Afterword: The Valley of Neander

by Robert Silverberg

The year was 1676, and a young German theologian named Joachim Neumann was in trouble. He had been rector of the Latin school at the town of Dusseldorf on the Rhine, but his rather original ideas about religious ritual, particularly holy communion, had brought upon him a suspension from his post.

During this period of idleness, Neumann occupied the time by strolling through the valley of Diissel, the small stream that gives Dusseldorf its name. About ten miles from town, the narrow valley widens into a pleasant canyon bordered with high limestone cliffs, and here Neumann would halt, passing a restful day at the quiet spot. He was moved to compose poems there, hymns which he set to music. Eventually he returned to his native Bremen, and published two volumes of these hymns before his death in 1680, when he was only thirty years of age.

The hymns were strikingly lovely, so much so that they are sung in Germany to this day. The people of Dusseldorf, remembering the young teacher who had so briefly dwelled among them, honored his memory by giving his name to the valley where he had spent so many happy hours. Since

Neumann had preferred to use the Greek form of his name, Neander, after a custom of his day, the people of Diisseldorf named it "Neander's Valley"—in German, Neanderthal.

Over the next century and a half, the peace of the Neanderthal was frequently disturbed by the sound of hammer and pickax and the roar of explosions. The limestone cliffs were fertile sources of lime, and by 1856 only two caverns in the face of the cliff had not yet been quarried. They were called the Feldhof grottoes, and they were sixty feet above the valley floor. Reaching them was a difficult matter until the summer of that year, when the quarriers blew up part of the cliff, widening the grotto entrances.

Two workmen entered one of the caves. It was about fifteen feet deep, and its floor was covered to a depth of about five feet by a layer of mud, mixed with fragments of a flintlike stone called chert. While cleaning away this mud to get down to the valuable limestone floor, the workmen came across a human skull, buried in the mud near the cave entrance, and then other bones farther in. They casually swept most of these bones out into the valley.

The skull and a few of the other bones were saved, though. The workmen gave them to Johann Karl Fuhlrott, a science teacher in the high school at the nearby town of Elberfeld. Fuhlrott was startled by the appearance of the skull. It seemed to be human, yet it was strangely brutish, long and narrow, with a sloping forehead out of which bulged an enormous ridge above the brows. The thighbones that accompanied the skull were so thick and heavy that they hardly looked human at all.

Fuhlrott brought the bones to Professor Hermann Schaaf hausen, of Bonn. Schaafhausen's opinion was that "the extraordinary form of the skull was due to a natural conformation hitherto not known to exist, even in the most barbarous races," and he added his belief that the relics could be traced to a very early period of man's existence, "at which the latest animals of the diluvium still existed."

The scientific world first learned of what would soon be called Neanderthal man at a meeting of the Lower Rhine Medical and Natural History Society, held at Bonn on February 4, 1857.

Schaafhausen displayed a plaster cast of the skull, and read a paper describing it. A year later, he published his paper, and termed the bones “the most ancient memorial of the early inhabitants of Europe.”

A find of such significance today would rate international headlines. News traveled more slowly in the last century. Not for three years afterward was Schaafhausen’s paper translated into another language. Scientists outside Germany took absolutely no notice of the Neanderthal skull during those three years.

Even in Germany, there was no general rush to back Schaafhausen’s opinions. Rudolf Virchow, who was not only a great man of medicine but a highly respected archaeologist, examined the skull and dismissed it as unimportant. According to Virchow, the strange appearance of Neanderthal man was the result of an attack of rickets in his youth, which had twisted his legs and deformed his pelvis. He had triumphed over this handicap, Virchow declared, and had become a doughty fighter. The flat forehead and the massive brow ridges were caused by repeated skull fractures suffered during combat. Finally, late in his life. Neanderthal man had been troubled by arthritis.

Rickets, blows on the head, arthritis—the famed Virchow thus explained away all of the peculiarities of Neanderthal man! Other experts joined in the dismissal. An anthropologist named Pruner-Bey announced that the man of the cave had been "a powerfully organized Celt somewhat resembling the modem Irish with low mental organization.” Professor Mayer of Bonn suggested that the skeleton was that of one of the Russian Cossacks who had invaded Germany in 1814. Another authority disagreed. “The skull is so deformed that the man must have been diseased. He had water on the brain, was feeble-minded, and no doubt lived in the woods like a beast.”

One thing everyone agreed on: the bones from the cave were not particularly ancient, nor were they those of some primitive type of man different from present-day beings. Only Schaafhausen continued to insist that the bones belonged to a member of “a barbarous and savage race.” Led by Virchow, the scientific community relegated the bones to the obscurity from which they had come. By the end of 1858, no one seriously discussed them anymore.

The following year was an explosive one in the understanding of man’s past. In November 1859, 1,250 copies of a book called *The Origin of Species* appeared for sale in British bookshops and were all sold in a single day.

The author was Charles Darwin. The book created perhaps the greatest controversy in scientific history.

To understand Darwin and his theory of evolution, we have to double back in time more than two thousand years to the Greek philosophers.

They had understood, those shrewd old Greeks, that nothing is permanent in the world. Everything is subject to change, including living things. Heraclitus and Anaximander had taught that living species might alter. Aristotle had looked at porpoises and whales, air-breathing creatures who live in the sea, and had speculated on the development of one sort of creature into another. The Roman philosopher Lucretius had written, “Many races of living things must have died out and been unable to beget and continue their breed.”

Change and extinction—the ancients had understood these patterns well enough. But the coming of Christianity had seen the ancient learning suppressed. The Bible was the only authority that could be consulted now. And the Bible was quite specific on the subject of Creation. In

Genesis, God is shown creating “grass, the herb yielding seed, and the fruit tree yielding fruit after his kind,” and then bringing forth “great whales, and every living creature that moveth . . . after their kind, and every winged fowl after his kind,” and then “cattle, and creeping thing, and beast of the earth after his kind,” and finally “man in his own image, in the image of God created he him.”

The phrase “after his kind,” repeated so often, indicated clearly that there could never be changes in species. Each type of creature would bring forth young “after his kind,” forever and unto eternity. The only species that would ever inhabit the earth were those created during that first week. Such creatures that Noah had brought upon the ark endured the Deluge; those, if any, that were left behind, perished.

No one seriously questioned this way of thinking for hundreds of years. Fossil evidence of curious and unknown creatures was, as we have seen, ticketed as the remains of beings that had missed the ark. The ark began to seem rather crowded as time went on, since by 1700 more than 10,000 species of plants and animals had been identified, and a century later that figure was seven times as great. Today we know of more than a million distinct species of plants and animals.

A few profound thinkers did publicly oppose the literal interpretation of Genesis. In the eighteenth century, the German philosopher Immanuel Kant wrote a book called *Anthropology* in which he pointed to the resemblance between man and the apes, and stated a theory of evolution in these words: “It is possible for a chimpanzee or an orangutan, by perfecting its organs, to change at some future date into a human being. Radical alterations in natural conditions may force the ape to walk upright, accustom its hands to the use of tools, and learn to talk.”

Another German thinker, Arthur Schopenhauer, phrased the same thought this way in a book published in 1851: "We must imagine the first human beings as having been born in Asia of orangutans and in Africa of chimpanzees, and not born as apes either but as full-fledged human beings.” And Count Buffon, before the theologians silenced him, had also linked man and the apes, suggesting that the ancestors of man had been tree-living apes, and that man was, as Buffon wittily put it, “an ape come down in the world.”

Such heretical talk was countered by men like Cuvier, of the nonevolutionist school. Cuvier, with his theory of catastrophes. sought to explain away the fossil evidence of change and extinction. He insisted that no species could ever change, but that it remained as God had created it until God destroyed it through natural catastrophe. (Somewhat mysteriously, Cuvier and his followers discarded the order of things as described in the Bible, making Adam appear *after* the Deluge and denying the existence of any antediluvian humans. Otherwise, Cuvier sought to uphold the teachings of Genesis.)

The evolutionary ideas of Buffon were developed and expounded most fully in the generation after Buffon’s death. The developer and expounder was a curious, pathetic Frenchman named Lamarck, who neither in his own day nor ours has received due credit for his importance.

Jean Baptiste Pierre Antoine de Monet de Lamarck, born in northern France in 1744, was the eleventh and youngest child of a noble but poverty-stricken family. His father picked a career in the Church for him, but soon after the death of the elder Lamarck, the seventeen-year-old boy fled the seminary and joined the army. He saw action in the Seven Years’ War between France and Germany, and for a while thought he might have a successful military career. Promotion eluded him, however. After injuring his neck in a wrestling bout, he resigned from the army and headed for Paris.

He studied medicine, music, and science, while supporting himself through such methods as clerking in a bank and writing literary potboilers. Somehow he drifted into botany about 1768, and after ten years of study produced his first book, *The Flora of France.* It won him the attention of Buffon, and the miserably poor Lamarck was given a post at Buffon's Jardin du Roi. Buffon aided him in another way, by hiring him as tutor to his own son.

Buffon died. Revolution swept France. Many of France's leading scientists fled the country. Others perished. Lamarck remained at his post at the Jardin du Roi—indeed, had even persuaded a rioting mob not to destroy the precious collections. With kings out of fashion in France, the Jardin du Roi became the Jardin des Plantes, and in 1794 Lamarck was awarded the title of Professor of Zoology at the Jardin. (The same title went to twenty-two-year-old Geoffroy Saint-Hilaire, who was really a specialist in mineralogy. They divided the animal kingdom between them, Lamarck agreeing to study animals without backbones, Saint-Hilaire the vertebrates.)

Lamarck was then fifty years old. He had been married four times and had a household full of children and another baby on the way. He was still desperately poor. And he was beginning to have trouble with his eyes.

He plunged into his new field of studies with enthusiasm, however, nearly ruining his eyesight completely by peering through his microscope hour after hour. He intended to classify all invertebrate creatures. The job took him seven years. In 1801, Lamarck published the first volume of his *System of Animals Without Backbones,* a pioneering and still valuable work in its field. During those years, too, Lamarck spent some time instructing young Georges Cuvier, who had also come to work and study at the Jardin. Cuvier, a firm believer in the teachings of the Bible, soon was a more important figure in French zoology than Lamarck, who lacked Cuvier's gifts of winning friends and influencing people.

The other zoologist at the Jardin, Geoffroy Saint-Hilaire, had gone to Egypt with Napoleon's invading force while Lamarck was still busy with the invertebrates. Saint-Hilaire searched for and found many new fossils in the sand of the Egyptian deserts and in the mud of the Nile. New species of elephants, odd sea cows and hitherto unknown types of rhinoceros came to light. Many of them resembled living African animals, but were just slightly different, as though they were transitional forms. Perhaps species changed with the passing generations, Saint-Hilaire thought. When he returned to France, he discussed his ideas with Lamarck.

Lamarck, puttering with insects and worms and jellyfish, had been developing some ideas of his own. He had set down what he called a "chain of life," beginning with the simplest creatures, the polyps and the jellyfish, and rising in complexity through worms and insects and crustaceans to fish, reptiles, birds, and finally mammals. It struck him that life quite probably had begun with very simple organisms, which had gradually, over who knew how many millions of years, altered and developed into the magnificently intricate being known as man. Saint-Hilaire's findings in Egypt lent strength to this evolutionary theory.

In 1802, Lamarck published his theory in a slim book called *Research on the Organization of Living Bodies.* He spoke of his chain of life, of the development from the simple to the complex. Species changed, Lamarck argued. In fact, he attacked the whole concept of "species."

What was a *species,* anyway?

The word is a Latin one, meaning "outward appearance." It was used to describe a type of creature. A dog belonged in one species, a cat in another, an elephant in yet another, and man,

naturally, in a species of his own.

As the classifiers, beginning with Aristotle, pondered the problem of classification (known as "taxonomy"), they began to come across some knotty problems. There were different varieties of animals, resembling each other in a general way but differing in fine details. As, for instance, the elephant. There was the African elephant, with large ears and two fingerlike projections at the end of its trunk. There was the Indian elephant, with small ears, one projection at the end of its trunk, and a pair of bumps on its skull that the African kind lacked. Were they both the same species? Then, too, there were men. They came in various shades: pink, brown, black, yellow. All the same species? Cats, dogs, fish, ail showed the same variety within a general group.

An Englishman named John Wray, in 1660, performed the first modem classification of animals. His system, while an improvement on the chaos that had existed before, did not go quite far enough. It remained for Linnaeus, in the following century, to do the job thoroughly.

Linnaeus began with two kingdoms of living things, the Animal Kingdom and the Plant Kingdom. These he divided into large groups called *phyla,* from the Greek word meaning "tribe." All mammals went into one phylum, all fish into another, all birds into a third, and so forth.

The phyla were further divided into classes, the classes into orders, and the orders into *genera,* the plural of the word *genus,* meaning "race" or "sort." Finally, each genus was divided into a number of species.

The Linnaean system of taxonomy is called *binomial nomenclature,* which means simply that he gave two names to each creature he classified, one name referring to the genus, the other to the species. Thus, the dog family became the genus *Canis,* which included such species as *Cams familiaris* (the domestic dog), *Canis lupus* (the European gray wolf) and Cam's *occidentalis* (the American timber wolf). The various types of domestic dog—-spaniel, terrier, dachshund, and so on—were regarded as breeds, or races, within the species *Canis familiaris.*

So, too, with human beings. They all went into the genus *Homo.* And only one species of living man was recognized, *Homo sapiens. Sapiens* means "wise." This species included the various races of mankind, the yellow and the brown, the pink ones we call "white," and the black ones.

But the elephants went into different species. The African elephant was given the scientific name *Elephas africanus,* and its small-eared counterpart from India was styled *Elephas maximus.* Indeed, some taxonomists today think they should go into different genera as well as different species, calling the African elephant *Loxodonta africanus.*

What determined the division of species?

The simplest rule of thumb was that of interbreeding. If two creatures could mate and produce offspring, they were of the same species, no matter how different they looked. Thus, all men belonged in the same species, since interbreeding is possible between any of the races of man. Siamese cats and Angora cats belonged in the same species, because *they* could interbreed. Leopards, though they look like big cats, belonged in a different species of the same genus, *Felis.* Tigers were a different species also. As for the two types of elephants, they had to go into separate species because they could not interbreed at all.

This was neat and agreeable. All kinds of housecats could interbreed, and all kinds of dogs could interbreed, but dogs could not interbreed with wolves, nor house cats with lions, nor dogs

with cats.

The system tottered a bit when it was discovered that certain creatures usually considered to be of different species could mate with each other after all. In captivity, lions and tigers could be persuaded to produce ligers (or tiglons?). Dogs and wolves, though they did not interbreed in the wild, did so when man forced them to, and offspring were born. Cattle and bison were crossed to produce a "cattlo."

These exceptions struck a blow at the old idea of a species as reproductively isolated from all other species. Yet it had to be recognized that these nonnatural hybrids, brought about by man's intervention, were usually sterile and so genetically insignificant. Even when the hybrids were capable of reproducing, they were irrelevant to the concept, since they had come about only by human meddling.

So it is still possible to cling to the rough definition of a species as a group of living things that interbreed under natural circumstances and produce young similar to themselves. Of course, defining "group" and "similar" has led to difficulties in understanding. A species contains a wide range of variations. Each species is a population that has scope for difference; the Pekinese and the Great Dane, different as they may seem, both have enough characteristics in common so that they can be placed in the same genetic population, or species. Naturally, there is a certain fuzziness involved in making such arbitrary groupings. The division into species is a man-made system of classification, involving a great many debatable borderline cases.

The fuzziness of the concept bothered Lamarck, too. He wrote in 1802 that at one time it was easy enough to define a species as a type of creature which would not reproduce except with its own type. But, he observed, "The further we advance in the knowledge of the different organized bodies with which almost every part of the surface of the globe is covered, the more does our embarrassment increase in determining what should be regarded as species. . . . We find ourselves compelled to make an arbitrary determination, which sometimes leads us to seize upon the slightest differences between varieties to form of them the character of that which we call species, and sometimes one person designates as a variety of such a species individuals a little different, which others regard as constituting a particular species."

Instead, Lamarck said, the dividing line between one species and the next was anything but clear-cut. Rather, each species tended to flow into the next imperceptibly, to the distress of those who tried to set hard and fast boundaries. And—-this was the heart of his idea—species could change under the influence of their environment. As he put it, "As time goes on the continual differences of situation of individuals . . . give rise among them to differences which are, in some degree, essential to their being, in such a way that at the end of many successive generations these individuals, which originally belonged to another species, are at the end transformed into a new species, distinct from the other."

Lamarck gave many examples of this transformation. A bird, he said, driven by hunger to seek its prey in the water, will tend to spread the toes of its feet when it wishes to move on the surface of the water. In time, the skin connecting the toes becomes stretched. Later generations of birds will be born with webs between their toes as a result of this stretching process—as is the case with ducks and geese.

On the other hand, birds accustomed to perching in trees will develop longer and sharper claws as time goes by, to aid them in seizing the branches. And shore birds such as the heron will

tend to grow long, stiltlike legs, enabling them to run through the surf without having to swim.

The long neck of the giraffe was the result of the same process of adaptation. "We know," said Lamarck, "that this tallest of mammals, living in arid localities, is obliged to browse on the foliage of trees. It has resulted from this habit, maintained over a long period of time, that in all individuals of the race the forelegs have become longer than the hinder ones, and that the neck is so elongated that it raises the head almost six meters (nineteen feet) in height."

The essence of Lamarck's idea was that environment causes changes in an organism, and that these changes are inherited by the descendants of that organism. No one had ever formulated so clear an evolutionary theory before, buttressed by so many examples from nature.

It won few friends. The powerful Cuvier called it Lamarck's "new piece of madness." Cuvier's mockery destroyed Lamarck's scientific reputation. Few students came to hear him lecture. No one read his books. Lamarck went on with his research, hampered by poverty, illness, and increasing blindness. He died in 1829, at the age of eighty-five, old and blind and forgotten by the world. At the end, his only supporters had been two faithful daughters.

Even today, Lamarck is known chiefly as the man who worked out an incorrect theory of evolution. His idea of the evolution of inherited characteristics was overthrown in 1887 by August Weismann, a German professor of zoology. Weismann selected a dozen healthy mice, seven females and five males, and cut off their tails. In little more than a year, 333 baby mice had been born—all with normal tails. Weismann picked fifteen from this second generation of mice and cut off *their* tails. The 237 young produced by these mice also had tails. In all, 1,592 mice of twenty-two generations sacrificed their tails to prove Lamarck was wrong. Acquired characteristics were not transmitted—at least not in the way Lamarck said they were.

And so Lamarck is remembered more for his wrong guess than for his very important pioneering theory. The laurels went to another man, who does not even seem to have been aware of Lamarck.

Charles Darwin was born on the same day Abraham Lincoln came into the world—February 23, 1809. His grandfather, Erasmus Darwin, had been an eccentric physician and naturalist whose own speculations on a theory of evolution had appeared in the form of a vast and unreadable poem, in 1798. Charles' father, Robert Waring Darwin, was also a medical man, and Charles was intended for the same profession.

Much to Robert Darwin's disappointment, young Charles did not have the medical temperament. His medical studies at the University of Edinburgh alternately bored and sickened him. The sight of surgical operations left him trembling and disgusted. And he was at best an indifferent student. All through his childhood, his teachers had considered him slow-witted. He seemed interested only in his collection of insects, shells, plants, and stones. After his brief career as a medical student, Charles found himself enrolled at Cambridge to study for the clergy. For three years, he halfheartedly pursued his theological studies while spending most of his time collecting beetles and wild flowers. Gradually he became interested in geology, and forthwith abandoned the idea of a church career. His father, despairing of Charles, began to fear he would "turn into an idle sporting man."

In 1831 Darwin took his degree. He spent a few months studying the geology of the English countryside in company with his professor, Adam Sedgwick. Then came a sudden and startling invitation to join a round-the-world voyage aboard H.M.S. *Beagle.* The *Beagle* was under orders

from the British government to conduct a series of scientific observations over a five-year span, and a likely young man with a scientific background was needed to serve as expedition naturalist.

The post carried no salary, but the Darwins were a well- to-do family, and young Charles was financially independent. He was excited by the prospect of carrying his studies in natural history to every part of the globe, though his father sourly termed the idea a "wild scheme." Ultimately, Dr. Darwin gave in. Charles sailed with the *Beagle* in the last week of 1831.

It was a splendid voyage. The 242-ton brig crossed the Atlantic to Brazil, sailed southward to Patagonia, rounded Cape Horn, coasted along Chile to the Galapagos Islands, and struck westward toward the coral atolls of the Pacific. Eyes wide, Charles Darwin took it all in. He saw strange forms of life, drew certain conclusions about them, and pondered those conclusions. On the isolated Galapagos Islands, for instance, he discovered dozens of species of birds that were found nowhere else. They were similar to, but yet slightly different from, birds found on the South American mainland. What force of change had been at work on the Galapagos to create these new species?

The germ of Darwin's theory had been planted. He returned to England in 1837, took a bride soon after, and retired to a country home outside London to arrange his voyage notes and attempt to interpret his findings. In 1840 he published his first book, a journal of the *Beagle* voyage, still a lively and entertaining classic of travel and naturalism. Then he retired from public notice once again to solve the question of why species vary.

Shy, eccentric, plagued by headaches and ill health, Darwin lived a hermit's life. He was still a young man, but he was convinced he might die at any moment, and so bent all his energies toward his scientific research. (He surprised himself by living seventy-three years.) His inheritance from his father kept him free of financial worries. He read, wrote, studied flowers, and spent eight years examining the life cycle of the barnacle. He grew an enormous beard, and servants watched him with some amusement as the tall, gaunt, shawl-wrapped figure moved about the big house in an awkward, self-absorbed manner.

By 1844 Darwin had worked out a sketch of his ideas about evolution. Instead of rushing to a publisher, he continued to work, expanding and modifying his conclusions. Scientific-minded friends came down from London, and he discussed his ideas with them. They urged him to release the theory in book form, but Darwin was not ready. His 230-page sketch of 1844 grew and grew. Perhaps he might never have published his history-making book but few a jarring experience that finally pushed him into action.

One day in June 1858, a letter came to Darwin bearing the return address of Temate, in the Malayan Archipelago. It had been written four months earlier by a young naturalist, Alfred Russel Wallace, who was traveling through Asia studying flora and fauna as Darwin had done a quarter of a century before. Wallace had drawn some conclusions about the origin of species, and he had written a short paper which he called "On die Tendency of Varieties to Depart Indefinitely from the Original Type."

In a few pages, Wallace set forth in clear and simple terms the essence of the theory on which Darwin had been working for more than twenty years!

"I never saw a more striking coincidence," the shocked Darwin wrote to his friend Lyeil. "Even his terms now stand as heads of my chapters. So ail my originality, whatever it may amount to, will be smashed."

Lyeil, who had been one of those urging Darwin for years to publish, saved the day. He organized a meeting of the Linnaean Society on July 1, 1858, at which Wallace's essay was read, along with Darwin's 1844 sketch and a letter Darwin had written in 1857 outlining his ideas. It was the first public exposition of Darwin's theory, and was of historic importance on that count alone. The meeting also served as an open demonstration that Darwin and Wallace had arrived at the same theory totally independently of one another.

Wallace's paper was published a month later. Darwin, realizing that he finally had to give his findings to the world, began feverishly to write, and in thirteen months and ten days produced the volume he had been hatching for more than two decades, *The Origin of Species.*

Darwin offered four main explanations for the variations in species. The first and most important he called "natural selection." He wrote, "As many more individuals of each species are born than can possibly survive; and, as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be *naturally selected."* In other words, those individuals best equipped to survive *would* survive, and would leave descendants. Those who were too weak, too helpless, would die out without perpetuating themselves.

How did these variations arise? Sometimes spontaneously, through a process Darwin did not attempt to understand (the science of genetics is still solving the problem today), sometimes through special circumstances that might influence an individual's reproductive system, and sometimes by the inheritance of the results of use and disuse of organs.

This last was, of course, Lamarck's theory. But Darwin and Lamarck approached the idea from opposite ends. Lamarck said that because creatures willingly and continually exercised an organ in a given way, that organ tended to change. Darwin reversed it: first the organ changed, and *if* the change proved useful, those creatures who benefited from it would survive, and those who lacked it would not. He used Lamarck's own giraffe example. Suppose, he said, a group of short-necked creatures found it necessary to feed off tall branches. They would strain and stretch, and perhaps manage to nibble enough to stay alive—but all the stretching in the world would not produce a long-necked giraffe.

Then, out of the blue, spontaneously, a long-necked giraffe was born! Better fit to feed itself than its brothers and sisters, it ate happily, grew strong and healthy, and thrived. It mated with many of its short-necked companions, and some of the offspring were long-necked. Again and again, through a process of *natural selection,* the long-necked giraffes would excel their short-necked companions in health, vigor, and number of offspring. Eventually, most of the giraffes in the community would be long-necked. The short-necked kind, hampered by the inability to reach their food supply, would die out. But the change would have come about, not through any wish on the part of giraffes to have longer necks, but by a spontaneous change—we call such changes *mutations*—that established itself permanently because of its high survival value.

Not all mutations are beneficial, of course. Suppose a giraffe were born without legs? It would be unable to feed itself at all, and would perish quickly, without leaving offspring. Thus, as Darwin put it, "favorable variations would tend to be preserved, unfavorable to be destroyed. The result would be the formation of a new species."

The book was a bombshell. The controversy it touched off in 1860 was a violent one that went on having echoes right into our own time.

What was the effect of Darwin's evolutionary theory as it applied to the story of man?

Darwin had not said much about the ancestry of mankind in *The Origin of Species.* "Light will also be thrown upon the origin of mankind and its history," he promised in his book, but the promise was not kept. That was the only sentence in the book that mentioned the origin of man.

The truth was Darwin had not yet made up his own mind on the subject. He maintained his silence on the topic of man's evolution for twelve years, until in *The Descent of Man,* he finally linked man into his scheme.

Long before 1871, though, some of Darwin's followers had taken the jump. Using Darwin's own ideas, they asserted that men were closely related to apes—that we were, in effect, cousins to the chimpanzee and the orangutan.

This caused a more violent uproar than Darwin's book itself. Many laymen took the distorted view that Darwin and such associates of his as Lyell and Thomas Henry Huxley were saying that "man was descended from monkeys." This was hardly true. Darwin himself would one day write, "We must not fall into the error of supposing that the early progenitor of the whole simian stock [the apes and monkeys], including Man, was identical with, or even closely resembled, any existing ape or monkey."

All Darwin, Huxley, and the others meant to say was that man and the apes had a common ancestor, "some lowly organized form." Man had evolved one way, the chimpanzee another, the gorilla another. Men and apes, though, belonged in the same general family, that of Primates.

It was a blow to human prestige to be lumped in with the apes this way. Many classifiers had divided nature into a Plant Kingdom, an Animal Kingdom, and the Human Kingdom—the last containing but one species, *Homo sapiens.* As Darwin mockingly remarked, "If Man had not been his own classifier, he would never have thought of founding a separate order for his own reception."

Today, no longer approaching the matter emotionally, we agree that the apes and monkeys are indeed our close relatives. Our skeleton contains precisely the same number of bones as the skeletons of gorillas and apes. Our blood has the same chemical composition as the blood of apes. The similarities between man and the other primates are more numerous than the differences. As the anthropologist Earnest A. Hooton noted about forty years ago, "The monkey asserts his kinship with us; the anthropoid ape proclaims it from the treetops. Man shows his primate origin in every bodily character, and if he is a rational being he must admit this self-evident relationship."

A century ago, the relationship was not so self-evident. If a man had indeed evolved from a more primitive, apelike form, as Darwin's supporters were saying, where was the fossil evidence? Where was the "missing link" that would show man in the process of evolving?

It was at this point that an Englishman named George Busk dusted off Schaafhausen's report on the strange skull from Neanderthal.

Busk, a geologist, translated Schaafhausen's paper and had it published in *The Natural History Review* for April 1861. He addressed a group of English scientists that same month, displaying a plaster cast of the Neanderthal skull and also the skull of a chimpanzee. He said he had "no doubt of the enormous antiquity" of the Neanderthal bones, and called attention to the way

the shape of the skull approached "that of some of the higher apes."

Neither Darwin nor his chief popularizer, Huxley, attended Busk's lecture. But the geologist Charles Lyell did, and he saw to it that the Neanderthal skull cast got to Huxley. Huxley reported, in 1863, that the skull was that of a primitive variety of man, "different from *Homo sapiens* but not wholly distinct anatomically." Though he admitted it was the most apelike human skull yet found, Huxley added cautiously that "in no sense can the Neanderthal bones be regarded as the remains of a human being intermediate between men and apes." That opinion caused some surprise among the evolutionists, but, as we shall see, it proved a wise guess.

Since many experts, particularly in Germany, were still insisting that the Neanderthal skull was only that of a deformed idiot, what was needed was more skeletal evidence— other skulls showing the same strange appearance. Within a year, Busk had come forward with a fossilized skull found at Gibraltar in 1848. No one had quite known what to make of it then, and it had been shunted from sight. Sixteen years later, Busk tracked it down and showed that it, too, had Neanderthal characteristics—the receding forehead, the huge eyes topped by massive brow ridges, the thick bones. On the basis of the two skulls, an assistant of Lyell's christened a new species of man, *Homo neanderthalensis,* in 1864.

The evidence mounted. In 1866, a distinguished Belgian geologist named Dupont found a peculiar jawbone near the town of Dinant, lying among the bones of mammoth, rhinoceros, and reindeer. It was curiously chinless and very thick, extremely primitive and apelike in appearance. The anthropologist E. T. Hamy leaped to the conclusion that the jawbone belonged to the same species of man as the Neanderthal and

Gibraltar skulls, which had been found without their lower jaws. But there was no proof of the relationship.

The proof appeared twenty years later, in 1886. In the cave of Spy, near the town of Namur, Belgium, two geologists found five separate layers of relics. Digging down carefully, they came upon the bones of mammoths and rhinoceroses, crude stone knives and tools, and then—in the second layer from the bottom—the remains of three skeletons, huddled together as though in sleep.

They were Neanderthal skeletons. The geologists found two skulls, two lower jaws, some skeletal remains of one face, and a number of well-preserved leg bones. There could no longer be any doubt that a strangely brutish-looking but undeniably human creature had once roved Europe, a chinless man with a sloping forehead and huge, beetling brows. The Spy find was handled with such scientific precision that no one could possibly assail it—no one, that is, except the famous Dr. Rudolf Virchow, who had been denying Neanderthal man for nearly thirty years and could not retreat now.

Virchow went to his grave, in 1902, still a skeptic. The procession of Neanderthals continued in increasing tempo. In 1899, a professor at the University of Zagreb, in what is now Yugoslavia, described a find he had made at the Croatian town of Krapina: portions of a dozen Neanderthal skulls, fourteen jaw fragments, and one hundred and forty-four isolated teeth! An even more spectacular discovery was made on August 3, 1908, at the village of La-Chapelle-aux-Saints, in France's department of the Dordogne.

Three priests entered a cave there. It may seem strange to find members of the clergy engaged in such research, in view of the anti-Biblical nature of the whole idea of man's antiquity. But priests—particularly French priests—had been playing an active part in paleontology since the

1860s, deliberately overlooking the contradictions between their scientific work and the Biblical teachings. As one such clerical paleontologist had put it in the 1870s, "To those who ask me how I intend to reconcile my discoveries to the Biblical story, I can only answer that I take my stand on the basis of facts without trying to explain them."

These three archaeologist-priests, two named Bouyssonie and the other Bardon, dug down through recent deposits to a layer about a foot thick, containing the familiar animal bones: woolly rhinoceros, bison, reindeer, and others. At the bottom of the trench lay the skeleton of a man who had apparently been deliberately buried there. His features were Neanderthal.

The priests recognized the importance of their discovery and summoned the ranking French authority on ancient man at that time, Marcellin Boule, of the Institute of Human Paleontology in Paris. (*Paleontology,* a word coined in 1838, means "the study of extinct creatures.") Boule and the three priests laboriously reassembled the skeleton, which was somewhat crushed and battered. It was the most complete Neanderthal skeleton yet found, including the skull and lower jaw, twenty-one vertebrae, twenty ribs, a collarbone, two nearly complete arm bones, various leg and foot bones, including both kneecaps, a heel bone, and part of a toe.

Because it was the first nearly complete Neanderthal skeleton found, Boule made certain mistakes in assembling it. As he reconstructed it, it seemed to him that Neanderthal man's head would have to hang forward like an ape's, instead of sitting upright on its spinal column as does ours. Soon after, other skeletal evidence showed the world that Neanderthal man held his head as upright as *Homo sapiens,* but Boule's error of 1908 has unhappily created misleading ideas that have proved hard to eradicate. Supposed "portraits" of Neanderthal man painted on the basis of Boule's findings are still being reprinted in popular magazine articles and some books, keeping the error alive.

In any event, there was soon an even finer Neanderthal skeleton to study. A Swiss dealer in antiquities, Otto Hauser, made the discovery at the cave of Le Moustier, also in the Dordogne.

Hauser, a sickly, lame-legged man, had wanted to be a serious archaeologist. Financed by his family's wealth, he had conducted excavations in Switzerland in the 1890s, while still in his early twenties. His work was received with hostility by the older men of the profession, who objected to the haphazard way this amateur was ripping up the ground.

Embittered, Hauser moved on to France and bought up great tracts of land in the Dordogne, which by this time was known to be honeycombed with the remains of ancient man. He began to dig everywhere—and, to cover his expenses, he started to sell off some of the hand axes and bones he uncovered. Bit by bit, Hauser made the transition from archaeologist to profiteer. "He is without scientific training and without scruples," one angry professional archaeologist declared. "Hauser is merely exploiting the sites of discovery in the interests of trade."

In March 1908, this much-hated man came across a human bone in a layer of the Le Moustier grotto that was believed— correctly, we think today—to be at least 250,000 years old. Hauser would normally have begun digging right away. But, heeding the scorn that had been poured on him for fifteen years, he decided to do this the right way. Posting a guard at the cave, he halted all work and sent invitations to the leading archaeologists of Europe to attend the uncovering.

Of the six hundred notables Hauser invited, only nine bothered to accept—all German. There were no French experts present at the scene on August 10, 1908. They were all busy at nearby Chapelle-aux-Saints, where the three priests and Boule were at work. As a result, the French were

annoyed and angered when Hauser, under the close watch of the nine German experts, proceeded to dig up an even more perfect skeleton than the one at Chapelle-aux-Saints!

It was the well-preserved skeleton of a Neanderthal boy of about fifteen. It was not, however, 250,000 years old. It apparently had been deliberately buried in the ancient layers at the bottom of the cave, and actually was no older than perhaps 100,000 years—still of a respectable antiquity.

Hauser did not realize this. He insisted that he had found the skeleton of a type of man far older than Neanderthal man, and—with the backing of the German scientists—gave it a new scientific name, *Homo mousteriensis hauseri,* "Hauser's man from Le Moustier." The name soon was discarded; Hauser's man was *Homo neanderthalensis,* a teenage specimen, while the skeleton from Chapelle-aux-Saints was that of an old man crippled by arthritis. But the name "Mousterian" still is used by archaeologists today to describe the culture of the Neanderthal man. The type of axes and tools found in association with Neanderthal bones is called Mousterian, after the cave Hauser excavated.

Hauser's next move, after announcing his discovery, was typical of him. He sold the skeleton. The buyer was the Berlin Ethnological Museum, which paid 125,000 gold francs, the equivalent then of $25,000.

Hauser never again made an important discovery. When World War I broke out in 1914, he had to leave France. Many European countries passed laws preventing the sort of profit-making excavations Hauser specialized in. Now and then, in the closing years of his life, Hauser would visit Berlin with his wife, and would go to the Ethnological Museum to view the Le Moustier skeleton. There he would reverently lay a bouquet of flowers over the glass exhibition case, as though decorating a grave.

The story has a jarring sequel. The boy of Le Moustier, whose bones lay safely in the ground for a thousand centuries, lasted less than four decades in the care of *Homo sapiens.* During the Second World War a bomb fell on the Berlin Ethnological Museum and the $25,000 skeleton from Le Moustier was burned to ashes. So much for progress, evolution, and man's long climb from the caves!

Other Neanderthal skeletons came to light soon after, particularly in France, and especially in that part of France known as the Dordogne. Caves at La Ferrassie, La Quina, Banolas in Spain, and Repashuta in Hungary yielded Neanderthal bones. In 1924, Neanderthal remains were found at Kiik-Koba, in the Russian Crimea. The Isle of Jersey in the English Channel has given up fragments of three Neanderthals. Italy, Romania, Czechoslovakia—nearly every part of continental Europe has made its contribution. To date there have been close to a hundred Neanderthal skeletons or partial skeletons recovered, at more than forty different sites. Most of them have been found in Western Europe.

Neanderthals have been found in Asia, too. Important discoveries were made in Palestine between 1925 and 1933; these shed some light on the relationship between Neanderthal man and modem *Homo sapiens.* In 1949, and again in 1954, Turkish archaeologists discovered teeth of a Neanderthal type in Asia Minor. And between 1953 and 1960, the American archaeologist Ralph Solecki discovered seven Neanderthal skeletons, six adults and a baby, in Shanidar Cave in northern Iraq.

We know, from this geographical spread, that Neanderthal man ranged over much of Europe and the Near East, with particular concentration in Western Europe. We have his skeletons, his

tools, and even—in Italy—some of his footprints. (They were found in 1950 in a northern Italian cave called Tana della Basura, "Cave of the Witch," where two dozen splay-footed Neanderthal imprints can be seen in clayey soil under an overhanging ledge of rock.)

What do we know of Neanderthal man today, more than a century after Schaafhausen's first hesitant announcement of the "barbarous" skull?

We have a fair idea of how this not-quite-man looked. He was short and squat, not much more than five feet tall on the average, with a deep barrel of a chest and flat feet. His forehead sloped backward, his brow ridges were enormous, and he had no chin. His nose was broad and low-bridged and his mouth jutted forward like a muzzle. His legs were bowed; he may have walked in a kind of shuffle, with his knees permanently bent or flexed, though some doubt this idea.

All this is the evidence of the bones. Neanderthal man left us no portraits of himself, and, of course, no complete and undecayed corpses. We do not know how hairy he was, but we do know that he clothed himself in animal hides; so probably he did not have a thick, apelike pelt of fur growing on his body. We do not know, and will never know, the color of his skin. It is most likely that he was some shade of pink or brown, rather than a novel blue or green or polkadotted— but we will never know.

He had a big brain. The brains of skeletons are measured by cranial capacities—that is, how much volume, in cubic centimeters, the skull cavity has. Among modem *Homo sapiens,* the average cranial capacity is something like 1400 or 1500 cc. Some men have brain capacities of 1100-1200 cc; Cuvier's brain, on the other hand, had a capacity of 1830 cc, and that of the Russian novelist Turgenev a capacity of 2012!

The average brain capacity of Neanderthal man was about 1600 cc for male skulls, and about 1350 cc for female skulls. This is higher than the average figure for *Homo sapiens.* Does that mean that this big-brained caveman of long ago was more intelligent than modem man?

Not at all. Chimpanzees have smaller brains than gorillas, but are more intelligent than gorillas. Elephants have bigger brains than apes or men, but do not display greater intelligence, even so. Some remarkably intelligent members of *Homo sapiens* have had brains measuring less than 1300 cc, and a good many village idiots have had brain capacities of 1800 cc and upwards.

So Neanderthal man's big brain proves nothing. He certainly was an intelligent creature, but he was not necessarily any cleverer than *Homo sapiens.* It is not necessarily the size of the brain that counts. On the anatomical score. Neanderthal man, with his sloping forehead, may well have been dull-witted. We are fairly certain today that the centers of higher intelligence are located in the front of the brain. Our skulls bulge forward to make room for our frontal brain lobes. Neanderthal man's skull slopped backward; he had very little brain up front, but a great deal indeed in back, where the less intellectual processes of thought are believed to take place.

He was different from us, but not enormously different. In fact, the modem school of anthropologists favors the idea of moving him right into our species and abolishing the name *Homo neanderthalensis.* They would call him *Homo sapiens neanderthalensis,* making him an early type of our own species. We would be termed *Homo sapiens sapiens.*

Certainly a fully dressed, clean-shaven Neanderthal man could walk among us without attracting a crowd. He would seem somewhat stocky, and perhaps rather odd of face. But only by stripping him down to his bones could we get to the real differences between his kind of man and

ours.

The skeletons show that his arm and leg bones, his shoulder blades, and some of his ankle bones are quite different in shape from those of *Homo sapiens*. His bones are heavy, thick, and large-jointed, with signs that his muscles were unusually well developed. His eye sockets are bigger than ours, and of course there is that bulging brow ridge. His nose was huge, a great protruding beak, and the distance between his nose and his upper teeth was greater than it is in us. His teeth differ from ours in many minor ways, his jaw has a shape not quite like that of our jaws, and he has only a rounded lower jaw where we have chin protrusions. His head is big in proportion to his short body, requiring heavy muscles to support it. And there are other differences. He is quite certainly a distinct variety of human being. Yet, as we will see, there are good reasons for welcoming him into our species.

What kind of life did he lead? Again, we can only guess from our limited evidence. He was a hunter, not a farmer; that seems certain. He probably had some sort of language, though it may only have been a few dozen grunts. We cannot tell from his skull and jaws alone whether he was really capable of speech, but it appears likely that he was.

He may have been a barbarian, but he had some civilized ways. Among wild animals and many primitive human tribes, the old and sick are often put to death as a matter of general convenience, but we know that Neanderthals sometimes cared for the elderly and ailing. The Chapelle-aux-Saints man was crippled with arthritis and had only two teeth left. Someone had cared for him, had found food that he could chew and brought it to him, and finally had given him a decent burial. One of the Shanidar men had been born with a withered right arm, which during his lifetime had been amputated by an ancient surgeon. He had lived on for many years after the operation, dying when the roof of his cave collapsed on him. A Neanderthal from La Ferrassie was so arthritic that he could not have chewed his food; someone must have tended him. These are not the acts of savages.

Neanderthal man may have had some sort of religion. He buried his dead, which apes do not do. That indicated some sense of an afterlife, or at least of the importance of preserving the peace of the dead. He buried objects with his dead, too. In one German cave that had been inhabited by Neanderthals, ten bear skulls were found in niches in the walls, as well as in a crude stone box, and more bones of bear on a stone platform. Was the bear sacred to the Neanderthal? The cavern of Montespan in the Pyrenees contained a bear statue, perhaps Neanderthal, perhaps later. There are many such hints of a bear cult among the early inhabitants of Europe.

The earliest true Neanderthal fossils that have been found to date are 150,000 to 200,000 years old. They date from a period known as the “Third Interglacial.” Certain Neanderthal-like types, as we will see, are even older, dating back more than 250,000 years.

Europe and North America, during the Pleistocene, were covered again and again by sheets of ice, great glaciers slowly creeping down over the land. How scientists have worked out our knowledge of the Ice Age is a story by itself; we can simply say here that the present belief is that there were four separate glacial periods over a span of 600,000 to 1,000,000 years, each marked off from the next by an interglacial period. The First and Second Glacial periods and the First Interglacial each lasted about 50,000 to 100,000 years. The Second Interglacial was probably some 200,000 years in duration, and was followed by a relatively brief (60,000 to 100,000 years) Third Glacial.

Then came the Third Interglacial, of about the same length, during which Neanderthal fossils begin to show up in the record; and then a Fourth Glacial, lasting 100,000 years or more, and ending perhaps no more than 10,000 years ago. It may be that we are living in the Fourth Interglacial, and that the sheets of ice will sweep down to destroy our civilization a few tens of thousands of years hence.

Neanderthal man's greatest period of expansion came during the Fourth Glacial. Europe then was an icebox continent, raked by bitter winds, tormented by near-Arctic cold, roamed by woolly beasts like the extinct mammoths and rhinoceroses. The warm-weather creatures had all fled to Africa and Asia, where, in the tropics, heavy rains and mild climate prevailed.

Neanderthal man seems to have withstood the cold very well. He sheltered himself from it in caves, wrapped himself in the hides of the woolly beasts, and endured the deep freeze for hundreds of generations. He was physically well equipped for the cold, thick-bodied and tough and of great physical strength and endurance. One important anthropologist. Carle- ton S. Coon, has argued that even the huge Neanderthal nose was an adaptation to the frosty climate. In his *The Origin of Races* (1962) Coon writes, "Recent military research has shown that in very cold climates it is not so much the lungs but the brain that is in danger of being chilled by inhaled air. The lungs are a long way from the nose. In arctic populations necks are generally short, skulls broad and low, and the distance from nose to lungs less than in many long-necked tropical peoples." The nose, Coon notes, "serves the purpose, among others, of warming and moistening the inhaled air on its way to the lungs." According to Coon, Neanderthal man's big nose was a kind of built-in radiator that kept his brain and lungs from a fatal chill during the Ice Age. In proper Darwinian fashion. Neanderthals who lacked the most useful nasal equipment died young, without leaving children, and only the big-nosed trait was passed along. This theory, it ought to be noted, has not yet won universal scientific acceptance.

The date of Neanderthal man's arrival on the scene is in doubt. The date of his departure is less shadowy, thanks to carbon-14 dating.

Carbon-14 is a radioactive element. Every living creature absorbs it at a steady rate during its life. At death, the C-14 intake stops, and the accumulated supply in the body starts to break down into nonradioactive carbon. Carbon-14 has a "half-life" of about 5700 years, which means that if a creature's body contained an ounce of C-14 at its death, half an ounce would be left after 5700 years, a quarter of an ounce after 11,400 years, an eighth of an ounce after 17,100 years, and so on until a vanishingly small amount of C-14 remained.

In 1947, a group of scientists led by Dr. Willard F. Libby began to perfect a complex and ingenious method for dating organic substances by measuring the quantity of Carbon-14 they contain. The early attempts were not always accurate, but today the technique is widely regarded as the best method of dating the recent past. It cannot be used with objects older than about 50,000 years, since not enough C-14 remains to be measurable. Libby received the 1960 Nobel Prize for Chemistry to honor his work in Carbon-14 dating.

A Neanderthal-occupied cave in Israel provided a C-14 date of about 30,000 years for samples of burned charcoal. (Neanderthal man knew the use of fire, as such remains prove.) A Belgian cave containing Mousterian stone tools also contained a layer of peat whose radiocarbon age was 36,000 years. The Shanidar Cave skeletons were dated at about 46,000 years.

The evidence indicates that there were still Neanderthal men in Europe and the Near East as

late as 30,000 B.C., and possibly as late as 20,000 B.C. By that time our own ancestors, the true *Homo sapiens* type, were firmly entrenched in Europe. With the end of the Fourth Glacial period, Neanderthal man disappears from the archaeological record, as though perhaps wiped out by *Homo sapiens.*

Perhaps.

There are no Neanderthal men alive today in any part of the world, nor have there been any in many thousands of years. That much seems certain. But they may have "survived" in a different way.

The folklore of many lands, particularly Northern European lands, abounds with tales of gnomes, ogres, and trolls. Small, ugly, hairy men are described, living either in caves or underground. They are unpleasant, brutish creatures, sullen and nasty, whose sole delight seems to be to make war on the human race and create as much mischief as possible.

Where did this myth of gnomes and trolls originate? Could it be that the ugly men of the Grimm and Andersen tales, the Nibelungen of the German myths, were Neanderthal survivors, living on into historic times? Did isolated pockets of them survive until only a few thousand years ago, here and there in Europe, the memory of them lingering from generation to generation in tales told to frighten children?

Perhaps!