions which now exist. Organs in this latter state are not strictly rudimentary, but they are tending in this direction. Nascent organs, on the other hand, though not fully developed, are of high service to their possessors, and are capable of further development. Rudimentary organs are eminently variable; and this is partly intelligible, as they are useless, or nearly useless, and consequently are no longer subjected to natural selection. They often become wholly suppressed. When this occurs, they are nevertheless liable to occasional reappearance through reversion—a circumstance well worthy of attention.

The chief agents in causing organs to become rudimentary seem to have been disuse at that period of life when the organ is chiefly used (and this is generally during maturity), and also

generations ago into two branches; so that the head of the above-mentioned branch is cousin in the seventh degree to the head of the other branch. This distant cousin resides in another part of France; and on being asked whether he possessed the same faculty, immediately exhibited his power. This case offers a good illustration how persistent may be the transmission of an absolutely useless faculty, probably derived from our remote semi-human progenitors; since many monkeys have, and frequently use the power, of largely moving their scalps up and down.[27]

The extrinsic muscles which serve to move the external ear, and the intrinsic muscles which move the different parts, are in a rudimentary condition in man, and they all belong to the system of the *panniculus*; they are also variable in development, or at least in function. I have seen one man who could draw the whole ear forwards; other men can draw it upwards; another who could draw it backwards;[28] and from what one of these persons told me, it is probable that most of us, by often touching our ears, and thus directing our attention towards them, could recover some power of movement by repeated trials. The power of erecting and directing the shell of the ears to the various points of the compass, is no doubt of the highest service to many animals, as they thus perceive the direction of danger; but I have never heard, on sufficient evidence, of a man who possessed this power, the one which might be of use to him. The whole external shell may be considered a rudiment, together with the various folds and prominences (helix and anti-helix, tragus and anti-tragus, &c.) which in the lower animals strengthen and support the ear when

erect, without adding much to its weight. Some authors, however, suppose that the cartilage of the shell serves to transmit vibrations to the acoustic nerve; but Mr Toynbee,[29] after collecting all the known evidence on this head, concludes that the external shell is of no distinct use. The ears of the chimpanzee and orang are curiously like those of man, and the proper muscles are likewise but very slightly developed.[30] I am also assured by the keepers in the Zoological Gardens that these animals never move or erect their ears; so that they are in an equally rudimentary condition with those of man, as far as function is concerned. Why these animals, as well as the progenitors of man, should have lost the power of erecting their ears, we cannot say. It may be, though I am not satisfied with this view, that owing to their arboreal habits and great strength they were but little exposed to danger, and so during a lengthened period moved their ears but little, and thus gradually lost the power of moving them. This would be a parallel case with that of those large and heavy birds, which, from inhabiting oceanic islands, have not been exposed to the attacks of beasts of prey, and have consequently lost the power of using their wings for flight. The inability to move the ears in man and several apes is, however, partly compensated by the freedom with which they can move the head in a horizontal plane, so as to catch sounds from all directions. It has been asserted that the ear of man alone possesses a lobule; but 'a rudiment of it is found in the gorilla',[31] and, as I hear from Prof. Preyer, it is not rarely absent in the negro.

Fig. 2. Human Ear, modelled and drawn by Mr Woolner.
*a*. The projecting point.

The celebrated sculptor, Mr Woolner, informs me of one little peculiarity in the external ear, which he has often observed both in men and women, and of which he perceived the full significance. His attention was first called to the subject whilst at work on his figure of Puck, to which he had given pointed ears. He was thus led to examine the ears of various monkeys, and subsequently more carefully those of man. The peculiarity consists in a little blunt point, projecting from the inwardly folded margin, or helix. When present, it is developed at birth, and, according to Prof. Ludwig Meyer, more frequently in man than in woman. Mr Woolner made an exact model of one such case, and sent me the accompanying drawing. (Fig. 2.) These points not only project inwards towards the centre of the ear, but often a little outwards from its plane, so as to be visible when the head is viewed from directly in front or behind. They are variable in size, and somewhat in position, standing either a little higher or lower; and they sometimes occur on one ear and not on the other. They are

not confined to mankind, for I observed a case in one of the spider-monkeys (*Ateles beelzebuth*) in our Zoological Gardens; and Dr E. Ray Lankester informs me of another case in a chimpanzee in the gardens at Hamburg. The helix obviously consists of the extreme margin of the ear folded inwards; and this folding appears to be in some manner connected with the whole external ear being permanently pressed backwards. In many monkeys, which do not stand high in the order, as baboons and some species of macacus,[32] the upper portion of the ear is slightly pointed, and the margin is not at all folded inwards; but if the margin were to be thus folded, a slight point would necessarily project inwards towards the centre, and probably a little outwards from the plane of the ear; and this I believe to be their origin in many cases. On the other hand, Prof. L. Meyer, in an able paper recently published,[33] maintains that the whole case is one of mere variability; and that the projections are not real ones, but are due to the internal cartilage on each side of the points not having been fully developed. I am quite ready to admit that this is the correct explanation in many instances, as in those figured by Prof. Meyer, in which there are several minute points, or the whole margin is sinuous. I have myself seen, through the kindness of Dr L. Down, the ear of a microcephalous idiot, on which there is a projection on the outside of the helix, and not on the inward folded edge, so that this point can have no relation to a former apex of the ear. Nevertheless in some cases, my original view, that the points are vestiges of the tips of formerly erect and pointed ears, still seems to me probable. I think so from the frequency of their occurrence, and from the general correspondence in position with that of the

tip of a pointed ear. In one case, of which a photograph has been sent me, the projection is so large, that supposing, in accordance with Prof. Meyer's view, the ear to be made perfect by the equal development of the cartilage throughout the whole extent of the margin, it would have covered fully one-third of the whole ear. Two cases have been communicated to me, one in North America, and the other in England, in which the upper margin is not at all folded inwards, but is pointed, so that it closely resembles the pointed ear of an ordinary quadruped in outline. In one of these cases, which was that of a young child, the father compared the ear with the drawing which I have given[34] of the ear of a monkey, the *Cynopithecus niger*, and says that their outlines are closely similar. If, in these two cases, the margin had been folded inwards in the normal manner, an inward projection must have been formed. I may add that in two other cases the outline still remains somewhat pointed, although the margin of the upper part of the ear is normally folded inwards—in one of them, however, very narrowly. The following woodcut (Fig. 3.) is an accurate copy of a photograph of the foetus of an orang (kindly sent me by Dr Nitsche), in which it may be seen how different the pointed outline of the ear is at this period from its adult condition, when it bears a close general resemblance to that of man. It is evident that the folding over of the tip of such an ear, unless it changed greatly during its further development, would give rise to a point projecting inwards. On the whole, it still seems to me probable that the points in question are in some cases, both in man and apes, vestiges of a former condition.

hair.[38] There can be little doubt that the hairs thus scattered over the body are the rudiments of the uniform hairy coat of the lower animals. This view is rendered all the more probable, as it is known that fine, short, and pale-coloured hairs on the limbs and other parts of the body, occasionally become developed into 'thickset, long, and rather coarse dark hairs', when abnormally nourished near old-standing inflamed surfaces.[39]

I am informed by Sir James Paget that often several members of a family have a few hairs in their eyebrows much longer than the others; so that even this slight peculiarity seems to be inherited. These hairs, too, seem to have their representatives; for in the chimpanzee, and in certain species of Macacus, there are scattered hairs of considerable length rising from the naked skin above the eyes, and corresponding to our eyebrows; similar long hairs project from the hairy covering of the superciliary ridges in some baboons.

The fine wool-like hair, or so-called lanugo, with which the human foetus during the sixth month is thickly covered, offers a more curious case. It is first developed, during the fifth month, on the eyebrows, and face, and especially round the mouth, where it is much longer than that on the head. A moustache of this kind was observed by Eschricht[40] on a female foetus; but this is not so surprising a circumstance as it may at first appear, for the two sexes generally resemble each other in all external characters during an early period of growth. The direction and arrangement of the hairs on all parts of the foetal body are the same as in the adult, but are subject to much variability. The whole surface,

including even the forehead and ears, is thus thickly clothed; but it is a significant fact that the palms of the hands and the soles of the feet are quite naked, like the inferior surfaces of all four extremities in most of the lower animals. As this can hardly be an accidental coincidence, the woolly covering of the foetus probably represents the first permanent coat of hair in those mammals which are born hairy. Three or four cases have been recorded of persons born with their whole bodies and faces thickly covered with fine long hairs; and this strange condition is strongly inherited, and is correlated with an abnormal condition of the teeth.[41] Prof. Alex. Brandt informs me that he has compared the hair from the face of a man thus characterised, aged thirty-five, with the lanugo of a foetus, and finds it quite similar in texture; therefore, as he remarks, the case may be attributed to an arrest of development in the hair, together with its continued growth. Many delicate children, as I have been assured by a surgeon to a hospital for children, have their backs covered by rather long silky hairs; and such cases probably come under the same head.

It appears as if the posterior molar or wisdom-teeth were tending to become rudimentary in the more civilised races of man. These teeth are rather smaller than the other molars, as is likewise the case with the corresponding teeth in the chimpanzee and orang; and they have only two separate fangs. They do not cut through the gums till about the seventeenth year, and I have been assured that they are much more liable to decay, and are earlier lost than the other teeth; but this is denied by some eminent dentists. They are also much more liable to vary, both in structure

and in the period of their development, than the other teeth.[42] In the Melanian races, on the other hand, the wisdom-teeth are usually furnished with three separate fangs, and are generally sound; they also differ from the other molars in size, less than in the Caucasian races.[43] Prof. Schaaffhausen accounts for this difference between the races by 'the posterior dental portion of the jaw being always shortened' in those that are civilised,[44] and this shortening may, I presume, be attributed to civilised men habitually feeding on soft, cooked food, and thus using their jaws less. I am informed by Mr Brace that it is becoming quite a common practice in the United States to remove some of the molar teeth of children, as the jaw does not grow large enough for the perfect development of the normal number.[45]

With respect to the alimentary canal, I have met with an account of only a single rudiment, namely the vermiform appendage of the caecum. The caecum is a branch or diverticulum of the intestine, ending in a cul-de-sac, and is extremely long in many of the lower vegetable-feeding mammals. In the marsupial koala it is actually more than thrice as long as the whole body.[46] It is sometimes produced into a long gradually-tapering point, and is sometimes constricted in parts. It appears as if, in consequence of changed diet or habits, the caecum had become much shortened in various animals, the vermiform appendage being left as a rudiment of the shortened part. That this appendage is a rudiment, we may infer from its small size, and from the evidence which Prof. Canestrini[47] has collected of its variability in man. It is occasionally quite absent, or again is largely developed. The

passage is sometimes completely closed for half or two-thirds of its length, with the terminal part consisting of a flattened solid expansion. In the orang this appendage is long and convoluted: in man it arises from the end of the short caecum, and is commonly from four to five inches in length, being only about the third of an inch in diameter. Not only is it useless, but it is sometimes the cause of death, of which fact I have lately heard two instances: this is due to small hard bodies, such as seeds, entering the passage, and causing inflammation.[48]

In some of the lower Quadrumana, in the Lemuridae and Carnivora, as well as in many marsupials, there is a passage near the lower end of the humerus, called the supra-condyloid foramen, through which the great nerve of the fore limb and often the great artery pass. Now in the humerus of man, there is generally a trace of this passage, which is sometimes fairly well developed, being formed by a depending hook-like process of bone, completed by a band of ligament. Dr Struthers,[49] who has closely attended to the subject, has now shewn that this peculiarity is sometimes inherited, as it has occurred in a father, and in no less than four out of his seven children. When present, the great nerve invariably passes through it; and this clearly indicates that it is the homologue and rudiment of the supra-condyloid foramen of the lower animals. Prof. Turner estimates, as he informs me, that it occurs in about one per cent of recent skeletons. But if the occasional development of this structure in man is, as seems probable, due to reversion, it is a return to a very ancient state of things, because in the higher Quadrumana it is absent.

There is another foramen or perforation in the humerus, occasionally present in man, which may be called the intercondyloid. This occurs, but not constantly, in various anthropoid and other apes,[50] and likewise in many of the lower animals. It is remarkable that this perforation seems to have been present in man much more frequently during ancient times than recently. Mr Busk[51] has collected the following evidence on this head: Prof. Broca 'noticed the perforation in four and a half per cent. of the arm-bones collected in the "Cimetière du Sud", at Paris; and in the Grotto of Orrony, the contents of which are referred to the Bronze period, as many as eight humeri out of thirty-two were perforated; but this extraordinary proportion, he thinks, might be due to the cavern having been a sort of "family vault". Again, M. Dupont found thirty per cent of perforated bones in the caves of the Valley of the Lesse, belonging to the Reindeer period; whilst M. Leguay, in a sort of *dolmen* at Argenteuil, observed twenty-five per cent to be perforated; and M. Pruner-Bey found twenty-six per cent in the same condition in bones from Vauréal. Nor should it be left unnoticed that M. Pruner-Bey states that this condition is common in Guanche skeletons.' It is an interesting fact that ancient races, in this and several other cases, more frequently present structures which resemble those of the lower animals than do the modern. One chief cause seems to be that the ancient races stand somewhat nearer in the long line of descent to their remote animal-like progenitors.

In man, the os coccyx, together with certain other vertebrae hereafter to be described, though functionless as a tail, plainly

rudimentary structures belonging to the reproductive system might have been here adduced.[55]

The bearing of the three great classes of facts now given is unmistakeable. But it would be superfluous fully to recapitulate the line of argument given in detail in my 'Origin of Species'. The homological construction of the whole frame in the members of the same class is intelligible, if we admit their descent from a common progenitor, together with their subsequent adaptation to diversified conditions. On any other view, the similarity of pattern between the hand of a man or monkey, the foot of a horse, the flipper of a seal, the wing of a bat, &c., is utterly inexplicable.[56] It is no scientific explanation to assert that they have all been formed on the same ideal plan. With respect to development, we can clearly understand, on the principle of variations supervening at a rather late embryonic period, and being inherited at a corresponding period, how it is that the embryos of wonderfully different forms should still retain, more or less perfectly, the structure of their common progenitor. No other explanation has ever been given of the marvellous fact that the embryos of a man, dog, seal, bat, reptile, &c., can at first hardly be distinguished from each other. In order to understand the existence of rudimentary organs, we have only to suppose that a former progenitor possessed the parts in question in a perfect state, and that under changed habits of life they became greatly reduced, either from simple disuse, or through the natural selection of those individuals which were least encumbered with a superfluous part, aided by the other means previously indicated.

Thus we can understand how it has come to pass that man and all other vertebrate animals have been constructed on the same general model, why they pass through the same early stages of development, and why they retain certain rudiments in common. Consequently we ought frankly to admit their community of descent; to take any other view, is to admit that our own structure, and that of all the animals around us, is a mere snare laid to entrap our judgment. This conclusion is greatly strengthened, if we look to the members of the whole animal series, and consider the evidence derived from their affinities or classification, their geographical distribution and geological succession. It is only our natural prejudice, and that arrogance which made our forefathers declare that they were descended from demi-gods, which leads us to demur to this conclusion. But the time will before long come, when it will be thought wonderful that naturalists, who were well acquainted with the comparative structure and development of man, and other mammals, should have believed that each was the work of a separate act of creation.

# 3

## Hominid Evolution

Having pointed out some of the imperfections and peculiarities of our anatomy, Darwin moves to the heart of his argument: Humans evolved from an apelike ancestor, primarily by means of natural selection. Darwin may have gotten some of the details wrong, but those shortcomings do not take away from an astonishingly visionary chapter.

Darwin maps out a path by which apes that walked on all fours might have evolved into the human form. Here Darwin has in mind Wallace's arguments against natural selection in humans. Darwin did not see any insuperable barrier. A species of ape might have shifted from life in the trees to a life on the ground, and natural selection would have triggered changes throughout its entire body. The shift would also have opened the way to the use of tools and an increasing level of intelligence.

Darwin does not consider fossil evidence as he sketches out this hypothesis. When he was writing *The Descent of Man*, scientists were only beginning to discover the prehistoric record of our lineage. Spears and skeletons were being unearthed. But these prehistoric humans seemed to be no different in anatomy from

living people. If Darwin was right, fossils of more apelike ancestors must be waiting to be found. In 1864 scientists uncovered fragments from a humanlike skeleton in the Neander Valley in Germany. Neanderthal man, as the skeleton came to be known, was hard to fathom. It had a massive browridge and stout limb bones. But Thomas Huxley considered it to be within the range of variation found in living humans.

Today the fossil record of humans is far larger, although by necessity still incomplete. Neanderthals, it's now generally agreed, split off from our own lineage about five hundred thousand years ago. The split probably occurred in Africa, after which Neanderthals spread into the Near East and Europe. There they endured in and out of Ice Ages until about twenty-eight thousand years ago. Our own species, *Homo sapiens*, evolved in Africa about two hundred thousand years ago and emerged from Africa at some point around one hundred thousand years ago, arriving in Europe forty thousand years ago. The two species may have interbred to a limited extent, but the fossil record shows Neanderthals retreating, century after century, to a few refuges before disappearing altogether.

Humans and Neanderthals belong to a group of species called hominids. In other words, they both belong to the lineage that split off from other apes and eventually gave rise to us. Neanderthals represent a relatively young twig on the hominid branch. The oldest fossils of hominids date back about six million years, and scientists have found a number of other hominid fossils between then and now. While they leave many questions

easy to confuse the two.

In the early 1970s, for example, the anthropologist Barry Bogin began to study the short stature of Maya Indians in Guatemala. Some scholars called them the pygmies of Central America, since the men averaged only five feet two, the women four feet eight. The other major ethnic group in Guatemala is the Ladinos, who are of Spanish descent. Ladinos are of average height. It seemed obvious that the difference between the Mayans and the Ladinos must be genetic. But Bogin demonstrated that the difference was a matter of culture: The Maya Indians were kept in severe poverty compared to the Ladinos, and had less food and medicine. That poverty helped spark a civil war in the country, which sent a million Guatemalans to the United States. Bogin found some Mayan refugee families and began to study the growth of their children. By the year 2000 American Mayans were four inches taller than Guatemalan Mayans—and the same height as Guatemalan Ladinos. The so-called pygmies only needed a decent diet to grow much taller.

Natural selection cannot act on this sort of variation. It can only act on hereditary variations that have their origins in different genetic codes. Over the past six million years, mutations have cropped up in the genomes of our ancestors, and natural selection has favored some of them. Together, those positively selected mutations have helped to make us what we are today.

Scientists are just beginning to reconstruct the history of natural selection in our ancestors. To begin with, they must first

pinpoint the parts of our DNA that were altered. One way to do this is to scan the human genome for genes, then search for their counterparts in other species. The versions of a gene found in humans, chimpanzees, and mice all descend from an ancestral gene that was carried by a tiny mammal that lived one hundred million years ago. In some cases, the gene has not changed significantly in all that time and is nearly identical in us and other mammals. In other words, they encode an identical protein. In the past, animals must have regularly acquired mutations to that gene, but natural selection weeded out the mutations that caused harmful changes to the protein.

In some cases, however, humans have a version of a gene that encodes a protein with a different structure. By statistically comparing these differences, scientists have pinpointed specific genes that have experienced significant natural selection in the time since our ancestors branched off from other apes. They identified hundreds of such genes. Now the challenge is to figure out what those genes do in humans, as opposed to other animals. In many cases, the genes do not have much to do with what we like to think of as our unique human nature. Some provide resistance to malaria and other diseases. These genes have undergone drastic remodeling because the genes of pathogens can evolve as well, trapping us in a host-parasite arms race. A few genes, however, offer some intriguing hints. Some of them, for example, are known to be expressed in neurons in the human brain. But simply pinpointing where a gene is active in the body is a tiny step toward finding out what it actually does in the human body.

CHAPTER 2:

# *On the Manner of Development of Man from some Lower Form*

IT IS MANIFEST that man is now subject to much variability. No two individuals of the same race are quite alike. We may compare millions of faces, and each will be distinct. There is an equally great amount of diversity in the proportions and dimensions of the various parts of the body; the length of the legs being one of the most variable points.[1] Although in some quarters of the world an elongated skull, and in other quarters a short skull prevails, yet there is great diversity of shape even within the limits of the same race, as with the aborigines of America and South Australia—the latter a race 'probably as pure and homogeneous in blood, customs, and language as any in existence'—and even with the inhabitants of so confined an area as the Sandwich Islands.[2] An eminent dentist assures me that there is nearly as much diversity in the teeth as in the features. The chief arteries so frequently run in abnormal courses, that it has been found useful for surgical purposes to calculate from 1040 corpses how often each course prevails.[3] The muscles are eminently variable: thus those of the foot were found by Prof. Turner[4] not to be strictly alike in any two out of fifty bodies; and in some the deviations were considerable. He adds, that the power of performing the appropriate movements must have been modified in accordance with the several deviations. Mr J. Wood has recorded[5] the occurrence of 295

muscular variations in thirty-six subjects, and in another set of the same number no less than 558 variations, those occurring on both sides of the body being only reckoned as one. In the last set, not one body out of the thirty-six was 'found totally wanting in departures from the standard descriptions of the muscular system given in anatomical text books'. A single body presented the extraordinary number of twenty-five distinct abnormalities. The same muscle sometimes varies in many ways; thus Prof. Macalister describes[6] no less than twenty distinct variations in the *palmaris accessorius*.

The famous old anatomist, Wolff,[7] insists that the internal viscera are more variable than the external parts: *Nulla particula est quae non aliter et aliter in aliis se habeat hominibus*. [There is no part whose condition does not differ in different men.] He has even written a treatise on the choice of typical examples of the viscera for representation. A discussion on the beau-ideal of the liver, lungs, kidneys, &c., as of the human face divine, sounds strange in our ears.

The variability or diversity of the mental faculties in men of the same race, not to mention the greater differences between the men of distinct races, is so notorious that not a word need here be said. So it is with the lower animals. All who have had charge of menageries admit this fact, and we see it plainly in our dogs and other domestic animals. Brehm especially insists that each individual monkey of those which he kept tame in Africa had its own peculiar disposition and temper: he mentions one baboon remarkable for its high intelligence; and the keepers in the

If we consider all the races of man as forming a single species, his range is enormous; but some separate races, as the Americans and Polynesians, have very wide ranges. It is a well-known law that widely-ranging species are much more variable than species with restricted ranges; and the variability of man may with more truth be compared with that of widely-ranging species, than with that of domesticated animals.

Not only does variability appear to be induced in man and the lower animals by the same general causes, but in both the same parts of the body are affected in a closely analogous manner. This, has been proved in such full detail by Godron and Quatrefages, that I need here only refer to their works.[14] Monstrosities, which graduate into slight variations, are likewise so similar in man and the lower animals, that the same classification and the same terms can be used for both, as has been shewn by Isidore Geoffroy St-Hilaire.[15] In my work on the variation of domestic animals, I have attempted to arrange in a rude fashion the laws of variation under the following heads:—The direct and definite action of changed conditions, as exhibited by all or nearly all the individuals of the same species, varying in the same manner under the same circumstances. The effects of the long-continued use or disuse of parts. The cohesion of homologous parts. The variability of multiple parts. Compensation of growth; but of this law I have found no good instance in the case of man. The effects of the mechanical pressure of one part on another; as of the pelvis on the cranium of the infant in the womb. Arrests of development, leading to the diminution or suppression of parts. The

reappearance of long-lost characters through reversion. And lastly, correlated variation. All these so-called laws apply equally to man and the lower animals; and most of them even to plants. It would be superfluous here to discuss all of them;[16] but several are so important, that they must be treated at considerable length.

*The direct and definite action of changed conditions*—This is a most perplexing subject. It cannot be denied that changed conditions produce some, and occasionally a considerable effect, on organisms of all kinds; and it seems at first probable that if sufficient time were allowed this would be the invariable result. But I have failed to obtain clear evidence in favour of this conclusion; and valid reasons may be urged on the other side, at least as far as the innumerable structures are concerned, which are adapted for special ends. There can, however, be no doubt that changed conditions induce an almost indefinite amount of fluctuating variability, by which the whole organisation is rendered in some degree plastic.

In the United States, above 1,000,000 soldiers, who served in the late war, were measured, and the States in which they were born and reared were recorded.[17] From this astonishing number of observations it is proved that local influences of some kind act directly on stature; and we further learn that 'the State where the physical growth has in great measure taken place, and the State of birth, which indicates the ancestry, seem to exert a marked influence on the stature'. For instance, it is established, 'that residence in the Western States, during the years of growth, tends

to produce increase of stature'. On the other hand, it is certain that with sailors, their life delays growth, as shewn 'by the great difference between the statures of soldiers and sailors at the ages of seventeen and eighteen years'. Mr B. A. Gould endeavoured to ascertain the nature of the influences which thus act on stature; but he arrived only at negative results, namely, that they did not relate to climate, the elevation of the land, soil, nor even 'in any controlling degree' to the abundance or the need of the comforts of life. This latter conclusion is directly opposed to that arrived at by Villermé, from the statistics of the height of the conscripts in different parts of France. When we compare the differences in stature between the Polynesian chiefs and the lower orders within the same islands, or between the inhabitants of the fertile volcanic and low barren coral islands of the same ocean,[18] or again between the Fuegians on the eastern and western shores of their country, where the means of subsistence are very different, it is scarcely possible to avoid the conclusion that better food and greater comfort do influence stature. But the preceding statements shew how difficult it is to arrive at any precise result. Dr Beddoe has lately proved that, with the inhabitants of Britain, residence in towns and certain occupations have a deteriorating influence on height; and he infers that the result is to a certain extent inherited, as is likewise the case in the United States. Dr Beddoe further believes that wherever a 'race attains its maximum of physical development, it rises highest in energy and moral vigour'.[19]

Whether external conditions produce any other direct effect on

man is not known. It might have been expected that differences of climate would have had a marked influence, in as much as the lungs and kidneys are brought into activity under a low temperature, and the liver and skin under a high one.[20] It was formerly thought that the colour of the skin and the character of the hair were determined by light or heat; and although it can hardly be denied that some effect is thus produced, almost all observers now agree that the effect has been very small, even after exposure during many ages. But this subject will be more properly discussed when we treat of the different races of mankind. With our domestic animals there are grounds for believing that cold and damp directly affect the growth of the hair; but I have not met with any evidence on this head in the case of man.

*Effects of the increased Use and Disuse of Parts*—It is well known that use strengthens the muscles in the individual, and complete disuse, or the destruction of the proper nerve, weakens them. When the eye is destroyed, the optic nerve often becomes atrophied. When an artery is tied, the lateral channels increase not only in diameter, but in the thickness and strength of their coats. When one kidney ceases to act from disease, the other increases in size, and does double work. Bones increase not only in thickness, but in length, from carrying a greater weight.[21] Different occupations, habitually followed, lead to changed proportions in various parts of the body. Thus it was ascertained by the United States Commission[22] that the legs of the sailors employed in the late war were longer by 0.217 of an inch than those of the soldiers, though the sailors were on an average shorter men; whilst their

arms were shorter by 1.09 of an inch, and therefore, out of proportion, shorter in relation to their lesser height. This shortness of the arms is apparently due to their greater use, and is an unexpected result: but sailors chiefly use their arms in pulling, and not in supporting weights. With sailors, the girth of the neck and the depth of the instep are greater, whilst the circumference of the chest, waist, and hips is less, than in soldiers.

Whether the several foregoing modifications would become hereditary, if the same habits of life were followed during many generations, is not known, but it is probable. Rengger[23] attributes the thin legs and thick arms of the Payaguas Indians to successive generations having passed nearly their whole lives in canoes, with their lower extremities motionless. Other writers have come to a similar conclusion in analogous cases. According to Cranz,[24] who lived for a long time with the Esquimaux, 'the natives believe that ingenuity and dexterity in seal-catching (their highest art and virtue) is hereditary; there is really something in it, for the son of a celebrated seal-catcher will distinguish himself, though he lost his father in childhood'. But in this case it is mental aptitude, quite as much as bodily structure, which appears to be inherited. It is asserted that the hands of English labourers are at birth larger than those of the gentry.[25] From the correlation which exists, at least in some cases,[26] between the development of the extremities and of the jaws, it is possible that in those classes which do not labour much with their hands and feet, the jaws would be reduced in size from this cause. That they are generally smaller in refined and civilised men than in hard-working men or savages, is certain.

*Reversion*—Many of the cases to be here given, might have been introduced under the last heading. When a structure is arrested in its development, but still continues growing, until it closely resembles a corresponding structure in some lower and adult member of the same group, it may in one sense be considered as a case of reversion. The lower members in a group give us some idea how the common progenitor was probably constructed; and it is hardly credible that a complex part, arrested at an early phase of embryonic development, should go on growing so as ultimately to perform its proper function, unless it had acquired such power during some earlier state of existence, when the present exceptional or arrested structure was normal. The simple brain of a microcephalous idiot, in as far as it resembles that of an ape, may in this sense be said to offer a case of reversion.[38] There are other cases which come more strictly under our present head of reversion. Certain structures, regularly occurring in the lower members of the group to which man belongs, occasionally make their appearance in him, though not found in the normal human embryo; or, if normally present in the human embryo, they become abnormally developed, although in a manner which is normal in the lower members of the group. These remarks will be rendered clearer by the following illustrations.

In various mammals the uterus graduates from a double organ with two distinct orifices and two passages, as in the marsupials, into a single organ, which is in no way double except from having a slight internal fold, as in the higher apes and man. The rodents exhibit a perfect series of gradations between these two extreme

states. In all mammals the uterus is developed from two simple primitive tubes, the inferior portions of which form the cornua; and it is in the words of Dr Farre, 'by the coalescence of the two cornua at their lower extremities that the body of the uterus is formed in man; while in those animals in which no middle portion or body exists, the cornua remain ununited. As the development of the uterus proceeds, the two cornua become gradually shorter, until at length they are lost, or, as it were, absorbed into the body of the uterus.' The angles of the uterus are still produced into cornua, even in animals as high up in the scale as the lower apes and lemurs.

Now in women, anomalous cases are not very infrequent, in which the mature uterus is furnished with cornua, or is partially divided into two organs; and such cases, according to Owen, repeat 'the grade of concentrative development', attained by certain rodents. Here perhaps we have an instance of a simple arrest of embryonic development, with subsequent growth and perfect functional development; for either side of the partially double uterus is capable of performing the proper office of gestation. In other and rarer cases, two distinct uterine cavities are formed, each having its proper orifice and passage.[39] No such stage is passed through during the ordinary development of the embryo; and it is difficult to believe, though perhaps not impossible, that the two simple, minute, primitive tubes should know how (if such an expression may be used) to grow into two distinct uteri, each with a well-constructed orifice and passage, and each furnished with numerous muscles, nerves, glands and vessels, if they had not

formerly passed through a similar course of development, as in the case of existing marsupials. No one will pretend that so perfect a structure as the abnormal double uterus in woman could be the result of mere chance. But the principle of reversion, by which a long-lost structure is called back into existence, might serve as the guide for its full development, even after the lapse of an enormous interval of time.

Professor Canestrini, after discussing the foregoing and various analogous cases, arrives at the same conclusion as that just given. He adduces another instance, in the case of the malar bone,[40] which, in some of the Quadrumana and other mammals, normally consists of two portions. This is its condition in the human foetus when two months old; and through arrested development, it sometimes remains thus in man when adult, more especially in the lower prognathous races. Hence Canestrini concludes that some ancient progenitor of man must have had this bone normally divided into two portions, which afterwards became fused together. In man the frontal bone consists of a single piece, but in the embryo, and in children, and in almost all the lower mammals, it consists of two pieces separated by a distinct suture. This suture occasionally persists more or less distinctly in man after maturity; and more frequently in ancient than in recent crania, especially, as Canestrini has observed, in those exhumed from the Drift, and belonging to the brachycephalic type. Here again he comes to the same conclusion as in the analogous case of the malar bones. In this, and other instances presently to be given, the cause of ancient races approaching the lower animals in certain characters

more frequently than do the modern races, appears to be, that the latter stand at a somewhat greater distance in the long line of descent from their early semi-human progenitors.

Various other anomalies in man, more or less analogous to the foregoing, have been advanced by different authors, as cases of reversion; but these seem not a little doubtful, for we have to descend extremely low in the mammalian series, before we find such structures normally present.[41]

In man, the canine teeth are perfectly efficient instruments for mastication. But their true canine character, as Owen[42] remarks, 'is indicated by the conical form of the crown, which terminates in an obtuse point, is convex outward and flat or sub-concave within, at the base of which surface there is a feeble prominence. The conical form is best expressed in the Melanian races, especially the Australian. The canine is more deeply implanted, and by a stronger fang than the incisors.' Nevertheless, this tooth no longer serves man as a special weapon for tearing his enemies or prey; it may, therefore, as far as its proper function is concerned, be considered as rudimentary. In every large collection of human skulls some may be found, as Häckel[43] observes, with the canine teeth projecting considerably beyond the others in the same manner as in the anthropomorphous apes, but in a less degree. In these cases, open spaces between the teeth in the one jaw are left for the reception of the canines of the opposite jaw. An interspace of this kind in a Kaffir skull, figured by Wagner, is surprisingly wide.[44] Considering how few are the ancient skulls which have been examined, compared to recent skulls, it is an interesting fact that

in at least three cases the canines project largely; and in the Naulette jaw they are spoken of as enormous.[45]

Of the anthropomorphous apes the males alone have their canines fully developed; but in the female gorilla, and in a less degree in the female orang, these teeth project considerably beyond the others; therefore the fact, of which I have been assured, that women sometimes have considerably projecting canines, is no serious objection to the belief that their occasional great development in man is a case of reversion to an ape-like progenitor. He who rejects with scorn the belief that the shape of his own canines, and their occasional great development in other men, are due to our early forefathers having been provided with these formidable weapons, will probably reveal, by sneering, the line of his descent. For though he no longer intends, nor has the power, to use these teeth as weapons, he will unconsciously retract his 'snarling muscles' (thus named by Sir C. Bell),[46] so as to expose them ready for action, like a dog prepared to fight.

Many muscles are occasionally developed in man, which are proper to the Quadrumana or other mammals. Professor Vlacovich[47] examined forty male subjects, and found a muscle, called by him the ischio-pubic, in nineteen of them; in three others there was a ligament which represented this muscle; and in the remaining eighteen no trace of it. In only two out of thirty female subjects was this muscle developed on both sides, but in three others the rudimentary ligament was present. This muscle, therefore, appears to be much more common in the male than in the female sex; and on the belief in the descent of man from some

rudimentary in man, as the os coccyx in both sexes, and the mammae in the male sex, are always present; whilst others, such as the supracondyloid foramen, only occasionally appear, and therefore might have been introduced under the head of reversion. These several reversionary structures, as well as the strictly rudimentary ones, reveal the descent of man from some lower form in an unmistakable manner.

*Correlated Variation*—In man, as in the lower animals, many structures are so intimately related, that when one part varies so does another, without our being able, in most cases, to assign any reason. We cannot say whether the one part governs the other, or whether both are governed by some earlier developed part. Various monstrosities, as I. Geoffroy repeatedly insists, are thus intimately connected. Homologous structures are particularly liable to change together, as we see on the opposite sides of the body, and in the upper and lower extremities. Meckel long ago remarked, that when the muscles of the arm depart from their proper type, they almost always imitate those of the leg; and so, conversely, with the muscles of the legs. The organs of sight and hearing, the teeth and hair, the colour of the skin and of the hair, colour and constitution, are more or less correlated.[55] Professor Schaaffhausen first drew attention to the relation apparently existing between a muscular frame and the strongly-pronounced supra-orbital ridges, which are so characteristic of the lower races of man.

Besides the variations which can be grouped with more or less

civilised people, they would no doubt rapidly increase if their numbers were not by some means rigidly kept down. The Santali, or hill-tribes of India, have recently afforded a good illustration of this fact; for, as shewn by Mr Hunter,[50] they have increased at an extraordinary rate since vaccination has been introduced, other pestilences mitigated, and war sternly repressed. This increase, however, would not have been possible had not these rude people spread into the adjoining districts, and worked for hire. Savages almost always marry; yet there is some prudential restraint, for they do not commonly marry at the earliest possible age. The young men are often required to shew that they can support a wife; and they generally have first to earn the price with which to purchase her from her parents. With savages the difficulty of obtaining subsistence occasionally limits their number in a much more direct manner than with civilised people, for all tribes periodically suffer from severe famines. At such times savages are forced to devour much bad food, and their health can hardly fail to be injured. Many accounts have been published of their protruding stomachs and emaciated limbs after and during famines. They are then, also, compelled to wander much, and, as I was assured in Australia, their infants perish in large numbers. As famines are periodical, depending chiefly on extreme seasons, all tribes must fluctuate in number. They cannot steadily and regularly increase, as there is no artificial increase in the supply of food. Savages, when hard pressed, encroach on each other's territories, and war is the result; but they are indeed almost always at war with their neighbours. They are liable to many accidents on land and water in their search for food; and in some countries they suffer much from

savages. What the precise nature of these checks were, we cannot say, any more than with most other animals. We know that horses and cattle, which are not extremely prolific animals, when first turned loose in South America, increased at an enormous rate. The elephant, the slowest breeder of all known animals, would in a few thousand years stock the whole world. The increase of every species of monkey must be checked by some means; but not, as Brehm remarks, by the attacks of beasts of prey. No one will assume that the actual power of reproduction in the wild horses and cattle of America, was at first in any sensible degree increased; or that, as each district became fully stocked, this same power was diminished. No doubt in this case, and in all others, many checks concur, and different checks under different circumstances; periodical dearths, depending on unfavourable seasons, being probably the most important of all. So it will have been with the early progenitors of man.

*Natural Selection*—We have now seen that man is variable in body and mind; and that the variations are induced, either directly or indirectly, by the same general causes, and obey the same general laws, as with the lower animals. Man has spread widely over the face of the earth, and must have been exposed, during his incessant migrations,[63] to the most diversified conditions. The inhabitants of Tierra del Fuego, the Cape of Good Hope, and Tasmania in the one hemisphere, and of the Arctic regions in the other, must have passed through many climates, and changed their habits many times, before they reached their present homes.[64] The early progenitors of man must also have tended, like

Chauncey Wright remarks:[66] 'a psychological analysis of the faculty of language shews, that even the smallest proficiency in it might require more brain power than the greatest proficiency in any other direction.' He has invented and is able to use various weapons, tools, traps, &c., with which he defends himself, kills or catches prey, and otherwise obtains food. He has made rafts or canoes for fishing or crossing over to neighbouring fertile islands. He has discovered the art of making fire, by which hard and stringy roots can be rendered digestible, and poisonous roots or herbs innocuous. This discovery of fire, probably the greatest ever made by man, excepting language, dates from before the dawn of history. These several inventions, by which man in the rudest state has become so pre-eminent, are the direct results of the development of his powers of observation, memory, curiosity, imagination, and reason. I cannot, therefore, understand how it is that Mr Wallace[67] maintains, that 'natural selection could only have endowed the savage with a brain a little superior to that of an ape'.

Although the intellectual powers and social habits of man are of paramount importance to him, we must not underrate the importance of his bodily structure, to which subject the remainder of this chapter will be devoted; the development of the intellectual and social or moral faculties being discussed in a later chapter.

Even to hammer with precision is no easy matter, as every one who has tried to learn carpentry will admit. To throw a stone with as true an aim as a Fuegian in defending himself, or in killing birds, requires the most consummate perfection in the correlated action


image
not
available

them, provided that they were not thus rendered less fitted for climbing trees. We may suspect that a hand as perfect as that of man would have been disadvantageous for climbing; for the most arboreal monkeys in the world, namely, Ateles in America, Colobus in Africa, and Hylobates in Asia, are either thumbless, or their toes partially cohere, so that their limbs are converted into mere grasping hooks.[71]

As soon as some ancient member in the great series of the Primates came to be less arboreal, owing to a change in its manner of procuring subsistence, or to some change in the surrounding conditions, its habitual manner of progression would have been modified: and thus it would have been rendered more strictly quadrupedal or bipedal. Baboons frequent hilly and rocky districts, and only from necessity climb high trees;[72] and they have acquired almost the gait of a dog. Man alone has become a biped; and we can, I think, partly see how he has come to assume his erect attitude, which forms one of his most conspicuous characters. Man could not have attained his present dominant position in the world without the use of his hands, which are so admirably adapted to act in obedience to his will. Sir C. Bell[73] insists that 'the hand supplies all instruments, and by its correspondence with the intellect gives him universal dominion'. But the hands and arms could hardly have become perfect enough to have manufactured weapons, or to have hurled stones and spears with a true aim, as long as they were habitually used for locomotion and for supporting the whole weight of the body, or, as before remarked, so long as they were especially fitted for climbing trees. Such

rough treatment would also have blunted the sense of touch, on which their delicate use largely depends. From these causes alone it would have been an advantage to man to become a biped; but for many actions it is indispensable that the arms and whole upper part of the body should be free; and he must for this end stand firmly on his feet. To gain this great advantage, the feet have been rendered flat; and the great toe has been peculiarly modified, though this has entailed the almost complete loss of its power of prehension. It accords with the principle of the division of physiological labour, prevailing throughout the animal kingdom, that as the hands became perfected for prehension, the feet should have become perfected for support and locomotion. With some savages, however, the foot has not altogether lost its prehensile power, as shewn by their manner of climbing trees, and of using them in other ways.[74]

If it be an advantage to man to stand firmly on his feet and to have his hands and arms free, of which, from his pre-eminent success in the battle of life, there can be no doubt, then I can see no reason why it should not have been advantageous to the progenitors of man to have become more and more erect or bipedal. They would thus have been better able to defend themselves with stones or clubs, to attack their prey, or otherwise to obtain food. The best built individuals would in the long run have succeeded best, and have survived in larger numbers. If the gorilla and a few allied forms had become extinct, it might have been argued, with great force and apparent truth, that an animal could not have been gradually converted from a quadruped into a

biped, as all the individuals in an intermediate condition would have been miserably ill-fitted for progression. But we know (and this is well worthy of reflection) that the anthropomorphous apes are now actually in an intermediate condition; and no one doubts that they are on the whole well adapted for their conditions of life. Thus the gorilla runs with a sidelong shambling gait, but more commonly progresses by resting on its bent hands. The long-armed apes occasionally use their arms like crutches, swinging their bodies forward between them, and some kinds of Hylobates, without having been taught, can walk or run upright with tolerable quickness; yet they move awkwardly, and much less securely than man. We see, in short, in existing monkeys a manner of progression intermediate between that of a quadruped and a biped; but, as an unprejudiced judge[75] insists, the anthropomorphous apes approach in structure more nearly to the bipedal than to the quadrupedal type.

As the progenitors of man became more and more erect, with their hands and arms more and more modified for prehension and other purposes, with their feet and legs at the same time transformed for firm support and progression, endless other changes of structure would have become necessary. The pelvis would have to be broadened, the spine peculiarly curved, and the head fixed in an altered position, all which changes have been attained by man. Prof. Schaaffhausen[76] maintains that 'the powerful mastoid processes of the human skull are the result of his erect position', and these processes are absent in the orang, chimpanzee, &c., and are smaller in the gorilla than in man.

The belief that there exists in man some close relation between the size of the brain and the development of the intellectual faculties is supported by the comparison of the skulls of savage and civilised races, of ancient and modern people, and by the analogy of the whole vertebrate series. Dr J. Barnard Davis has proved,[79] by many careful measurements, that the mean internal capacity of the skull in Europeans is 92.3 cubic inches; in Americans 87.5; in Asiatics 87.1; and in Australians only 81.9 cubic inches. Professor Broca[80] found that the nineteenth century skulls from graves in Paris were larger than those from vaults of the twelfth century, in the proportion of 1484 to 1426; and that the increased size, as ascertained by measurements, was exclusively in the frontal part of the skull—the seat of the intellectual faculties. Prichard is persuaded that the present inhabitants of Britain have 'much more capacious brain-cases' than the ancient inhabitants. Nevertheless, it must be admitted that some skulls of very high antiquity, such as the famous one of Neanderthal, are well developed and capacious.[81] With respect to the lower animals, M. E. Lartet,[82] by comparing the crania of tertiary and recent mammals belonging to the same groups, has come to the remarkable conclusion that the brain is generally larger and the convolutions are more complex in the more recent forms. On the other hand, I have shewn[83] that the brains of domestic rabbits are considerably reduced in bulk, in comparison with those of the wild rabbit or hare; and this may be attributed to their having been closely confined during many generations, so that they have exerted their intellect, instincts, senses and voluntary movements but little.

The gradually increasing weight of the brain and skull in man must have influenced the development of the supporting spinal column, more especially whilst he was becoming erect. As this change of position was being brought about, the internal pressure of the brain will also have influenced the form of the skull; for many facts show how easily the skull is thus affected. Ethnologists believe that it is modified by the kind of cradle in which infants sleep. Habitual spasms of the muscles, and a cicatrix from a severe burn, have permanently modified the facial bones. In young persons whose heads have become fixed either sideways or backwards, owing to disease, one of the two eyes has changed its position, and the shape of the skull has been altered apparently by the pressure of the brain in a new direction.[84] I have shewn that with long-eared rabbits even so trifling a cause as the lopping forward of one ear drags forward almost every bone of the skull on that side; so that the bones on the opposite side no longer strictly correspond. Lastly, if any animal were to increase or diminish much in general size, without any change in its mental powers, or if the mental powers were to be much increased or diminished, without any great change in the size of the body, the shape of the skull would almost certainly be altered. I infer this from my observations on domestic rabbits, some kinds of which have become very much larger than the wild animal, whilst others have retained nearly the same size, but in both cases the brain has been much reduced relatively to the size of the body. Now I was at first much surprised on finding that in all these rabbits the skull had become elongated or dolichocephalic; for instance, of two skulls of nearly equal breadth, the one from a wild rabbit and the other

that man became divested of hair from having aboriginally inhabited some tropical land? That the hair is chiefly retained in the male sex on the chest and face, and in both sexes at the junction of all four limbs with the trunk, favours this inference—on the assumption that the hair was lost before man became erect; for the parts which now retain most hair would then have been most protected from the heat of the sun. The crown of the head, however, offers a curious exception, for at all times it must have been one of the most exposed parts, yet it is thickly clothed with hair. The fact, however, that the other members of the order of Primates, to which man belongs, although inhabiting various hot regions, are well clothed with hair, generally thickest on the upper surface,[88] is opposed to the supposition that man became naked through the action of the sun. Mr Belt believes[89] that within the tropics it is an advantage to man to be destitute of hair, as he is thus enabled to free himself of the multitude of ticks (acari) and other parasites, with which he is often infested, and which sometimes cause ulceration. But whether this evil is of sufficient magnitude to have led to the denudation of his body through natural selection, may be doubted, since none of the many quadrupeds inhabiting the tropics have, as far as I know, acquired any specialised means of relief. The view which seems to me the most probable is that man, or rather primarily woman, became divested of hair for ornamental purposes, as we shall see under Sexual Selection; and, according to this belief, it is not surprising that man should differ so greatly in hairiness from all other Primates, for characters, gained through sexual selection, often differ to an extraordinary degree in closely-related forms.

According to a popular impression, the absence of a tail is eminently distinctive of man; but as those apes which come nearest to him are destitute of this organ, its disappearance does not relate exclusively to man. The tail often differs remarkably in length within the same genus: thus in some species of Macacus it is longer than the whole body, and is formed of twenty-four vertebrae; in others it consists of a scarcely visible stump, containing only three or four vertebrae. In some kinds of baboons there are twenty-five, whilst in the mandrill there are ten very small stunted caudal vertebrae, or, according to Cuvier,[90] sometimes only five. The tail, whether it be long or short, almost always tapers towards the end; and this, I presume, results from the atrophy of the terminal muscles, together with their arteries and nerves, through disuse, leading to the atrophy of the terminal bones. But no explanation can at present be given of the great diversity which often occurs in its length. Here, however, we are more specially concerned with the complete external disappearance of the tail. Professor Broca has recently shewn[91] that the tail in all quadrupeds consists of two portions, generally separated abruptly from each other; the basal portion consists of vertebrae, more or less perfectly channelled and furnished with apophyses like ordinary vertebrae; whereas those of the terminal portion are not channelled, are almost smooth, and scarcely resemble true vertebrae. A tail, though not externally visible, is really present in man and the anthropomorphous apes, and is constructed on exactly the same pattern in both. In the terminal portion the vertebrae, constituting the *os coccyx*, are quite rudimentary, being much reduced in size and number. In the basal

portion, the vertebrae are likewise few, are united firmly together, and are arrested in development; but they have been rendered much broader and flatter than the corresponding vertebrae in the tails of other animals: they constitute what Broca calls the accessory sacral vertebrae. These are of functional importance by supporting certain internal parts and in other ways; and their modification is directly connected with the erect or semi-erect attitude of man and the anthropomorphous apes. This conclusion is the more trustworthy, as Broca formerly held a different view, which he has now abandoned. The modification, therefore, of the basal caudal vertebrae in man and the higher apes may have been effected, directly or indirectly, through natural selection.

But what are we to say about the rudimentary and variable vertebrae of the terminal portion of the tail, forming the *os coccyx*? A notion which has often been, and will no doubt again be ridiculed, namely, that friction has had something to do with the disappearance of the external portion of the tail, is not so ridiculous as it at first appears. Dr Anderson[92] states that the extremely short tail of *Macacus brunneus* is formed of eleven vertebrae, including the imbedded basal ones. The extremity is tendinous and contains no vertebrae; this is succeeded by five rudimentary ones, so minute that together they are only one line and a half in length, and these are permanently bent to one side in the shape of a hook. The free part of the tail, only a little above an inch in length, includes only four more small vertebrae. This short tail is carried erect; but about a quarter of its total length is doubled on to itself to the left; and this terminal part, which

progenitors, probably lived in society. With strictly social animals, natural selection sometimes acts on the individual, through the preservation of variations which are beneficial to the community. A community which includes a large number of well-endowed individuals increases in number, and is victorious over other less favoured ones; even although each separate member gains no advantage over the others of the same community. Associated insects have thus acquired many remarkable structures, which are of little or no service to the individual, such as the pollen-collecting apparatus, or the sting of the worker-bee, or the great jaws of soldier-ants. With the higher social animals, I am not aware that any structure has been modified solely for the good of the community, though some are of secondary service to it. For instance, the horns of ruminants and the great canine teeth of baboons appear to have been acquired by the males as weapons for sexual strife, but they are used in defence of the herd or troop. In regard to certain mental powers the case, as we shall see in the fifth chapter, is wholly different; for these faculties have been chiefly, or even exclusively, gained for the benefit of the community, and the individuals thereof, have at the same time gained an advantage indirectly.

It has often been objected to such views as the foregoing, that man is one of the most helpless and defenceless creatures in the world; and that during his early and less well-developed condition he would have been still more helpless. The Duke of Argyll, for instance, insists[96] that 'the human frame has diverged from the structure of brutes, in the direction of greater physical

is a much wider interval in mental power between one of the lowest fishes, as a lamprey or lancelet, and one of the higher apes, than between an ape and man; yet this interval is filled up by numberless gradations.

Nor is the difference slight in moral disposition between a barbarian, such as the man described by the old navigator Byron, who dashed his child on the rocks for dropping a basket of seaurchins, and a Howard or Clarkson; and in intellect, between a savage who uses hardly any abstract terms, and a Newton or Shakespeare. Differences of this kind between the highest men of the highest races and the lowest savages, are connected by the finest gradations. Therefore it is possible that they might pass and be developed into each other.

My object in this chapter is to shew that there is no fundamental difference between man and the higher mammals in their mental faculties. Each division of the subject might have been extended into a separate essay, but must here be treated briefly. As no classification of the mental powers has been universally accepted, I shall arrange my remarks in the order most convenient for my purpose; and will select those facts which have struck me most, with the hope that they may produce some effect on the reader.

With respect to animals very low in the scale, I shall give some additional facts under Sexual Selection, shewing that their mental powers are much higher than might have been expected. The variability of the faculties in the individuals of the same species is

converted into instincts and are inherited, as when birds on oceanic islands learn to avoid man. These actions may then be said to be degraded in character, for they are no longer performed through reason or from experience. But the greater number of the more complex instincts appear to have been gained in a wholly different manner, through the natural selection of variations of simpler instinctive actions. Such variations appear to arise from the same unknown causes acting on the cerebral organisation, which induce slight variations or individual differences in other parts of the body; and these variations, owing to our ignorance, are often said to arise spontaneously. We can, I think, come to no other conclusion with respect to the origin of the more complex instincts, when we reflect on the marvellous instincts of sterile worker-ants and bees, which leave no offspring to inherit the effects of experience and of modified habits.

Although, as we learn from the above-mentioned insects and the beaver, a high degree of intelligence is certainly compatible with complex instincts, and although actions, at first learnt voluntarily can soon through habit be performed with the quickness and certainty of a reflex action, yet it is not improbable that there is a certain amount of interference between the development of free intelligence and of instinct—which latter implies some inherited modification of the brain. Little is known about the functions of the brain, but we can perceive that as the intellectual powers become highly developed, the various parts of the brain must be connected by very intricate channels of the freest intercommunication; and as a consequence, each separate

part would perhaps tend to be less well fitted to answer to particular sensations or associations in a definite and inherited—that is instinctive—manner. There seems even to exist some relation between a low degree of intelligence and a strong tendency to the formation of fixed, though not inherited habits; for as a sagacious physician remarked to me, persons who are slightly imbecile tend to act in everything by routine or habit; and they are rendered much happier if this is encouraged.

I have thought this digression worth giving, because we may easily underrate the mental powers of the higher animals, and especially of man, when we compare their actions founded on the memory of past events, on foresight, reason, and imagination, with exactly similar actions instinctively performed by the lower animals; in this latter case the capacity of performing such actions has been gained, step by step, through the variability of the mental organs and natural selection, without any conscious intelligence on the part of the animal during each successive generation. No doubt, as Mr Wallace has argued,[5] much of the intelligent work done by man is due to imitation and not to reason; but there is this great difference between his actions and many of those performed by the lower animals, namely, that man cannot, on his first trial, make, for instance, a stone hatchet or a canoe, through his power of imitation. He has to learn his work by practice; a beaver, on the other hand, can make its dam or canal, and a bird its nest, as well, or nearly as well, and a spider its wonderful web, quite as well,[6] the first time it tries, as when old and experienced.

To return to our immediate subject: the lower animals, like

man, manifestly feel pleasure and pain, happiness and misery. Happiness is never better exhibited than by young animals, such as puppies, kittens, lambs, &c., when playing together, like our own children. Even insects play together, as has been described by that excellent observer, P. Huber,[7] who saw ants chasing and pretending to bite each other, like so many puppies.

The fact that the lower animals are excited by the same emotions as ourselves is so well established, that it will not be necessary to weary the reader by many details. Terror acts in the same manner on them as on us, causing the muscles to tremble, the heart to palpitate, the sphincters to be relaxed, and the hair to stand on end. Suspicion, the offspring of fear, is eminently characteristic of most wild animals. It is, I think, impossible to read the account given by Sir E. Tennent, of the behaviour of the female elephants, used as decoys, without admitting that they intentionally practise deceit, and well know what they are about. Courage and timidity are extremely variable qualities in the individuals of the same species, as is plainly seen in our dogs. Some dogs and horses are ill-tempered, and easily turn sulky; others are good-tempered; and these qualities are certainly inherited. Every one knows how liable animals are to furious rage, and how plainly they show it. Many, and probably true, anecdotes have been published on the long-delayed and artful revenge of various animals. The accurate Rengger, and Brehm[8] state that the American and African monkeys which they kept tame, certainly revenged themselves. Sir Andrew Smith, a zoologist whose scrupulous accuracy was known to many persons, told me the

dispute that animals possess some power of reasoning. Animals may constantly be seen to pause, deliberate, and resolve. It is a significant fact, that the more the habits of any particular animal are studied by a naturalist, the more he attributes to reason and the less to unlearnt instincts.[22] In future chapters we shall see that some animals extremely low in the scale apparently display a certain amount of reason. No doubt it is often difficult to distinguish between the power of reason and that of instinct. For instance, Dr Hayes, in his work on 'The Open Polar Sea', repeatedly remarks that his dogs, instead of continuing to draw the sledges in a compact body, diverged and separated when they came to thin ice, so that their weight might be more evenly distributed. This was often the first warning which the travellers received that the ice was becoming thin and dangerous. Now, did the dogs act thus from the experience of each individual, or from the example of the older and wiser dogs, or from an inherited habit, that is from instinct? This instinct, may possibly have arisen since the time, long ago, when dogs were first employed by the natives in drawing their sledges; or the Arctic wolves, the parent-stock of the Esquimaux dog, may have acquired an instinct, impelling them not to attack their prey in a close pack, when on thin ice.

We can only judge by the circumstances under which actions are performed, whether they are due to instinct, or to reason, or to the mere association of ideas: this latter principle, however, is intimately connected with reason. A curious case has been given by Prof. Möbius,[23] of a pike, separated by a plate of glass from an adjoining aquarium stocked with fish, and who often dashed