

LIVES IN EXPLORATION

John Scales Avery

July 31, 2020

INTRODUCTION¹

Epic journeys of humankind

This book traces the history of how humans explored and settled in the entire earth, and in our own times even reached out farther, exploring the outermost parts of the solar system.

Out of Africa

Human history began in Africa. One of the first of our remote ancestors to leave the continent was *Pithocanthropos Erectus*, a species whose remains were discovered in Java by Eugène Dubois in 1894. Remains of members of the species *Homo Erectus* were discovered in China and these early hominids, known as “Peking Man”, were also among the first to leave Africa.

Neanderthals left Africa before modern humans. Their presence outside Africa may have frustrated the first attempts of modern humans to explore and populate the regions outside Africa. *Homo sapiens neanderthalensis* lived side by side with *Homo sapiens sapiens* (modern man) in Europe, for a hundred thousand years. In relatively recent times, only 30,000 years ago, the Neanderthals disappeared. However, modern humans outside Africa intermixed with Neanderthals, and carry a significant amount of the Neanderthal genome.

About 70,000 years before the present, a small band of modern humans left Africa and succeeded in exploring and populating the world outside.

Humans reach Australia

Early humans reached Australia about 50,000 years ago, after intermixing with the Denisovans (the eastern cousins of the Neanderthals). At that time, much water was locked in the ice of a glacial period, and the ocean level was much lower than it is today. The first people in Australia were probably able to see land on the other side whenever they crossed open water. Nevertheless, highly developed sailing skills were still required to make the journey.

¹This book makes use of chapters and articles that I have previously written, but most of the material is new

Crossing the Bering Strait to the Americas

During another ice age, about 20,000 years ago there was a land bridge across what is now the Bering Strait. Humans took advantage of this land bridge, and they reached North America. Travel through the North American continent was impossible at that time, because it was covered with ice. However, much evidence shows that the first humans to arrive there traveled southward along the coast in small boats, living off fish and shellfish. In this way they travelled as far as South America. Traces of very early human habitation have been found on an island off the coast of South America, demonstrating that these pioneering settlers were proficient in the use of boats.

Alexander of Macedon: conqueror or explorer?

In another chapter, we look at the amazing journey through the known world of Alexander of Macedon. Was this purely motivated by a warlike desire for conquest? Or was there a strong element of curiosity behind the young leader's efforts to reach the sea beyond India? In his youth, he had been tutored by Aristotle. Whatever its main motivation was, Alexander's tour through the known world of the time had the effect of blending the cultures of regions through which he passed and creating the cosmopolitan and advanced civilization that we call the Hellenistic Era.

Viking explorers change the world

Between the 8th and 11th centuries AD, Viking conquests and explorations helped to create the modern world. Not only Scandinavia, the Viking heartland, but also Russia, England, France, Germany, Spain and Italy, owe much of their present character to Viking exploration and conquest. Russia takes its name from the Rus Vikings who ruled the region near to Kiev.

Marco Polo

In 1271 AD the 17-year-old Marco Polo set off on a journey to the court of the Mongol emperor, Kublai Khan together with his father and uncle, who were successful Venetian traders, and who had previously visited the great Khan. Arriving at Kublai Khan's summer palace, Shangdu (Xanadu) after four years of travel, they were warmly welcomed by the emperor. Marco Polo

found special favor with Kublai Khan because of his intelligence and humility, and because told the emperor entertaining stories of other countries. Marco Polo became an ambassador in the service of Kublai Khan and remained so for many years. When he finally returned to Venice in 1295, his city was at war with Genoa. Marco Polo was captured and imprisoned by the Genoans, and while in prison, he dictated his recollections to a cell-mate who happened to be an author of colorful romances. The resulting book became immensely popular in Europe. It made Europeans aware of the great wealth and knowledge of Asian civilizations, and it did much to initiate the Age of Exploration.

European voyages of discovery

During the Age of Exploration, initiated by Marco Polo's book, Christopher Columbus rediscovered the American continent in an effort to reach India and China. Columbus has been much honored in America, but today, his reputation has been re-evaluated, and he is criticized for his cruel treatment of the people whom he found living on the Caribbean islands. Indeed, cruelty and greed characterized many of the European explorers of the New World.

Other notable voyages of exploration

Among the other famous voyages of exploration, we can think of explorers, such as Henry Hudson, Samuel de Champlain, Vitus Bering, Meriwether Lewis and William Clark, who increased our knowledge of North America. The Voyage of the Beagle circumnavigated the globe, and led to Darwin's revolutionary theory of evolution through natural selection. Other famous voyages have explored the Arctic and the Antarctic.

Exploration of the solar system

Remarkably, in modern times, humans have extended their explorations into space, setting foot on the moon, and sending unmanned exploratory missions to the farthest planets. The spirit of curiosity and discovery that has motivated these journeys into space is the same as the spirit that has motivated human voyages of discovery throughout history.

Human history as cultural history

We need to reform our teaching of history so that the emphasis will be placed on the gradual growth of human culture and knowledge, a growth to which all nations and ethnic groups have contributed.

This book is part of a series on cultural history. Here is a list of the other books in the series that have, until now, been completed:

- Lives in Education
- Lives in Poetry
- Lives in Painting
- Lives in Engineering
- Lives in Astronomy
- Lives in Chemistry
- Lives in Medicine
- Lives in Ecology
- Lives in Physics
- Lives in Economics
- Lives in the Peace Movement

The pdf files of these books may be freely downloaded and circulated from the following web addresses:

<http://eacpe.org/about-john-scales-avery/>

<https://wsimag.com/authors/716-john-scales-avery>

Contents

1	OUT OF AFRICA	11
1.1	Early ancestors of modern humans	11
1.2	Y-chromosomal DNA and mitochondrial DNA	16
1.3	Exodus: Out of Africa	20
1.4	Joseph Greenberg's classification of languages and DNA analysis	22
2	THE FIRST HUMANS IN AUSTRALIA	29
2.1	Across the open water to Australia	29
2.2	Fire farming and megafauna extinctions	32
3	THE FIRST DISCOVERY OF AMERICA	33
3.1	Early migration across the Bering Strait	33
3.2	Agriculture in the western hemisphere	34
3.3	Ethics of the American Indians	38
4	ALEXANDER OF MACEDON	43
4.1	Alexander's early life and education	43
4.2	Conquest or exploration?	43
4.3	The Hellenistic era	49
4.4	Eratosthenes' map of the world	50
5	VIKING EXPLORERS	57
5.1	A seafaring culture	57
5.2	Icelandic Sagas	61
5.3	Aud the Deep-Minded (9th century)	63
5.4	Cnut the Great	64
5.5	Russia takes its name from the Rus Vikings	68
5.6	Harald Hardrada, 1015-1066	72
5.7	William of Normandy	74
5.8	Erik the Red	76
5.9	Leif Erikson	77

6	MARCO POLO	81
6.1	Family and early life	81
6.2	Marco travels to China with his father and uncle	84
6.3	Return to Venice and capture by the Genoans	90
6.4	History of the Silk Road	93
6.5	Timeline for European exploration of Asia	102
7	EUROPEAN VOYAGES OF DISCOVERY	107
7.1	Prince Henry the Navigator, (1394-1460)	107
7.2	Christopher Columbus, (1451-1506)	109
7.3	John Cabot, (c.1450-c.1500)	111
7.4	Amerigo Vespucci, (1454-1512)	114
7.5	Vasco da Gama, (c.1460-1524)	115
7.6	Ferdinand Magellan, (1480-1521)	117
7.7	Sir Francis Drake, (c.1540-1596)	119
7.8	Abel Tasman, (1603-1659)	121
7.9	James Cook, (1728-1779)	123
8	EXPLORATION OF NORTHERN AMERICA	129
8.1	Henry Hudson, (c.1565-c.1611)	129
8.2	Samuel de Champlain, (1567-1635)	131
8.3	Vitus Bering, (1681-1741)	133
8.4	Meriwether Lewis (1774-1809) and William Clark, (1770-1838)	134
9	THE VOYAGE OF THE BEAGLE	147
9.1	Charles Darwin's life and work	147
9.2	Aboard the Beagle	150
9.3	Work in London and Down	156
9.4	The Origin of Species	157
9.5	The Descent of Man	162
9.6	The Expression of Emotions in Man and Animals; ethology	163
10	POLAR EXPLORATION	169
10.1	Willem Barentsz, (c.1550-1597)	169
10.2	Robert Peary, (1856-1920)	171
10.3	Fridtjof Nansen, (1861-1930)	174
10.4	Robert Falcon Scott, (1868-1912)	175
10.5	Roald Amundsen, (1872-1928)	178
10.6	Ernest Shackleton, (1874-1922)	180
10.7	Knud Rasmussen, (1879-1933)	182

11 SPACE EXPLORATION	193
11.1 Astronautics	193
11.2 Exploration of the Earth's Moon	199
11.3 Missions to Mars	205
11.4 The Cassini-Huygens space probe	210
11.5 Life elsewhere in the universe	219

Chapter 1

OUT OF AFRICA

1.1 Early ancestors of modern humans

In his *Systema Naturae*, published in 1735, Carolus Linnaeus correctly classified humans as mammals associated with the anthropoid apes. However, illustrations of possible ancestors of humans in a later book by Linnaeus, showed one with a manlike head on top of a long-haired body, and another with a tail. A century later, in 1856, light was thrown on human ancestry by the discovery of some remarkable bones in a limestone cave in the valley of Neander, near Düsseldorf - a skullcap and some associated long bones. The skullcap was clearly manlike, but the forehead was low and thick, with massive ridges over the eyes. The famous pathologist Rudolf Virchow dismissed the find as a relatively recent pathological idiot. Other authorities thought that it was “one of the Cossacks who came from Russia in 1814”. Darwin knew of the “Neanderthal man”, but he was too ill to travel to Germany and examine the bones. However, Thomas Huxley examined them, and in his 1873 book, *Zoological Evidences of Man’s Place in Nature*, he wrote: “Under whatever aspect we view this cranium... we meet with apelike characteristics, stamping it as the most pithecoïd (apelike) of human crania yet discovered.”

“In some older strata,” Huxley continued, “do the fossilized bones of an ape more anthropoid, or a man more pithecoïd, than any yet known await the researches of some unborn paleontologist?” Huxley’s question obsessed Eugene Dubois, a young Dutch physician, who reasoned that such a find would be most likely in Africa, the home of chimpanzees and gorillas, or in the East Indies, where orang-outangs live. He was therefore happy to be appointed to a post in Sumatra in 1887. While there, Dubois heard of a site in Java where the local people had discovered many ancient fossil bones, and at this site, after much searching, he uncovered a cranium which was much too low and flat to have belonged to a modern human. On the other hand it had features which proved that it could not have belonged to an ape. Near the cranium, Dubois found a leg bone which clearly indicated upright locomotion, and which he (mistakenly) believed to belong to the same creature. In announcing his find in 1894, Dubois proposed the provocative name “*Pithecanthropus erectus*”, i.e. “upright-walking ape-man” Neand

Instead of being praised for this discovery, Dubois was denounced. His attackers included not only the clergy, but also many scientists (who had expected that an early ancestor of man would have an enlarged brain associated with an apelike body, rather than apelike head associated with upright locomotion). He patiently exhibited the fossil bones at scientific meetings throughout Europe, and gave full accounts of the details of the site where he had unearthed them. When the attacks nevertheless continued, Dubois became disheartened, and locked the fossils in a strongbox, out of public view, for the next 28 years. In 1923, however, he released a cast of the skull, which showed that the brain volume was about 900 cm^3 - well above the range of apes, but below the $1200\text{-}1600 \text{ cm}^3$ range which characterizes modern man. Thereafter he again began to exhibit the bones at scientific meetings.

The fossil bones of about 1000 hominids, intermediate between apes and humans, have now been discovered. The oldest remains have been found in Africa. Many of these were discovered by Raymond Dart and Robert Broom, who worked in South Africa, and by Louis and Mary Leakey and their son Richard, who made their discoveries at the Olduvai Gorge in Tanzania and at Lake Rudolph in Kenya. Table 6.1 shows some of the more important species and their approximate dates.

One can deduce from biochemical evidence that the most recent common ancestor of the anthropoid apes and of humans lived in Africa between 5 and 10 million years before the present. Although the community of palaeoanthropologists is by no means unanimous, there is reasonably general agreement that while *A. africanus* is probably an ancestor of *H. habilis* and of humans, the “robust” species, *A. aethiopicus*, *A. robustus* and *A. boisei*¹ represent a sidebranch which finally died out. “*Pithecanthropus erectus*”, found by Dubois, is now classified as a variety of *Homo erectus*, as is “*Sinanthropus pekinensis*” (“Peking man”), discovered in 1929 near Beijing, China.

Footprints 3.7 million years old showing upright locomotion have been discovered near Laetoli in Tanzania. The Laetoli footprints are believed to have been made by *A. afarensis*, which was definitely bipedal, but upright locomotion is thought to have started much earlier. There is even indirect evidence which suggests that *A. ramidus* may have been bipedal. *Homo habilis* was discovered by Mary and Louis Leakey at the Olduvai Gorge, among beds of extremely numerous pebble tools. The Leakeys gave this name (meaning “handy man”) to their discovery in order to call special attention to his use of tools. The brain of *H. habilis* is more human than that of *A. africanus*, and in particular, the bulge of Broca’s area, essential for speech, can be seen on one of the skull casts. This makes it seem likely that *H. habilis* was capable of at least rudimentary speech.

Homo erectus was the first species of homonid to leave Africa, and his remains are found not only there, but also in Europe and Asia. “Peking man”, who belonged to this species, probably used fire. The stone tools of *H. erectus* were more advanced than those of *H. habilis*; and there is no sharp line of demarcation between the most evolved examples of *H. erectus* and early fossils of archaic *H. sapiens*.

¹ *A. boisei* was originally called “*Zinjanthropus boisei*” by Mary and Louis Leakey who discovered the fossil remains at the Olduvai Gorge. Charles Boise helped to finance the Leakey’s expedition.



Figure 1.1: *Australopithecus afarensis* lived between 3.9 and 2.9 million years ago, and walked upright. The most famous example of this homonid was given the name Lucy.



Figure 1.2: *Homo erectus*. Fossil evidence for this homonid starts 1.9 million years ago. *Homo erectus* left Africa and spread throughout Eurasia, as far as Georgia, Armenia, India, Sri Lanka, China and Indonesia.



Figure 1.3: *Homo sapiens neanderthalis*. Neanderthal man lived in Europe until about 30,000 years before the present and interbred with modern humans (*Homo sapiens sapiens*).

Homo sapiens neanderthalensis lived side by side with *Homo sapiens sapiens* (modern man) for a hundred thousand years; but in relatively recent times, only 30,000 years ago, Neanderthal man disappeared. Did modern man out-compete him? Do present-day humans carry any Neanderthal genes? To what extent was modern man influenced by Neanderthal cultural achievements? Future research may tell us the answers to these questions, but for the moment they are mysteries.

The early ancestors of modern humans show an overall progression in various characteristics: Their body size and brain size grew. They began to mature more slowly and to live longer. Their tools and weapons increased in sophistication. Meanwhile their teeth became smaller, and their skeletons more gracile - less heavy in proportion to their size. What were the evolutionary forces which produced these changes? How were they rewarded by a better chance of survival?

Our ancestors moved from a forest habitat to the savannas of Africa. They changed from a vegetarian diet to an omnivorous one, becoming hunter-gatherers. The primate hand, evolved for grasping branches in a forest environment, found new uses. Branches and stones became weapons and tools - essential to hunters whose bodies lacked powerful claws and teeth. With a premium on skill in making tools, brain size increased. The beginnings of language helped to make hunts successful, and also helped in transmitting cultural skills, such as toolmaking and weaponmaking, from one generation to the next.

A modern human baby is almost entirely helpless. Compared with off- spring of grazing animals, which are able to stand up and follow the herd immediately after birth, a human baby's development is almost ludicrously slow. However, there is nothing slow about the rate at which a young member of our species learns languages. Between the ages of

one and four, young humans develop astonishing linguistic skills, far surpassing those of any other animal on earth. In the learning of languages by human children there is an interplay between genes and culture: The language learned is culturally determined, but the predisposition to learn some form of speech seems to be an inherited characteristic. For example, human babies of all nationalities have a tendency to “babble” - to produce random sounds. The sounds which they make are the same in all parts of the world, and they may include many sounds which are not used in the languages which the babies ultimately learn.

In his book, *Descent of Man* (John Murray, London, 1871) Charles Darwin wrote: “Man has an instinctive tendency to speak, as we see in the babble of young children, while no child has an instinctive tendency to bake, brew or write.” Thus Darwin was aware of the genetic component of learning of speech by babies. When our ancestors began to evolve a complex language and culture, it marked the start of an entirely new phase in the evolution of life on earth.

1.2 Y-chromosomal DNA and mitochondrial DNA

Recent DNA studies have cast much light on human prehistory, and especially on the story of how a small group of anatomically and behaviorally modern humans left Africa and populated the remainder of the world. Two types of DNA have been especially useful - Y-chromosomal DNA and mitochondrial DNA.

When we reproduce, the man's sperm carries either an X chromosome or a Y chromosome. It is almost equally probable which of the two it carries. The waiting egg of the mother has an X chromosome with complete certainty. When the sperm and egg unite to form a fertilized egg and later an embryo, the YX combinations become boys while the XX combinations become girls. Thus every male human carries a Y chromosome inherited from his father, and in fact this chromosome exists in every cell of a male's body.

Humans have a total of 23 chromosomes, and most of these participate in what might be called the "genetic lottery" - part of the remaining 22 chromosomes come from the father, and part from the mother, and it is a matter of chance which parent contributes which chromosome. Because of this genetic lottery, no two humans are genetically the same, except in the case of identical twins. This diversity is a great advantage, not only because it provides natural selection variation on which to act, but also it because prevents parasites from mimicking our cell-surface antigens and thus outwitting our immune systems. In fact the two advantages of diversity just mentioned are so great that sexual reproduction is almost universal among higher animals and plants.

Because of its special role in determining the sex of offspring, the Y chromosome is exempted from participation in the genetic lottery. This makes it an especially interesting object of study because the only changes that occur in Y chromosomes as they are handed down between generations are mutations. These mutations are not only infrequent but they also happen at a calculable rate. Thus by studying Y-chromosomal lineages, researchers have been able not only to build up prehistoric family trees but also to assign dates to events associated with the lineages.

The mutation M168 seems to have occurred just before the ancestral population of anatomically and behaviorally modern humans left Africa, roughly 60,000 years ago. All of the men who left Africa at that time carried this mutation. The descendents of this small group, probably a single tribe, were destined to populate the entire world outside Africa.

After M168, further mutations occurred, giving rise to the Y-chromosomal groups C, D, E and F-R. Men carrying Y chromosomes of type C migrated to Central Asia, East Asia and Australia/New Guinea. The D group settled in Central Asia, while men carrying Y chromosomes of type E can be found today in East Asia, Sub-Saharan Africa, the Middle East, West Eurasia, and Central Asia. Populations carrying Y chromosomes of types F-R migrated to all parts of the world outside Africa. Those members of population P who found their way to the Americas carried the mutation M242. Only indigenous men of the Americas have Y chromosomes with M242.

Mitochondrial DNA is present in the bodies of both men and women, but is handed on only from mother to daughter. The human family tree constructed from mutations in

mitochondrial DNA is closely parallel to the tree constructed by studying Y chromosomes. In both trees we see that only a single small group left Africa, and that the descendants of this small group populated the remainder of the world. The mitochondrial groups L1a, L1b, and L2 are confined to Sub-Saharan Africa, but by following the lineage L3 we see a path leading out of Africa towards the population of the remainder of the world, as is shown in the next figure.

While the unmutated L3 lineage remained in Africa, a slightly changed group of people found their way out. It seems to have been a surprisingly small group, perhaps only a single tribe. Their descendants populated the remainder of the world. The branching between the N and M lineages occurred after their exodus from Africa. All women in Western Eurasia are daughters of the N line, while in Eastern Eurasia women are descended from both the N and M lineages. Daughters of both N and M reached the Americas.

Mitochondrial DNA is also exempted from participation in the genetic lottery, but for a different reason. Mitochondria were once free-living eubacteria of a type called alpha-proteobacteria. These free-living bacteria were able to perform oxidative phosphorylation, i.e. they could couple the combustion of glucose to the formation of the high-energy phosphate bond in ATP. When photosynthesis evolved, the earth's atmosphere became rich in oxygen, which was a deadly poison to most of the organisms alive at the time. Two billion years ago, when atmospheric oxygen began to increase in earnest, many organisms retreated into anaerobic ecological niches, while others became extinct; but some survived the oxygen crisis by incorporating alpha-proteobacteria into their cells and living with them symbiotically. Today, mitochondria living as endosymbionts in all animal cells, use oxygen constructively to couple the burning of food with the synthesis of ATP. As a relic of the time when they were free-living bacteria, mitochondria have their own DNA, which contained within them rather than within the cell nuclei.

When a sperm and an egg combine, the sperm's mitochondria are lost; and therefore all of the mitochondria in the body of a human child come from his or her mother. Just as Y-chromosomal DNA is passed essentially unchanged between generations in the male lines of a family tree, mitochondrial DNA is passed on almost without change in the female lines. The only changes in both cases are small and infrequent mutations. By estimating the frequency of these mutations, researchers can assign approximate dates to events in human prehistory.

Mitochondrial Eve and Y-Chromosomal Adam

On the female side of the human family tree, all lines lead back to a single woman, whom we might call "Mitochondrial Eve". Similarly, all the lines of the male family tree lead back to a single man, to whom we can give the name "Y-Chromosomal Adam". ("Eve" and "Adam" were not married, however; they were not even contemporaries!)

But why do the female and male family trees both lead back to single individuals? This has to do with a phenomenon called "genetic drift". Sometimes a man will have no sons, and in that case, his male line will end, thus reducing the total number of Y-chromosomes in the population. Finally, after many generations, all Y-chromosomes will

Table 1.1: **Events leading up to the dispersal of fully modern humans from Africa (a model proposed by Sir Paul Mellars).**

Years before present	Event
150,000-200,000 BP	Initial emergence of anatomically modern populations in Africa
110,000-90,000 BP	Temporary dispersal of anatomically modern populations (with Middle Paleolithic technology) from Africa to southwest Asia, associated with clear symbolic expression
80,000-70,000 BP	Rapid climatic and environmental changes in Africa
80,000-70,000 BP	Major technological, economic and social changes in south and east Africa
70,000-60,000 BP	Major population expansion in Africa from small source area
ca. 60,000 BP	Dispersal of modern populations from Africa to Eurasia

have dropped away through the ending of male lines except those that can be traced back to a single individual. Similar considerations hold for female lines.

When did Y-Chromosomal Adam walk the earth? Peter Underhill and his colleagues at Stanford University calculate that, on the basis of DNA evidence, Adam lived between 40,000 and 140,000 years before the present (BP). However, on the basis of other evidence (for example the dating of archaeological sites in Australia) 40,000 years BP can be ruled out as being much too recent. Similar calculations on the date of Mitochondrial Eve find that she lived very approximately 150,000 years BP, but again there is a wide error range.



Figure 1.4: A 2014 photograph of Prof. Dr. Svante Pääbo, one of the founders of paleogenetics. In 1997, Pääbo and his colleagues at the Max Planck Institute for Evolutionary Anthropology reported their successful sequencing of Neanderthal mitochondrial DNA. Later they sequenced the DNA of Denisovans, the eastern cousins of the Neanderthals. They were also able to show that 3-5% of the DNA of humans living outside Africa is shared with Neanderthals and Denisovans, indicating intermarriage.

1.3 Exodus: Out of Africa

A model for the events leading up to the exodus of fully modern humans from Africa has been proposed by Sir Paul Mellars of Cambridge University, and it is shown in Table 6.3. In the article on which this table is based, Mellars calls our attention to archaeological remains of anatomically modern humans at the sites of Skhul and Qafzeh in what is now northern Israel. The burials have been dated as having taken place 110,000-90,000 BP, and they show signs of cultural development, including ceremonial arrangement with arms folded, and sacrificial objects such as pierced shell ornaments. This early exodus was short-lived, however, probably because of competition with the long-established Neanderthal populations in the region.

In Mellars' model, rapid climatic and environmental changes took place in Africa during the period 80,000-70,000 BP. According to the Toba Catastrophe Theory² the climatic changes in Mellars' model were due to the eruption of a supervolcano at the site of what is now Lake Toba in Indonesia. This eruption, one of the largest known to us, took place ca. 73,000 BP, and plunged the earth into a decade of extreme cold, during which the population of our direct ancestors seem to have been reduced to a small number, perhaps as few as 10,000 individuals³.

The survivors of the Toba Catastrophe may have been selected for improved linguistic ability, which gave them a more advanced culture than their contemporaries. Mellars points to archaeological and genetic evidence that a major population expansion of the L2 and L3 mitochondrial lineages took place in Africa 70,000-60,000 BP, starting from a small source region in East Africa, and spreading west and south. The expanding L2 and L3 populations were characterized by advanced cultural features such as upper paleolithic technology, painting and body ornaments.

All researchers agree that it was a small group of the L3 mitochondrial lineage that made the exodus from Africa, but there is some disagreement about the date of this event. These differences reflect the intrinsic inaccuracy of the genetic dating methods, but all researchers agree that the group passing out of Africa was remarkably small, especially when we reflect that the entire population of the remainder of the world is descended from them.

The small group of modern humans leaving Africa probably crossed the Red Sea at its narrowest point⁴. The men in this tiny but brave group of explorers carried with them the Y-chromosomal mutation M168, while the women were of the mitochondrial lineage L3. Shortly after they crossed the Red Sea (like Moses and his followers), a mutation occurred and two new mitochondrial lineages were established, M and N. All women today

²The Toba Catastrophe Theory is supported by such authors as Ann Gibbons, Michael R. Rampino and Steven Self

³Additional support to the Toba Catastrophe Theory comes from DNA studies of mammals, such as chimpanzees, orangutans, macques, cheetahs, tigers and gorillas. These mammals also seem, on the basis of DNA studies, to have been reduced to very small populations at the time of the Toba eruption.

⁴Today this narrow place is sometimes called "Gate of Grief" because many shipwrecks take place there.

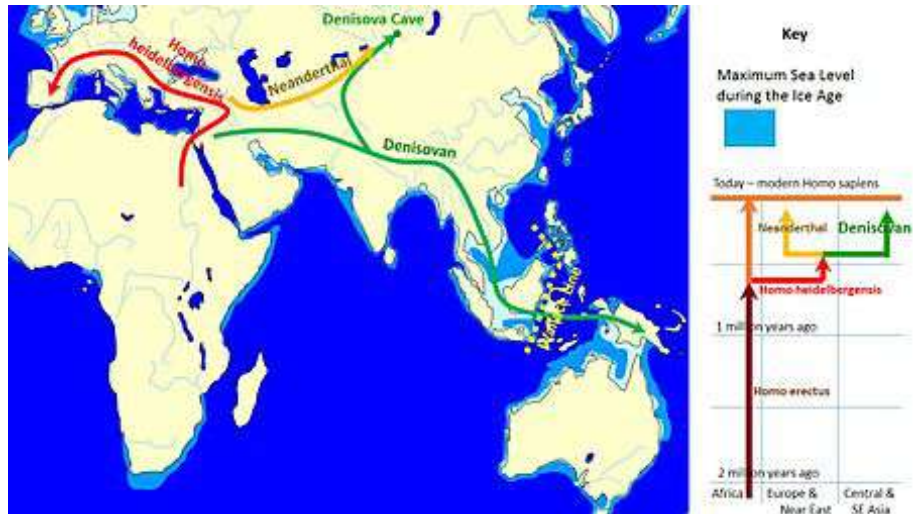


Figure 1.5: Spread and evolution of the Denisovans

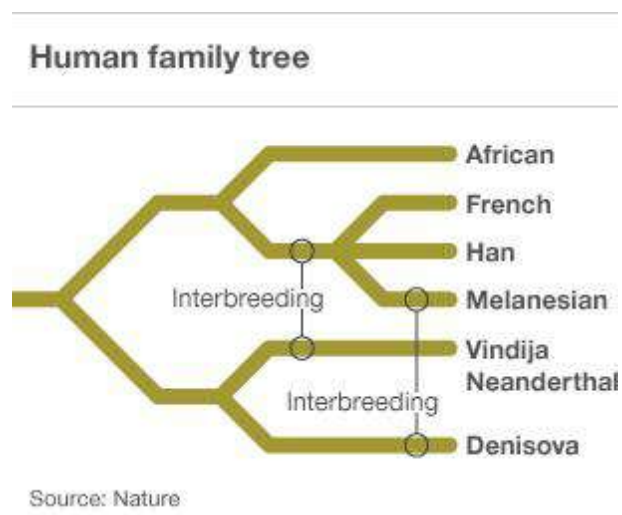


Figure 1.6:

in Western Eurasia are daughters of the N lineage⁵, while the M lineage spread to the entire world outside Africa. The mitochondrial lineages M and N had further branches, and daughters of the A, B, C, D and X lineages passed over a land bridge which linked Siberia to Alaska during the period 22,000-7,000 BP, thus reaching the Americas.

1.4 Joseph Greenberg's classification of languages and DNA analysis

In his excellent and fascinating book *Before the Dawn*, the science journalist Nicholas Wade discusses linguistic studies that support the early human migration scenarios that can be deduced from DNA research. The work of the unconventional but visionary linguist Joseph Greenberg of Stanford University is particularly interesting.

While other linguists were content to demonstrate relationships between a few languages, such as those in the Indo-European family, Greenberg attempted to arrange all known languages into an enormous family tree. He published this work in the 1950's, long before the DNA studies that we have just been discussing, and because of what other linguists regarded as lack of rigor in his methods, Greenberg's prophetic voice was largely ignored by his peers. The linguist Paul Newman recalls visiting the London School of Oriental and African Studies ca. 1970. He was told that he could use the Common Room as long as he promised never to mention the name of Joseph Greenberg.

Finally, after Joseph Greenberg's death, his visionary studies were vindicated by DNA-based human migration scenarios, which agreed in surprising detail with the great but neglected scholar's linguistically-based story of how early humans left their ancestral homeland in Africa and populated the entire earth.

The Wikipedia article on Joseph Greenberg states that "Greenberg's reputation rests partly on his contributions to synchronic linguistics and the quest to identify linguistic

⁵Of course, this broad statement does not take into account the movements of peoples that have taken place during historic times.



Figure 1.7: A photograph of the great but controversial linguist Joseph Greenberg (1915-2001). After his death, his visionary studies were vindicated by DNA-based human migration scenarios, which agreed in surprising detail with Greenberg's linguistically-based story of how early humans left their ancestral homeland in Africa and populated the entire earth.

universals. During the late 1950s, Greenberg began to examine languages covering a wide geographic and genetic distribution. He located a number of interesting potential universals as well as many strong cross-linguistic tendencies.

"In particular, Greenberg conceptualized the idea of 'implicational universal', which has the form, 'if a language has structure X, then it must also have structure Y.' For example, X might be 'mid front rounded vowels' and Y 'high front rounded vowels' (for terminology see phonetics). Many scholars adopted this kind of research following Greenberg's example and it remains important in synchronic linguistics.

"Like Noam Chomsky, Greenberg sought to discover the universal structures on which human language is based. Unlike Chomsky, Greenberg's method was functionalist, rather than formalist. An argument to reconcile the Greenbergian and Chomskyan methods can be found in *Linguistic Universals* (2006), edited by Ricardo Mairal and Juana Gil."

Suggestions for further reading

1. Mairal. Ricardo and Juana Gil, (2006), *Linguistic Universals*, Cambridge University Press.
2. Chafe, Wallace. (1987). [Review of Greenberg 1987]. *Current Anthropology*, 28, 652-653.
3. Goddard, Ives. (1987). [Review of Joseph Greenberg, *Language in the Americas*]. *Current Anthropology*, 28, 656-657.
4. Goddard, Ives. (1990). [Review of *Language in the Americas* by Joseph H. Greenberg]. *Linguistics*, 28, 556-558.
5. Golla, Victor. (1988). [Review of *Language in the Americas*, by Joseph Greenberg]. *American Anthropologist*, 90, 434-435.
6. Kimball, Geoffrey. (1992). A critique of Muskogean, 'Gulf,' and Yukian materials in *Language in the Americas*. *International Journal of American Linguistics*, 58, 447-501.
7. Poser, William J. (1992). The Salinan and YurumanguÃ data in *Language in the Americas*. *International Journal of American Linguistics*, 58 (2), 202-229. PDF
8. D.R. Griffin, *Animal Mind - Human Mind*, Dahlem Konferenzen 1982, Springer, Berlin, (1982).
9. S. Savage-Rumbaugh, R. Lewin, et al., *Kanzi: The Ape at the Brink of the Human Mind*, John Wiley and Sons, New York, (1996).
10. R. Dunbar, *Grooming, Gossip, and the Evolution of Language*, Harvard University Press, (1998).
11. J.H. Greenberg, *Research on language universals*, *Annual Review of Anthropology*, 4, 75-94 (1975).
12. M.E. Bitterman, *The evolution of intelligence*, *Scientific American*, January, (1965).
13. R. Fox, *In the beginning: Aspects of hominid behavioral evolution*, *Man*, **NS 2**, 415-433 (1967).
14. M.S. Gazzaniga, *The split brain in man*, *Scientific American*, **217**, 24-29 (1967).

15. D. Kimura, *The asymmetry of the human brain*, Scientific American, **228**, 70-78 (1973).
16. R.G. Klein, *Anatomy, behavior, and modern human origins*, Journal of World Prehistory, **9** (2), 167-198 (1995).
17. N.G. Jablonski and L.C. Aiello, editors, *The Origin and Diversification of Language*, Wattis Symposium Series in Anthropology. Memoirs of the California Academy of Sciences, **No. 24**, The California Academy of Sciences, San Francisco, (1998).
18. S. Pinker, *The Language Instinct: How the Mind Creates Language*, Harper-Collins Publishers, New York, (1995).
19. J.H. Barkow, L. Cosmides and J. Tooby, editors, *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, Oxford University Press, (1995).
20. D.R. Begun, C.V. Ward and M.D. Rose, *Function, Phylogeny and Fossils: Miocene Hominid Evolution and Adaptations*, Plenum Press, New York, (1997).
21. R.W. Byrne and A.W. Whitten, *Machiavellian Intelligence: Social Expertise and the Evolution of Intellect in Monkeys, Apes and Humans*, Cambridge University Press, (1988),
22. V.P. Clark, P.A. Escholz and A.F. Rosa, editors, *Language: Readings in Language and Culture*, St Martin's Press, New York, (1997).
23. T.W. Deacon, *The Symbolic Species: The Co-evolution of Language and the Brain*, W.W. Norton and Company, New York, (1997).
24. C. Gamble, *Timewalkers: The Prehistory of Global Colonization*, Harvard University Press, (1994).
25. K.R. Gibson and T. Ingold, editors, *Tools, Language and Cognition in Human Evolution*, Cambridge University Press, (1993).
26. P. Mellars, *The Emergence of Modern Humans: An Archeological Perspective*, Edinburgh University Press, (1990).
27. P. Mellars, *The Neanderthal Legacy: An Archeological Perspective of Western Europe*, Princeton University Press, (1996).
28. S. Mithen, *The Prehistory of the Mind*, Thames and Hudson, London, (1996).
29. D. Haraway, *Signs of dominance: from a physiology to a cybernetics, of primate biology*, C.R. Carpenter, 1939-1970, Studies in History of Biology, **6**, 129-219 (1983).
30. D. Johanson and M. Edey, *Lucy: The Beginnings of Humankind*, Simon and Schuster, New York, (1981).
31. B. Kurten, *Our Earliest Ancestors*, Colombia University Press, New York, (1992).
32. R. Lass, *Historical Linguistics and Language Change*, Cambridge University Press, (1997).
33. R.E. Leakey and R. Lewin, *Origins Reconsidered*, Doubleday, New York, (1992).
34. P. Lieberman, *The Biology and Evolution of Language*, Harvard University Press, (1984).
35. C.S.L. Lai, S.E. Fisher, J.A. Hurst, F. Vargha-Khadems, and A.P. Monaco, *A forkhead-domain gene is mutated in a severe speech and language disorder*, Nature, **413**, 519-523, (2001).

36. W. Enard, M. Przeworski, S.E. Fisher, C.S.L. Lai, V. Wiebe, T. Kitanoto, A.P. Monaco, and S. Paabo, *Molecular evolution of FOXP2, a gene involved in speech and language*, Nature AOP, published online 14 August 2002.
37. M. Gopnik and M.B. Crago, *Familial aggregation of a developmental language disorder*, Cognition, **39**, 1-50 (1991).
38. K.E. Watkins, N.F. Dronkers, and F. Vargha-Khadem, *Behavioural analysis of an inherited speech and language disorder. Comparison with acquired aphasia*, Brain, **125**, 452-464 (2002).
39. J.D. Wall and M. Przeworski, *When did the human population size start increasing?*, Genetics, **155**, 1865-1874 (2000).
40. L. Aiello and C. Dean, *An Introduction to Human Evolutionary Anatomy*, Academic Press, London, (1990).
41. F. Ikawa-Smith, ed., *Early Paleolithic in South and East Asia*, Mouton, The Hague, (1978).
42. M. Aitken, *Science Based Dating in Archeology*, Longman, London, (1990).
43. R.R. Baker, *Migration: Paths Through Space and Time*, Hodder and Stoughton, London, (1982).
44. P. Bellwood, *Prehistory of the Indo-Malaysian Archipelago*, Academic Press, Sidney, (1985).
45. P.J. Bowler, *Theories of Human Evolution: A Century of Debate, 1884-1944*, Basil Blackwell, Oxford, (1986).
46. G. Isaac and M. McCown, eds., *Human Origins: Louis Leaky and the East African Evidence*, Benjamin, Menlo Park, (1976).
47. F.J. Brown, R. Leaky, and A. Walker, *Early Homo erectus skeleton from west Lake Turkana, Kenya*, Nature, **316**, 788-92 (1985).
48. K.W. Butzer, *Archeology as Human Ecology*, Cambridge University Press, (1982).
49. A.T. Chamberlain and B.A. Wood, *Early hominid phylogeny*, Journal of Human Evolution, **16**, 119-33, (1987).
50. P. Mellars and C. Stringer, eds., *The Human Revolution: Behavioural and Biological Perspectives in the Origins of Modern Humans*, Edinburgh University Press, (1989).
51. G.C. Conroy, *Primate Evolution*, W.W. Norton, New York, (1990).
52. R.I.M. Dunbar, *Primate Social Systems*, Croom Helm, London, (1988).
53. B. Fagan, *The Great Journey: The Peopling of Ancient America*, Thames and Hudson, London, (1987).
54. R.A. Foley, ed., *Hominid Evolution and Community Ecology*, Academic Press, New York, (1984).
55. S.R. Binford and L.R. Binford, *Stone tools and human behavior*, Scientific American, **220**, 70-84, (1969).
56. G. Klein, *The Human Career, Human Biological and Cultural Origins*, University of Chicago Press, (1989).
57. B.F. Skinner and N. Chomsky, *Verbal behavior*, Language, **35**, 26-58 (1959).
58. D. Bickerton, *The Roots of Language*, Karoma, Ann Arbor, Mich., (1981).

59. E. Lenneberg in *The Structure of Language: Readings in the Philosophy of Language*, J.A. Fodor and J.A. Katz editors, Prentice-Hall, Englewood Cliffs N.J., (1964).
60. S. Pinker, Talk of genetics and visa versa, *Nature*, **413**, 465-466, (2001).
61. S. Pinker, *Words and rules in the human brain*, *Nature*, **387**, 547-548, (1997).
62. M. Ruhelen, *The Origin of Language*, Wiley, New York, (1994).
63. C.B. Stringer and R. McKie, *African Exodus: The Origins of Modern Humanity*, Johnathan Cape, London (1996).
64. R. Lee and I. DeVore, editors, *Kalahari Hunter-Gatherers*, Harvard University Press, (1975).
65. R.W. Sussman, *The Biological Basis of Human Behavior*, Prentice Hall, Englewood Cliffs, (1997).
66. D. Schamand-Besserat, *Before Writing, Volume 1, From Counting to Cuneiform*, University of Texas Press, Austin, (1992).
67. D. Schmandt-Besserat, *How Writing Came About*, University of Texas Press, Austin, (1992).
68. A. Robinson, *The Story of Writing*, Thames, London, (1995).
69. A. Robinson, *Lost Languages: The Enigma of the World's Great Undeciphered Scripts*, McGraw-Hill, (2002).
70. D. Jackson, *The Story of Writing*, Taplinger, New York, (1981).
71. G. Jeans, *Writing: The Story of Alphabets and Scripts*, Abrams and Thames, (1992).
72. W.M. Senner, editor, *The Origins of Writing*, University of Nebraska Press, Lincoln and London, (1989).
73. F. Coulmas, *The Writing Systems of the World*, Blackwell, Oxford, (1989).
74. F. Coulmas, *The Blackwell Encyclopedia of Writing Systems*, Blackwell, Oxford, (1996).
75. P.T. Daniels and W. Bright, editors, *The World's Writing Systems*, Oxford University Press, (1996).
76. H.J. Nissen, *The Early History of the Ancient Near East, 9000-2000 B.C.*, University of Chicago Press, (1988).
77. H.J. Nissen, *Archaic Bookkeeping: Early Writing and Techniques of Economic Administration in the Ancient Near East*, University of Chicago Press, (1993).
78. J. Bottero, *Ancient Mesopotamia: Everyday Life in the First Civilization*, Edinburgh University Press, (2001).
79. J. Bottero, *Mesopotamia: Writing, Reasoning and the Gods*, University of Chicago Press, (1992).
80. J.T. Hooker, *Reading the Past: Ancient Writing, from Cuneiform to the Alphabet*, University of California Press, Berkeley and Los Angeles, (1990).
81. W.A. Fairervis, Jr., *The Script of the Indus Valley*, *Scientific American*, March (1983), 41-49.
82. C.H. Gordon, *Forgotten Scripts: Their Ongoing Discovery and Decipherment*, Dorset Press, New York, (1992).
83. G. Ferraro, *Cultural Anthhropology, 3rd Edition*, Wadsworth, Belmont CA, (1998).
84. R. David, *Handbook to Life in Ancient Egypt*, Facts on File, New York, (1998).

85. D. Sandison, *The Art of Egyptian Hieroglyphs*, Reed, London, (1997).
86. K.T. Zauzich, *Hieroglyphs Without Mystery*, University of Texas Press, Austin, (1992).
87. B. Watterson, *Introducing Egyptian Hieroglyphs*, Scottish Academic Press, Edinburgh, (1981).
88. M. Pope, *The Story of Decipherment, from Egyptian Hieroglyphs to Maya Script*, Thames and Hudson, London, (1999).
89. M.D. Coe, *Breaking the Maya Script*, Thames and Hudson, New York, (1992).
90. M.D. Coe, *The Maya, 5th Edition*, Thames and Hudson, New York, (1993).
91. M.D. Coe, *Mexico: From the Olmecs to the Aztecs, 4th Edition*, Thames and Hudson, New York, (1994).
92. D. Preidel, L. Schele and J. Parker, *Maya Cosmos: Three Thousand Years on the Shaman's Path*, William Morrow, New York, (1993).
93. W.G. Bolz, *The Origin and Early Development of the Chinese Writing System*, American Oriental Society, New Haven Conn., (1994).
94. T.F. Carter, *The Invention of Printing in China and its Spread Westward*, Ronald Press, (1925).
95. E. Eisenstein, *The Printing Revolution in Early Modern Europe*, Cambridge University Press, (1983).
96. M. Olmert, *The Smithsonian Book of Books*, Wing Books, New York, (1992).

Chapter 2

THE FIRST HUMANS IN AUSTRALIA

2.1 Across the open water to Australia

In an article entitled *How Did the First People Get to Australia?*, published on April 2, 2018 by RealClear Science, Kasih Norman wrote:

“The First Australians were among the world’s earliest great ocean explorers, undertaking a remarkable 2,000km maritime migration through Indonesia which led to the discovery of Australia at least 65,000 years ago.

“But the voyaging routes taken through Indonesia’s islands, and the location of first landfall in Australia, remain a much debated mystery to archaeologists.

“Our research, published earlier this year in *Quaternary Science Reviews*, highlights the most likely route by mapping islands in the region over time through changing sea levels.

“The rise in global ocean levels at the end of the last ice age at around 18,000 years ago flooded continental shelves across the world, reshaping land-masses. This event drowned the ancient continent of Sunda, creating many of Indonesia’s islands, and split the continent of Sahul into Australia and New Guinea.

“This means that what is now under the ocean is very important to understanding where the First Australians might have made landfall.

“When people first migrated to Indonesia, reaching Australia by 65,000 years ago, they found a landscape that looked very different from today. During an ice age known as Marine Isotope Stage 4, which stretched from roughly 71,000 to 59,000 years ago, western Indonesia formed part of the Pleistocene continent of Sunda, while Australia and New Guinea were joined to form Sahul.”

The maps shown below are taken from Kasih Norman’s article. They show what the first Australians could have seen across the water before embarking in their boats.

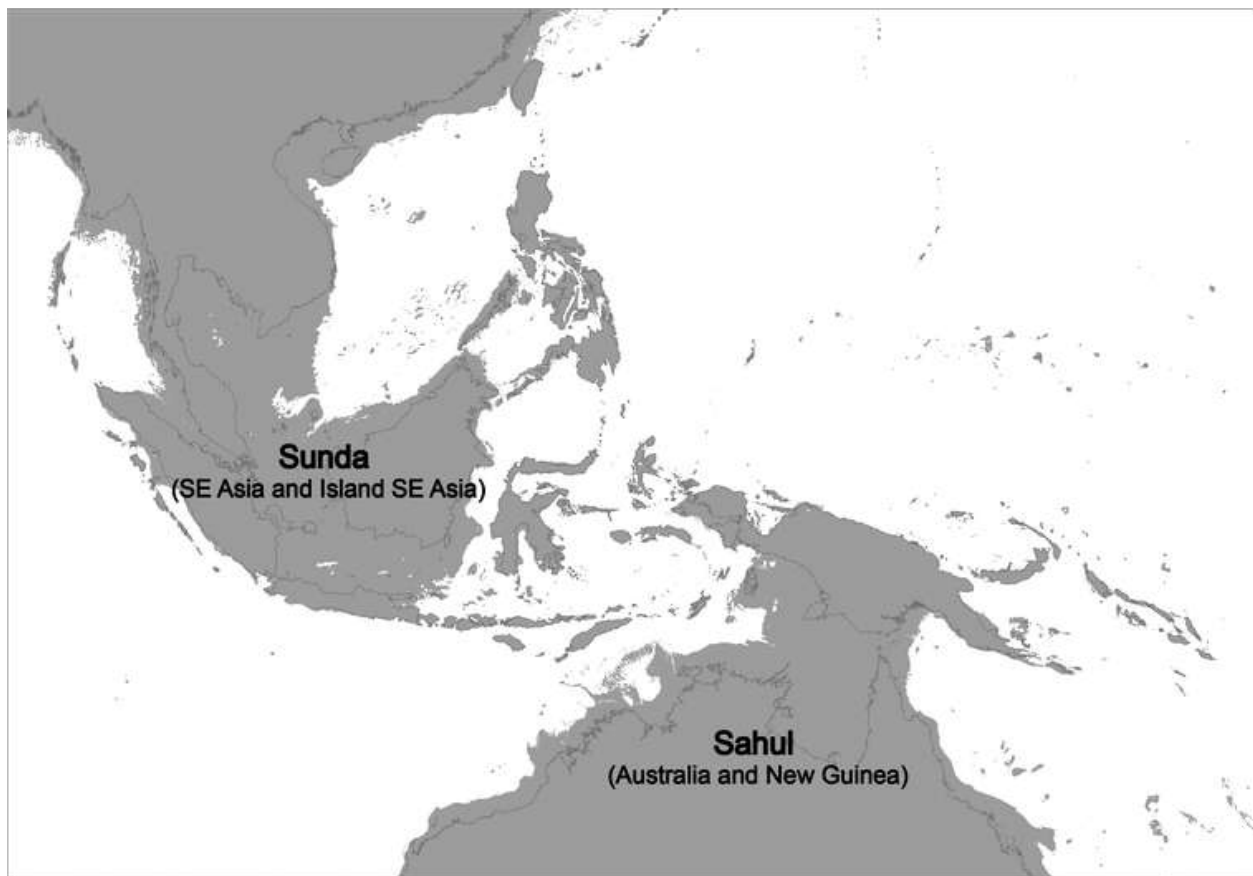
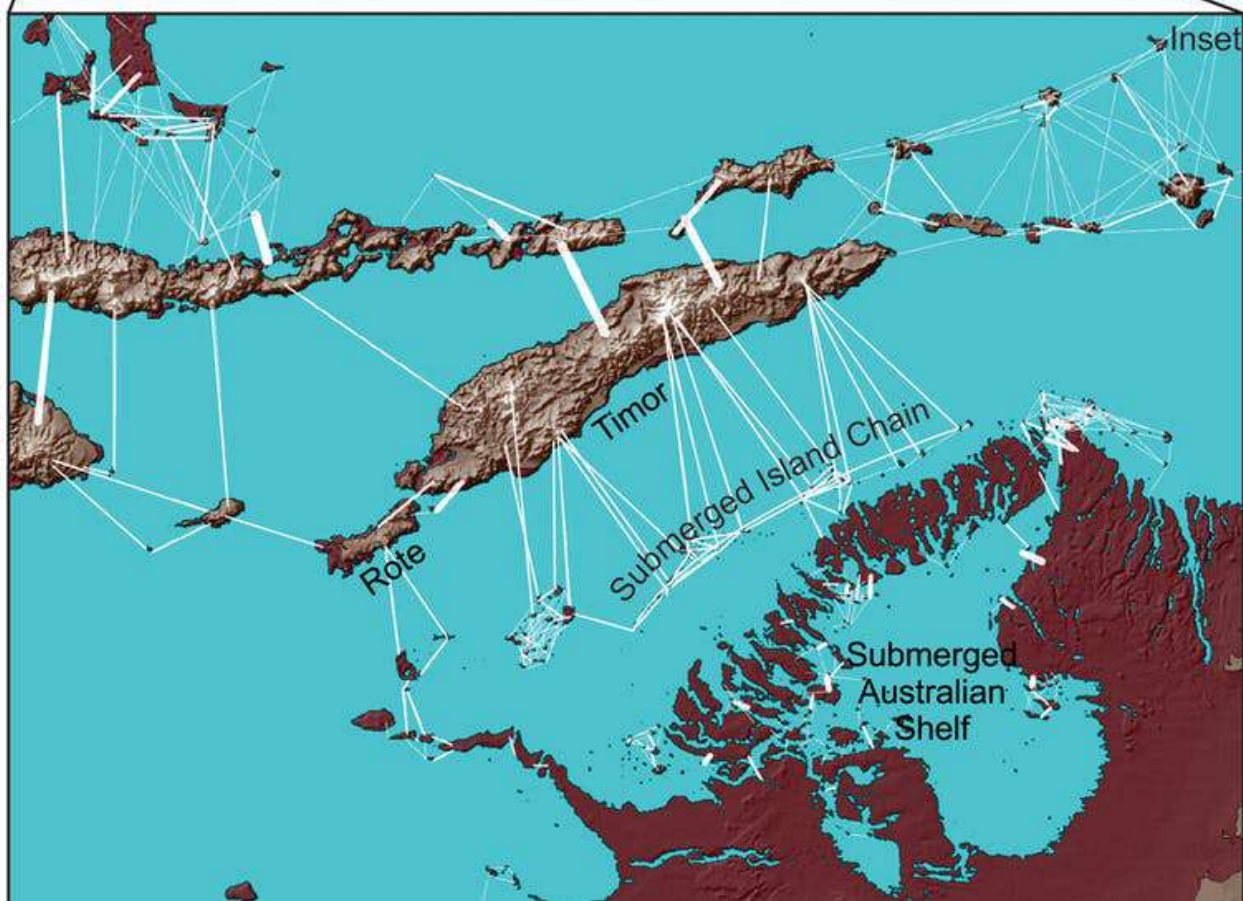
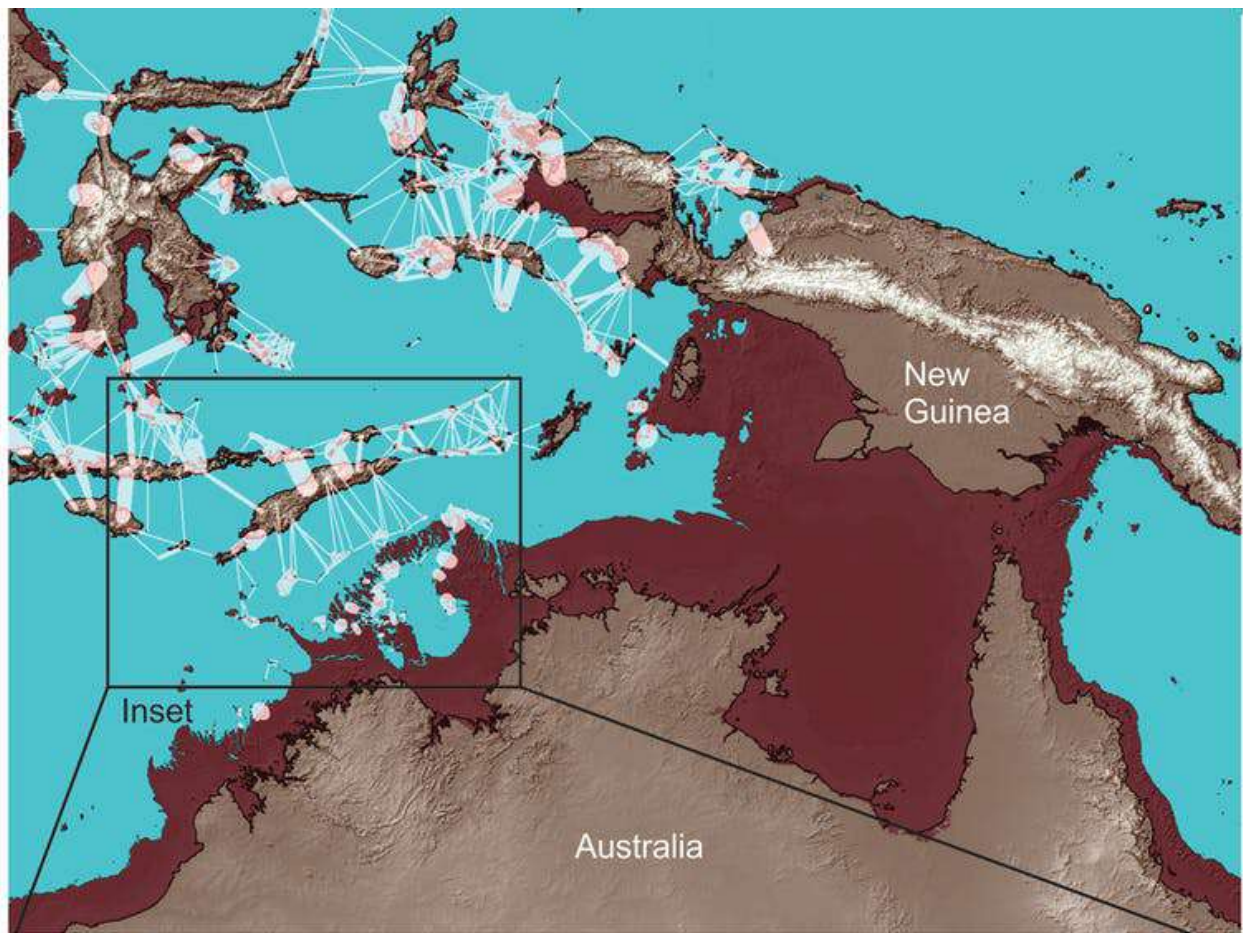


Figure 2.1: The grey area shows the extent of the ice age continents of Sunda and Sahul, much of which is now under water.



2.2 Fire farming and megafauna extinctions

There is evidence that the original Australians used fire to change the character of the landscape and to increase their food supply. This practice probably contributed to the extinction of megafauna in Australia.

According to Wikipedia,

“Archaeological evidence from ash deposits in the Coral Sea indicates that fire was already a significant part of the Australian landscape over 100,000 years BP. Over the past 70,000 years it became more frequent with one explanation being the use by hunter-gatherers as a tool to drive game, to produce a green flush of new growth to attract animals, and to open up impenetrable forest. In *The Biggest Estate on Earth: How Aborigines made Australia*, Bill Gammage claims that dense forest became more open sclerophyll forest, open forest became grassland and fire-tolerant species became more predominant: in particular, eucalyptus, acacia, banksia, casuarina and grasses.

“The changes to the fauna were even more dramatic: the megafauna, species significantly larger than humans, disappeared, and many of the smaller species disappeared too. All told, about 60 different vertebrates became extinct, including the genus *Diprotodon* (very large marsupial herbivores that looked rather like hippos), several large flightless birds, carnivorous kangaroos, *Wonambi naracoortensis*, a five-metre snake, a five-metre lizard and *Meiolania*, a tortoise the size of a small car.

“The direct cause of the mass extinctions is uncertain: it may have been fire, hunting, climate change or a combination of all or any of these factors.”

Suggestions for further reading

1. David Frankel (2017). *Between the Murray and the Sea. Aboriginal Archaeology in Southeastern Australia*. Sydney University Press.
2. Geoffrey Blainey (1976). *Triumph of the Nomads: History of Ancient Australia*. Palgrave Macmillan UK.
3. Harry Lourandos (1997). *Continent of Hunter-Gatherers: New Perspectives in Australian Prehistory*. Cambridge University Press.
4. D. J. Mulvaney (1969). *The Prehistory of Australia*. London: Thames and Hudson.
5. John Mulvaney; Johan Kamminga; Brissenden collection (1999). *Prehistory of Australia*. Allen & Unwin.
6. Jennifer Isaacs (2006). *Australian Dreaming: 40,000 Years of Aboriginal History*. New Holland.
7. Ronald M. Berndt (2005) [1952]. *Djanggalawul: An Aboriginal Religious Cult of North-Eastern Arnhem Land*. Routledge.
8. Tony Swain (1993). *A place for strangers: towards a history of Australian Aboriginal being*. Cambridge University Press.

Chapter 3

THE FIRST DISCOVERY OF AMERICA

3.1 Early migration across the Bering Strait

The continents of North America and South America have been discovered many times by humans. Figure 1.1 shows the path of the first migrations across the Bering Strait during a glacial period. These migrations are thought to have started approximately 20,000 years ago. The interiors of present-day Alaska and Canada were at that time entirely covered by a thick ice sheet, but archaeological evidence shows that these first Americans had boats and moved along the coast, living from fishing and from gathering shellfish.

It is possible that humans also later reached Central and South America by boat, both from the Pacific side and from the Atlantic side, as postulated by Thor Heyerdahl.

During the Viking era, Norsemen colonized both Iceland and Greenland. Their ships were capable of long ocean voyages, but they lacked magnetic compasses for navigation. Their practice was to sail along an east-west line, maintaining their constant longitude by observing the sun and stars. On one such voyage, a ship aiming for the Greenland colony was blown off course by a storm, and continued sailing westward, finally reached land on the coast of Labrador. After this discovery, Leif Erikson urged his father, Erik the Red, to lead an expedition to explore the new land. On the way to the boats, Erik the Red was thrown from his horse and injured his leg. He took this as a bad omen, and said “I am not destined to discover more lands than I already have.” Thus Leif Erikson and his men sailed westward alone, reached Labrador. They then sailed south along the coast.

The problem that prevented the Scandinavians from settling permanently in North America was that they failed to make peace with the people who were already there. *Vinlandia Saga* recounts an incident in which Leif Erickson’s men encounter three American Indians and fight with them, killing two. The third, however, escaped. That night, according to the saga, Leif Erikson was visited in a dream by his father, Erik the Red. The father said in a loud voice, “Wake up, Leif Erikson! Wake up and take your sword in your hand! Wake up, and wake your men! Wake up if you want to live!” Leif Erikson followed this

advice, just in time to be ready when a large band of First Peoples attacked. Although the Norse colonization of North America was not permanent, it lasted for many generations. The Greenland Norsemen called Labrador “Markland”, and there was even a Bishop of Markland. What the Norsemen called “Vinland” seems to have been Newfoundland. Remains of Norse buildings were found at L’Anseaux aux Meadows near the northern tip of Newfoundland in 1960.

The famous voyage of Columbus has been celebrated for a long time in the United States on Columbus Day. However, now, as the greed and crimes of Columbus have become more widely known, there is a movement to abolish Columbus Day and to replace it by Indigenous People’s Day.

3.2 Agriculture in the western hemisphere

During a glacial period between 20,000 and 10,000 years before the present, there was a land bridge across the Bering Strait. There is evidence that humans crossed this land bridge from Siberia and followed a coastal route past the glaciated regions of what is now Canada, finally reaching South America. Humans were able to build boats at that time, as evidenced by traces of very early settlements on islands off the coast of South America.

In a May 24, 2017 article in *Science*, Lizzie Wade wrote:

“About 600 kilometers north of Lima, an imposing earthen mound looms over the sea. People began building the ceremonial structure, called Huaca Prieta, about 7800 years ago. But according to a new study, the true surprise lies buried deep beneath the 30-meter-tall mound: stone tools, animal bones, and plant remains left behind by some of the earliest known Americans nearly 15,000 years ago. That makes Huaca Prieta one of the oldest archaeological sites in the Americas and suggests that the region’s first migrants may have moved surprisingly slowly down the coast.

“The evidence of early human occupation stunned Tom Dillehay, an archaeologist at Vanderbilt University in Nashville who led the new study. Initially, he was interested in examining the mound itself. But geologists on his team wanted to study the land-form under the mound, so ‘we just kept going down,’ he says. The deepest pit, which took 5 years to excavate, reached down 31 meters. Shockingly, those deep layers contained telltale signs of human occupation, Dillehay’s team reports today in *Science Advances*: evidence of hearth fires, animal bones, plant remains, and simple but unmistakable stone tools. Radiocarbon dates from charcoal place the earliest human occupation at nearly 15,000 years ago.

“That’s made some researchers say Huaca Prieta should join the small but growing list of pre-14,000-year-old sites that have revolutionized scientists’ vision of the earliest Americans. Archaeologists used to think that people walked from Siberia through an ice-free passage down Alaska and Canada, reaching the interior of the United States about 13,000 years ago. In recent years, however, well documented earlier sites like Chile’s Monte Verde have convinced most archaeologists that humans made it deep into the Americas by

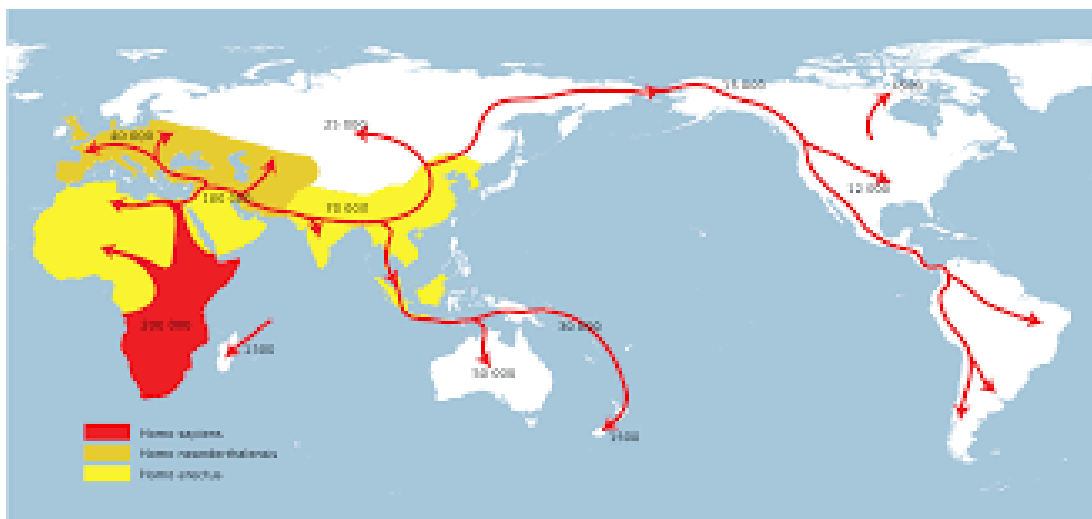


Figure 3.1: Modern humans crossed the Bering Straits during a glacial period between 20,000 and 10,000 years before the present.

14,500 years ago, meaning that they would have had to cross Canada long before an ice-free corridor existed. That would have left them with one logical route into the Americas: down the Pacific coast. But direct evidence for such a migration is lacking.”

Another site that shows evidence of early human presence is Piki Mach’ay cave in Peru. Radiocarbon dates from this cave give a human presence ranging from 22,200 to 14,700 years ago, but this evidence has been disputed. Wikipedia states that “Piki Mach’ay yielded some of the oldest plant remains in Peru, including an 11,000 year old bottle gourd. Strata from later periods at the site revealed fishtail points, manos, and metates. Plant remains indicate that, before 3,000 years BCE, amaranth, cotton, gourds, lucuma, quinoa, and squash were cultivated in the Ayacucho Basin before 3,000 years BCE. By 4,000 years BCE corn (*Zea mays*) and common beans were grown. Chili remains date from 5,500 to 4,300 years BCE. The large amounts of guinea pig bones suggest possible domestication, and llamas may have been domesticated by 4,300 to 2,800 years BCE.”

Peru gives potatoes to the world

Wikipedia states that “Cultivation of potatoes in South America may go back 10,000 years, yet the tubers do not preserve well in archaeological record, and there are problems with exact identification of those that are found... In the Altiplano, potatoes provided the principal energy source for the Inca Empire, its predecessors, and its Spanish successor... Potato was the staple food of most Pre-Columbian Mapuches¹, ‘specially in the southern and coastal [Mapuche] territories where maize did not reach maturity”

¹The Mapuches are a group of indigenous inhabitants of south-central Chile and southwestern Argentina, including parts of present-day Patagonia.



Figure 3.2: The “three sisters”, maize, squash and beans, traditionally grown by tribes of the first people in North America.

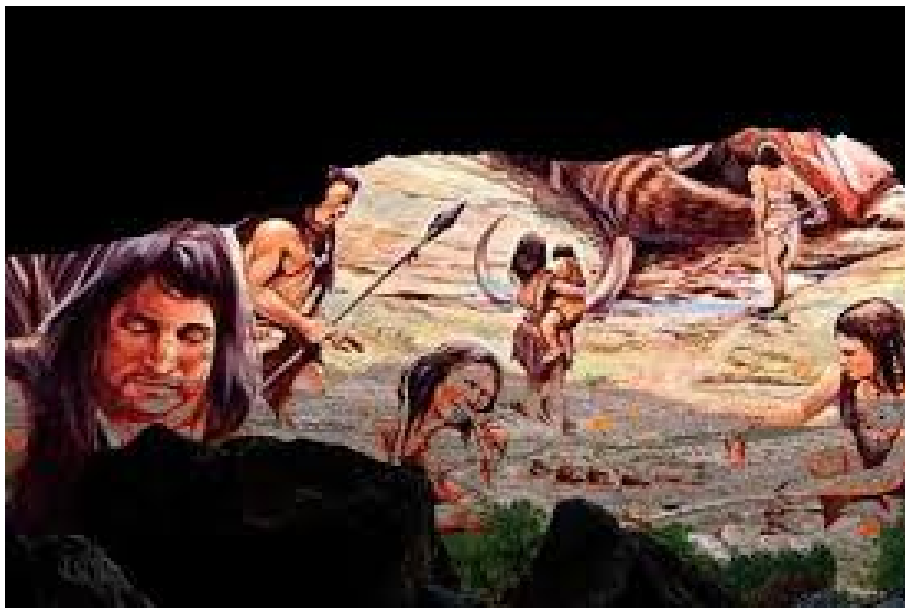


Figure 3.3: An artist's guess at what the inhabitants of Piki Mach'ay cave in Peru might have looked like.



Figure 3.4: In the mountainous regions of Peru, the ancient Incas built terraces for the cultivation of potatoes.



Figure 3.5: Sir Walter Raleigh presented potatoes to Queen Elizabeth I.

3.3 Ethics of the American Indians

Luther Standing Bear (1868-1939) was a native American Lakota chief. He spanned both his native traditions and the white culture, having received an education at the Carlisle Industrial School. He became the author of many books, for example *My People*, *The Sioux*, *My Indian Boyhood*, and *Land of the Spotted Eagle*.

Some quotations from Luther Standing Bear

The old Lakota was wise. He knew that man's heart away from nature becomes hard; he knew that lack of respect for growing, living things soon led to lack of respect for humans, too.

Out of the Indian approach to life there came a great freedom, an intense and absorbing respect for life, enriching faith in a Supreme Power, and principles of truth, honesty, generosity, equity and brotherhood as a guide to mundane relations.

As a child I understood how to give, I have forgotten this grace since I have become civilized.

There is a road in the hearts of all of us, hidden and seldom traveled, which leads to an unknown, secret place. The old people came literally to love the soil, and they sat or reclined on the ground with a feeling of being close to a mothering power. Their teepees were built upon the earth and their altars were made of earth. The soul was soothing, strengthening, cleansing, and healing. That is why the old Indian still sits upon the earth instead of propping himself up and away from its life giving forces. For him, to sit or lie upon the ground is to be able to think more deeply and to feel more keenly. He can see more clearly into the mysteries of life and come closer in kinship to other lives about him.

Hollow Horn Bear knew that to be leader and adviser of his people he must be honest and reliable, and that his word once given in promise must never be taken back. He knew that he must be a man of will-power, standing for the right no matter what happened to him personally; that he must have strength of purpose, allowing no influence to turn him from doing what was best for the tribe. He must be willing to serve his people without thought of pay. He must be utterly unselfish and kind-hearted to the old and poor and stand ready to give to those in need. Above all, he must be unafraid to deal equal justice to all.

Generosity is a mark of bravery, so all Sioux boys were taught to be generous.



Figure 3.6: Chief Luther Standing Bear (1868-1939), author and philosopher. In one of his books, he wrote: “I find [a] great distinction between the faith of the Indian and the white man. Indian faith sought the harmony of man with his surroundings, the other sought the dominance of surroundings.”

The Lakota was wise. He knew that man's heart, away from nature, becomes hard; he knew that a lack of respect for growing, living things soon led to a lack of respect for humans, too.

Wherever forests have not been mowed down, wherever the animal is recessed in their quiet protection, wherever the earth is not bereft of four-footed life - that to the white man is an 'unbroken wilderness.' But for us there was no wilderness, nature was not dangerous but hospitable, not forbidding but friendly. Our faith sought the harmony of man with his surroundings; the other sought the dominance of surroundings. For us, the world was full of beauty; for the other, it was a place to be endured until he went to another world. But we were wise. We knew that man's heart, away from nature, becomes hard.

Kinship with all creatures of the earth, sky, and water was a real and active principle. In the animal and bird world there existed a brotherly feeling that kept us safe among them... The animals had rights - the right of man's protection, the right to live, the right to multiply, the right to freedom, and the right to man's indebtedness. This concept of life and its relations filled us with the joy and mystery of living; it gave us reverence for all life; it made a place for all things in the scheme of existence with equal importance to all.

And here I find the great distinction between the faith of the Indian and the white man. Indian faith sought the harmony of man with his surroundings, the other sought the dominance of surroundings.

Suggestions for further reading

1. Bradley, B.; Stanford, D. (2004). *The North Atlantic ice-edge corridor: a possible Palaeolithic route to the New World*. World Archaeology. 36 (4): 459-478.
2. Bradley, B.; Stanford, D. (2006). *The Solutrean-Clovis connection: reply to Straus, Meltzer and Goebel*. World Archaeology. 38 (4): 704-714.
3. Dennis J. Stanford, Bruce Bradely, *Pre-Clovis First Americans: The Origin of America's Clovis Culture* (University of California Press, 2012).
4. Dennis J. Stanford, Bruce A. Bradley, *Across Atlantic Ice: The Origin of America's Clovis Culture* (University of California Press (2012).
5. Dixon, E. James. *Quest for the Origins of the First Americans*. University of New Mexico Press. 1993.
6. Dixon, E. James. *Bones, Boats, and Bison: the Early Archeology of Western North America*. University of New Mexico Press. 1993, 1999.
7. Erlandson, Jon M. *Early Hunter-Gatherers of the California Coast*. Plenum Press. 1994.

8. Erlandson, Jon M (2001). *The Archaeology of Aquatic Adaptations: Paradigms for a New Millennium*. Journal of Archaeological Research. 9 (4): 287-350.
9. Erlandson, Jon M. *Anatomically Modern Humans, Maritime Migrations, and the Peopling of the New World*. In *The First Americans: The Pleistocene Colonization of the New World*, edited by N. Jablonski, 2002. pp. 59-92. Memoirs of the California Academy of Sciences. San Francisco.
10. Erlandson, Jon. M.; Graham, M. H.; Bourque, Bruce J.; Corbett, Debra; Estes, James A.; Steneck, R. S. (2007). *The Kelp Highway Hypothesis: Marine Ecology, The Coastal Migration Theory, and the Peopling of the Americas*. Journal of Island and Coastal Archaeology. 2 (2): 161-174.
11. Eshleman, Jason A.; Malhi, Ripan S.; Glenn Smith, David (2003). *Mitochondrial DNA Studies of Native Americans: Conceptions and Misconceptions of the Population Prehistory of the Americas*. Evolutionary Anthropology. 12: 7-18.
12. Fedje; Christensen (1999). *Modeling Paleoshorelines and Locating Early Holocene Coastal Sites in Haida Gwaii*. American Antiquity. 64 (4): 635-652.
13. Greenman, E. F. (1963). *The Upper Palaeolithic and the New World*. Current Anthropology. 4: 41-66.
14. Hey, Jody (2005). *On the Number of New World Founders: A Population Genetic Portrait of the Peopling of the Americas*. PLOS Biology. 3 (6).
15. Nina G. Jablonski (2002). *The First Americans: The Pleistocene Colonization of the New World*. California Academy of Sciences. ISBN 978-0-940228-50-4.
16. Jones, Peter N. *Respect for the Ancestors: American Indian Cultural Affiliation in the American West*. Boulder, Colorado: Bauu Press. 2004, 2005.
17. Korotayev, Andrey et al. *Which genes and myths did the different waves of the peopling of Americas bring to the New World?*. History and Mathematics 6 (2017): 9-77.
18. Lauber, Patricia. *Who Came First? New Clues to Prehistoric Americans*. Washington, D.C.: National Geographic Society, 2003.
19. Matson and Coupland. *The Prehistory of the Northwest Coast*. Academic Press. New York. 1995.
20. David J. Meltzer (2009). *First Peoples in a New World: Colonizing Ice Age America*. University of California Press.
21. Snow, Dean R. *The First Americans and the Differentiation of Hunter-Gatherer Cultures*. In Bruce G. Trigger and Wilcomb E. Washburn, eds., *The Cambridge History of the Native Peoples of the Americas*, Volume I: North America (Cambridge: Cambridge University Press, 1996), 125-199.
22. Spencer Wells (2002). *The Journey of Man: A Genetic Odyssey*. Princeton University Press.

Chapter 4

ALEXANDER OF MACEDON

4.1 Alexander's early life and education

Alexander's father, King Philip II of Macedon (382 BC-336 BC) reformed the Macedonian army introduced the phalanx battle formation that made the army extremely effective. He led an effort to establish a federation of Greek city-states, the League of Corinth. Phillip was elected to be the commanding general of this federation, and he planned to lead all of the Greek and Macedonian forces in a united invasion of the Persian Empire. However, in 336 BC he was assassinated. Philip's son, Alexander, who had been tutored in his youth by Aristotle, then became King of Macedon, and led Philip's planned campaign against the Persian Empire.

4.2 Conquest or exploration?

How much influence did Aristotle have on his pupil, Alexander of Macedon? We know that in 327 B.C. Alexander, (who was showing symptoms of megalomania), executed Aristotle's nephew, Callisthenes; so Aristotle's influence cannot have been very complete. On the other hand, we can think of Alexander driving his reluctant army beyond the Caspian Sea to Parthia, beyond Parthia to Bactria, beyond Bactria to the great wall of the Himalayas, and from there south to the Indus, where he turned back only because of the rebellion of his homesick officers. This attempt to reach the uttermost limits of the world seems to have been motivated as much by a lust for knowledge as by a lust for power.



Figure 4.1: Alexander Mosaic (detail), House of the Faun, Pompeii..



Figure 4.2: Bust of a young Alexander the Great from the Hellenistic era, British Museum.

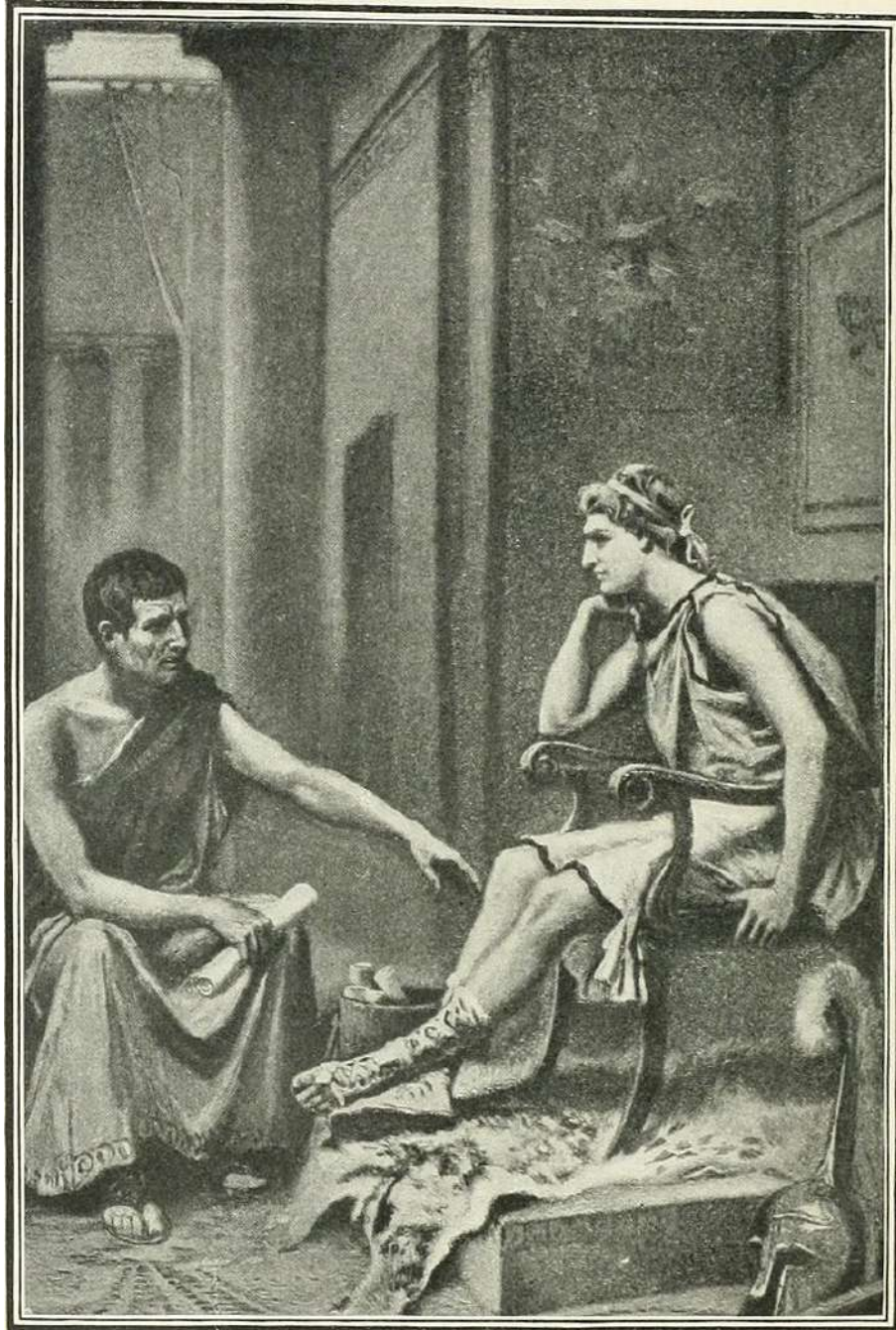


Figure 4.3: Aristotle Tutoring Alexander, by Jean Leon Gerome Ferris.



Figure 4.4: The Kingdom of Macedon in 336 BC.



Figure 4.5: The Macedonian phalanx at the “Battle of the Carts” against the Thracians in 335 BC.



Figure 4.6: Map of Alexander’s empire and his route.

4.3 The Hellenistic era

Alexander was not a Greek, but nevertheless he regarded himself as an apostle of Greek culture. As the Athenian orator, Isocrates, remarked, "The word 'Greek' is not so much a term of birth as of mentality, and is applied to a common culture rather than to a common descent."

Although he was cruel and wildly temperamental, Alexander could also display an almost hypnotic charm, and this charm was a large factor in his success. He tried to please the people of the countries through which he passed by adopting some of their customs. He married two barbarian princesses, and, to the dismay of his Macedonian officers, he also adopted the crown and robes of a Persian monarch.

Wherever Alexander went, he founded Greek-style cities, many of which were named Alexandria. In Babylon, In 323 B.C., after a drunken orgy, Alexander caught a fever and died at the age of 33. His loosely-constructed empire immediately fell to pieces. The three largest pieces were seized by three of his generals. The Persian Empire went to Seleucis, and became known as the Seleucid Empire. Antigonus became king of Macedon and protector of the Greek city-states. A third general, Ptolemy, took Egypt.

Although Alexander's dream of a politically united world collapsed immediately after his death, his tour through almost the entire known world had the effect of blending the ancient cultures of Greece, Persia, India and Egypt, and producing a world culture. The era associated with this culture is usually called the Hellenistic Era (323 B.C. - 146 B.C.). Although the Hellenistic culture was a mixture of all the great cultures of the ancient world, it had a decidedly Greek flavor, and during this period the language of educated people throughout the known world was Greek.

Nowhere was the cosmopolitan character of the Hellenistic Era more apparent than at Alexandria in Egypt. No city in history has ever boasted a greater variety of people. Ideally located at the crossroads of world trading routes, Alexandria became the capital of the world - not the political capital, but the cultural and intellectual capital.

Miletus in its prime had a population of 25,000; Athens in the age of Pericles had about 100,000 people; but Alexandria was the first city in history to reach a population of over a million!

Strangers arriving in Alexandria were impressed by the marvels of the city - machines which sprinkled holy water automatically when a five-drachma coin was inserted, water-driven organs, guns powered by compressed air, and even moving statues, powered by water or steam!

For scholars, the chief marvels of Alexandria were the great library and the Museum established by Ptolemy I. Credit for making Alexandria the intellectual capital of the world must go to Ptolemy I and his successors (all of whom were named Ptolemy except the last of the line, the famous queen, Cleopatra). Realizing the importance of the schools which had been founded by Pythagoras, Plato and Aristotle, Ptolemy I established a school at Alexandria. This school was called the Museum, because it was dedicated to the muses.

Near to the Museum, Ptolemy built a great library for the preservation of important manuscripts. The collection of manuscripts which Aristotle had built up at the Lyceum in

Athens became the nucleus of this great library. The library at Alexandria was open to the general public, and at its height it was said to contain 750,000 volumes. Besides preserving important manuscripts, the library became a center for copying and distributing books.

The material which the Alexandrian scribes used for making books was papyrus, which was relatively inexpensive. The Ptolemys were anxious that Egypt should keep its near-monopoly on book production, and they refused to permit the export of papyrus. Pergamum, a rival Hellenistic city in Asia Minor, also boasted a library, second in size only to the great library at Alexandria. The scribes at Pergamum, unable to obtain papyrus from Egypt, tried to improve the preparation of the skins traditionally used for writing in Asia. The resulting material was called *membranum pergamenum*, and in English, this name has become “parchment”.

4.4 Eratosthenes’ map of the world

Eratosthenes (276 B.C. - 196 B.C.), the director of the library at Alexandria, was probably the most cultured man of the Hellenistic Era. His interests and abilities were universal. He was an excellent historian, in fact the first historian who ever attempted to set up an accurate chronology of events. He was also a literary critic, and he wrote a treatise on Greek comedy. He made many contributions to mathematics, including a study of prime numbers and a method for generating primes called the “sieve of Eratosthenes”.

As a geographer, Eratosthenes made a map of the world which, at that time, was the most accurate that had ever been made. The positions of various places on Eratosthenes’ map were calculated from astronomical observations. The latitude was calculated by measuring the angle of the polar star above the horizon, while the longitude probably was calculated from the apparent local time of lunar eclipses.

As an astronomer, Eratosthenes made an extremely accurate measurement of the angle between the axis of the earth and the plane of the sun’s apparent motion; and he also prepared a map of the sky which included the positions of 675 stars.

Eratosthenes’ greatest achievement however, was an astonishingly precise measurement of the radius of the earth. The value which he gave for the radius was within 50 miles of what we now consider to be the correct value! To make this remarkable measurement, Eratosthenes of course assumed that the earth is spherical, and he also assumed that the sun is so far away from the earth that rays of light from the sun, falling on the earth, are almost parallel. He knew that directly south of Alexandria there was a city called Syene, where at noon on a midsummer day, the sun stands straight overhead. Given these facts, all he had to do to find the radius of the earth was to measure the distance between Alexandria and Syene. Then, at noon on a midsummer day, he measured the angle which the sun makes with the vertical at Alexandria. From these two values, he calculated the circumference of the earth to be a little over 25,000 miles. This was so much larger than the size of the known world that Eratosthenes concluded (correctly) that most of the earth’s surface must be covered with water; and he stated that “If it were not for the vast extent of the Atlantic, one might sail from Spain to India along the same parallel.”

Eratosthenes' friends (one of them was Archimedes) joked with him about his diletantism. They claimed that he was spreading his talents too thinly, and they gave him the nickname, "Beta", meaning that in all the fields in which he chose to exert himself, Eratosthenes was the second best in the world, rather than the best. This was unjust: In geography, Eratosthenes was unquestionably "Alpha"!

Eratosthenes' brilliant work in geography illustrates a difference between classical Greek science and Hellenistic science. In the classical Greek world, philosophers were far removed from everyday affairs. However, in busy, commercial Alexandria, men like Eratosthenes were in close contact with practical problems, such as the problems of navigation, metallurgy and engineering. This close contact with practical problems gave Hellenistic science a healthy realism which was lacking in the overly-theoretical science of classical Greece.

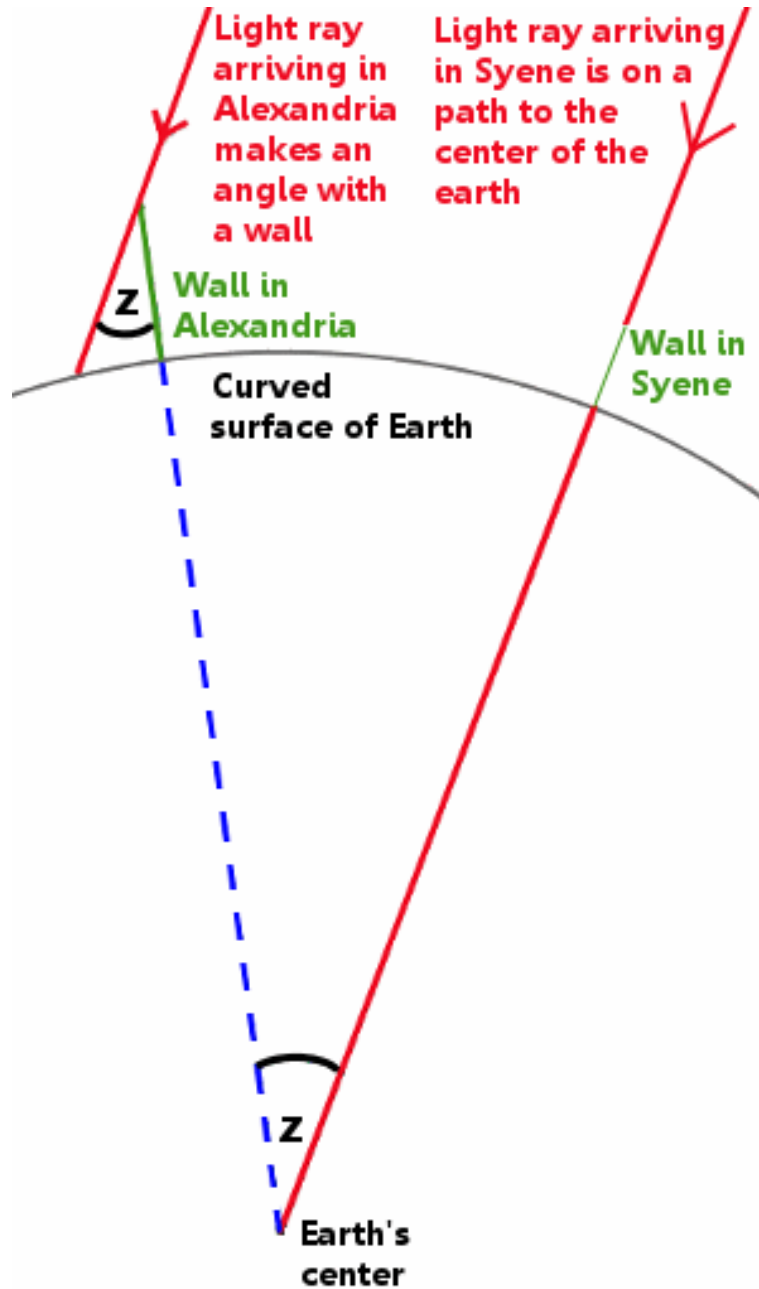


Figure 4.7: This figure shows the principle behind Eratosthenes' measurement of the radius of the earth.

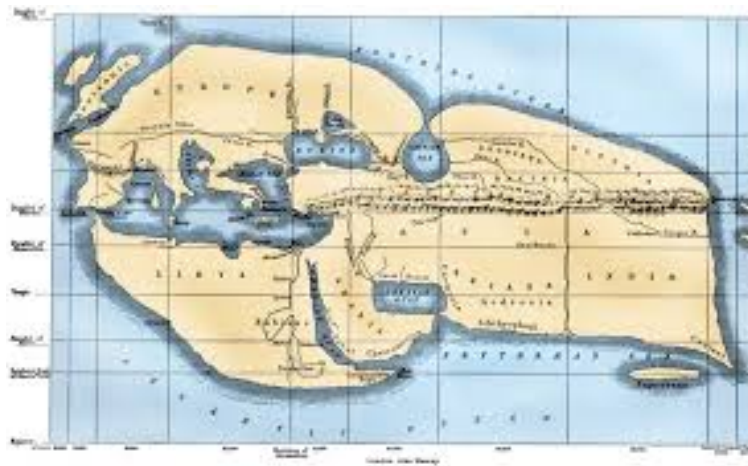


Figure 4.8: Eratosthenes' map of the known world. The Mediterranean region, the Red Sea, and the Black Sea are quite accurately depicted. We can also see Britain and Ireland as well as the Persian Gulf. From the small size of the known world, compared with the total surface of the earth, Eratosthenes correctly concluded that most of the earth's surface is covered with water; and he wrote: "If it were not for the vast extent of the ocean, it would be possible to reach India by sailing westward".

Suggestions for further reading

1. Arrian (1976). de Sélincourt, Aubrey (ed.). *Anabasis Alexandri (The Campaigns of Alexander)*. Penguin Books.
2. Quintus Curtius Rufus (1946). Rolfe, John (ed.). *History of Alexander*. Loeb Classical Library.
3. Siculus, Diodorus (1989). *Library of History*. CH Oldfather, translator. Perseus Project.
4. Plutarch (1919). Perrin, Bernadotte (ed.). *Plutarch, Alexander*. Perseus Project.
5. Plutarch (1936). Babbitt, Frank Cole (ed.). *On the Fortune of Alexander*. IV. Loeb Classical Library. pp. 379-487.
6. Trogus, Pompeius (1853). Justin (ed.). *Epitome of the Philippic History*. Rev. John Selby Watson, translator. Forum romanum.
7. Badian, Ernst (1958). *Alexander the Great and the Unity of Mankind*. Historia. 7.
8. Beazley, JD; Ashmole, B (1932). *Greek Sculpture and Painting*. Cambridge University Press.
9. Bowra, Maurice (1994). *The Greek Experience*. Phoenix.
10. Boardman, John (2018). *Alexander the Great: From His Death to the Present Day* illustrated history of his representations in art and literature.
11. Burn, AR (1951). *Alexander the Great and the Hellenistic Empire (2 ed.)*. London: English Universities Press.

12. Rufus, Quintus Curtius. *Quintus Curtius Rufus, History of Alexander the Great* (in Latin). U Chicago.
13. Cartledge, Paul (2004). *Alexander the Great*. Overlook.
14. Doherty, Paul (2004). *The Death of Alexander the Great*. Carroll & Graf.
15. Engels, Donald W (1978). *Alexander the Great and the Logistics of the Macedonian Army*. Berkeley: University of California Press.
16. Fawcett, Bill, ed. (2006). *How To Lose A Battle: Foolish Plans and Great Military Blunders*. Harper.
17. Fuller, JFC (1958). *The Generalship of Alexander the Great*. London: Eyre & Spottiswoode.
18. Green, Peter (1992). *Alexander of Macedon: 356-323 BC. A Historical Biography*. University of California Press.
19. Greene, Robert (2000). *The 48 Laws of Power*. Penguin.
20. Hammond, NGL (1989). *The Macedonian State: Origins, Institutions, and History*. Oxford University Press.
21. Hammond, NGL (1994). *Alexander the Great: King, Commander, and Statesman (3 ed.)*. London: Bristol Classical Press.
22. Hammond, NGL (1997). *The Genius of Alexander the Great*. Chapel Hill: University of North Carolina Press.
23. Mercer, Charles (1962). *The Way of Alexander the Great (1 ed.)*. Boston: American Heritage Inc.
24. McCrindle, J. W. (1893). *The Invasion of India by Alexander the Great as Described by Arrian, Q*
25. Curtius, Diodorus, *Plutarch, and Justin*. Westminster: Archibald Constable & Co.
26. Murphy, James Jerome; Katula, Richard A; Hill, Forbes I; Ochs, Donovan J (2003). *A Synoptic History of Classical Rhetoric*. Lawrence Erlbaum Associates.
27. Nandan, Y; Bhavan, BV (2003). *British Death March Under Asiatic Impulse: Epic of Anglo-Indian Tragedy in Afghanistan*. Mumbai: Bharatiya Vidya Bhavan.
28. O'Brien, John Maxwell (1992). *Alexander the Great: The Invisible Enemy*. London: Routledge.
29. Pomeroy, S; Burstein, S; Dolan, W; Roberts, J (1998). *Ancient Greece: A Political, Social, and Cultural History*. Oxford University Press.
30. Prevas, John (2004). *Envy of the Gods: Alexander the Great's Ill-Fated Journey Across Asia (3 ed.)*. Da Capo.
31. Roisman, Joseph, ed. (1995). *Alexander the Great Ancient and Modern Perspectives*. Problems in European Civilization. Lexington, MA: DC Heath.
32. Savill, Agnes (1959). *Alexander the Great and His Time (3 ed.)*. London: Barrie & Rockliff.
33. Stewart, Andrew (1993). *Faces of Power: Alexander's Image and Hellenistic Politics. Hellenistic Culture and Society. 11*. Berkeley: University of California Press.
34. Stoneman, Richard (2008). *Alexander the Great: A Life in Legend*. Yale University Press.
35. Tarn, WW (1948). *Alexander the Great*. Cambridge: Cambridge University Press.

36. Wheeler, Benjamin Ide (1900). *Alexander the Great; the merging of East and West in universal history*. New York: GP Putnam's sons.
37. Wilcken, Ulrich (1997) [1932]. *Alexander the Great*. New York: WW Norton & Co.
38. Worthington, Ian (2004). *Alexander the Great: Man And God*. Pearson.

Chapter 5

VIKING EXPLORERS

5.1 A seafaring culture

Shipbuilding was part of Scandinavian culture long before the age of Viking exploration, settlement and conquest. Denmark consists of a number of islands, and no part of Denmark is far from water. Norway is mountainous, and its coastline has numerous fjords and natural harbors. The easiest method of transportation and communication in Norway was always by sea. Thus it was natural for Scandinavia to develop a ship-building and seafaring culture.

The Wikipedia article on *Viking ships* states that: **“The ship has been functioning as the centerpiece of Scandinavian culture for millennia, serving both pragmatic and religious purposes, and its importance was already deeply rooted in the Scandinavian culture when the Viking Age began. Scandinavia is a region with relatively high inland mountain ranges, dense forests and easy access to the sea with many natural ports. Consequently, trade routes were primarily operated via shipping, as inland travel was both more hazardous and cumbersome. Many stone engravings from the Nordic Stone Age and in particular the Nordic Bronze Age, depict ships in various situations and valuable ships were sacrificed as part of ceremonial votive offerings since at least the Nordic Iron Age, as evidenced by the Hjortspring and Nydam boats.”**

Viking ships were built with overlapping wooden planks, held together by iron nails or bolts. They were long, slender and symmetrical, with a shallow draft and a true keel. Some Viking ships were designed for coastal waters and rivers, but other types, which were shorter, wider and more sturdy, could cross the open ocean.



Figure 5.1: Viking ships.



Figure 5.2: A replica of a Viking ship sails in the evening on Roskilde Fjord, Denmark. It was built at the Viking Ship Museum in Roskilde using traditional Viking methods.



Figure 5.3: A visitor at the Viking Ship Museum in Oslo, Norway.



Figure 5.4: The prow of a Viking ship.



Figure 5.5: Viking exploration routes.

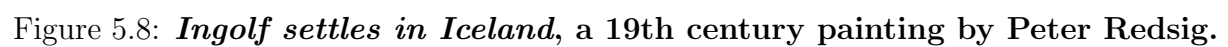


Figure 5.6: Map showing area of Scandinavian settlement in the eighth (dark red), ninth (red), tenth (orange) centuries. Yellow denotes areas conquered by the Normans in the 11th century. Green denotes areas subjected to Viking raids.

5.2 Icelandic Sagas

Iceland was originally populated by settlers from Scotland and Ireland. Nordic explorers and settlers arrived in the 9th century. Here are some excerpts from Wikipedia's *Timeline of Icelandic History*:

- 860: Naddodd discovers Iceland. He was heading to the Faroe Islands but drifted off course and landed near Reydarfjörður in Iceland. As he returned to his boat it started to snow and thereby he reputedly named the land Snæland (lit. Snowland).
- 860: Gardarr Svavarsson discovers Iceland. Blown from a storm near the Orkney Islands. He circumnavigated Iceland, thus the first to establish that the landmass was an island. He stayed for one winter in Skjálfandi. He praised the new land and called it Gardarshólmi (lit. Gardar's Islet)
- c.870: Hrafna-Flóki Vilgerdason becomes the first Scandinavian to deliberately sail to Iceland as news of a country in the west reached Norway. When Hrafna-Flóki climbed a mountain in Vatnsfjörður he spotted drift ice in a fjord that inspired the name of the country, Ísland (lit. Iceland).
- 874: Ingólfr Arnarson becomes the first permanent Nordic settler of Iceland. The settlement of Iceland begins.
- 930: The Icelandic Commonwealth is founded with the establishment of the Icelandic parliament (Althing), which had legislative and judicial power, but no executive power was present in the country.
- 1000: The Christianization of Iceland is initiated due to pressure from the King of Norway.



Saga writing and reading as a cure for immorality

In the year 1000, when many believed that the end of the world was near, Christianity came to Iceland. The Christian priests who then arrived were shocked by the immoral dancing and sex games with which Icelanders amused themselves during the long dark Icelandic winters. Therefore they introduced saga writing and reading in the hope that this would lead to a reduction of immorality.

In this way, the Christianization of Iceland led to a unique and beautiful literature to which we owe many of the facts about Viking history and exploration. The Icelandic sagas are typically written in blank verse, with strong use of alliteration. They often are aimed at showing the strong claims of a family dynasty to a particular region of Iceland. Since the purpose of the sagas was frequently to praise the previous generations of the writer's family, one often encounters laudatory introductions to the people described, for example, "There was a man called Knud, and he was tall and handsome. He could leap over a bar set as high as he was tall, and he could lift three men... " and so on. If a woman was introduced, she was the most beautiful ever seen, as well as the most virtuous and wise. In introducing people to their narrative, the sagas also give their genealogies.

Another unique feature of Icelandic sagas is that they usually cover long multi-generational time spans. They pass quickly over decades or even centuries. Nevertheless, when they come to an incident that they find interesting, for example a fight or an important feast, the narrative slows to such a degree that we hear of every word spoken, every bird that flew overhead, every arm or leg hacked off, or, in case of a feast, every gift given.

A few of the most famous sagas

- Laxdæla saga
- Njáls saga
- Hjemskringla
- Grønlandia saga
- Eiriks saga

5.3 Aud the Deep-Minded (9th century)

The countries of Scandinavia, Denmark, Norway, Sweden, Finland and Iceland, have a seafaring tradition. Especially during the Viking era (793-1066), the men were frequently away on voyages. The women, left behind to manage families and farms by themselves, established a tradition of independence which has lasted until modern times. In Scandinavia, the high educational level and social status of women is linked with low birth rates, which are in turn the cause of the prosperity of the region.

In the 9th century AD, a local king named Harold (c.850-c.932) resolved to become king of all of Norway. He swore that he would not cut or comb his hair until he had achieved this goal. Finally after much struggle, he became the first king of the entire country. He then cut and combed his hair, after which he was known as Harold Finehair.



Figure 5.9: **Aud (or Un) the Deep-Minded (9th century) was the daughter of Ketill Flatnose. She is remembered as a great matriarch, and one of the founders of the Icelandic nation.**

Many local leaders in Norway left the country rather than submit to the rule of Harold Finehair. One of these chieftains was Ketill Flatnose, who sailed to Ireland with his daughter Aud. Aud married Olaf the White, the son of King Ingjald, who had named himself King of Dublin after conquering the city. Aud and Olaf had a son, named Thorstein the Red, who later conquered northern Scotland. Thorstein was married in the Hebrides, and had six daughters. However, he was betrayed and killed in battle.

When the news of Thorstein's death reached Aud, she realized that she and her followers were no longer safe in Scotland. Therefore she ordered the secret building of ships, on which she and her people escaped and sailed to Iceland. Aud the Deep-Minded is remembered as a great matriarch and one of the founders of the Icelandic nation.

5.4 Cnut the Great

Cnut the Great was born in c.990 and he died in 1035. He was descended from the first Danish kings: His great-grandfather was Gorm the Old, and his grandfather, Harold Bluetooth, the first king to welcome Christianity to Denmark. Cnut's father was Harold's son, Sweyn Forkbeard, who invaded England.

The 13th century *Knýtlinga saga* has given us a description of Cnut's appearance: **“Cnut was exceptionally tall and strong, and the handsomest of men, all except for his nose, that was thin, high-set, and rather hooked. He had a fair complexion none-the-less, and a fine, thick head of hair. His eyes were better than those of other men, both the handsomer and the keener of their sight.”**

During the summer of 1013, Cnut accompanied his father, Sweyn Forkbeard, who invaded England. For decades, the Vikings had raided England, but this invasion was on a larger scale. By the end of the the year, the English king, Æthelred the Unready, had fled to France.

When Sweyn Forkbeard died in 1014, the Vikings immediately elected Cnut King of England. However, the English nobility had other ideas, and they recalled Æthelred from



Figure 5.10: The North Sea Empire of Cnut the Great, c. 1030.

France. Together they waged a successful campaign against Cnut, who was forced to retreat to Denmark.

In the summer of 1015, Cnut's fleet, re-enforced by Polish allies, sailed for England. There were roughly 10,000 men in 200 longships. We have a description of the fleet from *Emma's Encomium*: **"There were there so many kinds of shields, that you could have believed that troops of all nations were present. ... Gold shone on the prows, silver also flashed on the variously shaped ships. ... For who could look upon the lions of the foe, terrible with the brightness of gold, who upon the men of metal, menacing with golden face, ... who upon the bulls on the ships threatening death, their horns shining with gold, without feeling any fear for the king of such a force? Furthermore, in this great expedition there was present no slave, no man freed from slavery, no low-born man, no man weakened by age; for all were noble, all strong with the might of mature age, all sufficiently fit for any type of fighting, all of such great fleetness, that they scorned the speed of horsemen."**

This time, the conquest of England succeeded. Cnut showed himself to be a wise ruler of his North Sea empire, uniting his subjects and advocating tolerance for ethnic and religious differences.



Figure 5.11: A 14th-century portrait of Cnut the Great. He was a wise ruler. The semi-legendary story in which he commanded the tide to go back, if true, probably was meant to demonstrate the limitations of kingly power to his overly demanding nobles.



Figure 5.12: Angels crown Cnut as he and his wife, Emma of Normandy, present a large gold cross to Hyde Abbey in Winchester. (From the Liber Vitae in the British Library.)

5.5 Russia takes its name from the Rus Vikings

The Rus Vikings, or Vangarians, were Scandinavians who migrated to Russia and settled there. The word “Rus” originally meant “men who row”. Present day Russia takes its name from the Rus people, but Russia is a mixture of many ethnic groups, which have intermarried and blended over the centuries.

According to a number of sources, three Rus brothers were invited to restore order in districts near to present-day Kiev: **“The Chuds, the Slavs, the Krivichians and the Ves’ then said to the people of Rus, ‘Our land is great and rich, but there is no order in it. Come to rule and reign over us’. Thus they selected three brothers, with their kinsfolk, who took with them all the Russes and migrated. The oldest, Rurik, located himself in Novgorod; the second, Sineus, at Beloozero; and the third, Truvor, in Izborsk. On account of these Varangians, the district of Novgorod became known as the land of Rus.”**

Here is a description of the Rus by Ahmad ibn Fadlan, a contemporary Muslim diplomat: **“I have seen the Rus as they came on their merchant journeys and encamped by the Itil. I have never seen more perfect physical specimens, tall as date palms, blond and ruddy; they wear neither tunics nor caftans, but the men wear a garment which covers one side of the body and leaves a hand free. Each man has an axe, a sword, and a knife, and keeps each by him at all times. The swords are broad and grooved, of Frankish sort. Each woman wears on either breast a box of iron, silver, copper, or gold; the value of the box indicates the wealth of the husband. Each box has a ring from which depends a knife. The women wear neck-rings of gold and silver. Their most prized ornaments are green glass beads. They string them as necklaces for their women.”**



Figure 5.13: Map showing the major Varangian trade routes: the Volga trade route (in red) and the Dnieper and Dniester routes (in purple). Other trade routes of the 8th-11th centuries shown in orange.



Figure 5.14: *The Invitation of the Varangians*: Rurik and his brothers arrive in Staraya Ladoga, a painting by Viktor Vasnetsov.



Figure 5.15: Depiction of Yaroslav the Wise from Granovitaya Palata (The Palace of Facets). Yaroslav, a descendant of Rurik, was Prince of Novograd and Kiev. His daughter, Elisiv of Kiev, married King Harold Hardrada.



Figure 5.16: Golden ruble depicting Rurik, issued to mark the 1150th anniversary of the birth of the Russian state.

5.6 Harald Hardrada, 1015-1066

Harald Hardrada (sometimes translated as Harald the Ruthless or Harald Stern Ruler) was the King of Norway from 1046 until his death at the Battle of Stamford Bridge in 1066. In addition, he unsuccessfully claimed the thrones of both Denmark and England.

At the age of 15, Harald and his half-brother Olaf (later Saint Olaf) fought against Norwegian forces loyal to King Cnut the Great at the Battle of Stiklestad. They were defeated, and forced into exile. Harald fled from Norway to the Kievan Rus, where he became a captain in the army of Grand Prince Yarasslav the Wise. He fell in love with Yaroslav's daughter Elislev, but his marriage proposal was rejected because he had little wealth, and seemingly few prospects.

Disappointed in love, Harald left Yaroslav's service in 1034. He and about 500 of his followers sailed down the Dnieper and across the Black Sea to Constantinople. Harald soon became the commander of the Vangarian Guards of the Byzantine Empire.

Harald and the Vangarian Guards fought against pirates in the Mediterranean and against Arab forces in Asia Minor, as far east as the Tigris and Euphrates rivers in Mesopotamia. According to the sagas, Harald and his men captured eighty Arab strongholds. Later, Harald and his men fought in Sicily and Italy.

During his time in Byzantium, Harald became extremely rich. He sent his acquired treasures back to Yaroslav the Wise for safekeeping. Harald arrived back at the Kievan Rus in 1042, and again proposed marriage to Yaroslav's daughter, Elisiv. This time the proposal was accepted.

Returning to Norway, Harald used his new wealth to finance a successful campaign for the throne of Norway. He reigned as King Harald III of Norway from 1046 until his death in 1066, with Elisiv by his side as Queen.

Meanwhile, in England, the childless King Edward the Confessor had died. On his deathbed, Edward had named the powerful Earl Harold Godwinson to be King of England. However, two men both thought that they had a better claim to the English throne than Harold Godwinson. These two men were King Harald Hardrada of Norway and Duke William of Normandy. In 1066, both men sailed to England with their armies to fight for the English throne.

Harald Hardrada and his men landed in the north of England, near to the town of Stamford. The weather was hot, and they took off their armor while foraging for food. They were surprised by Harold Godwinson's army, which had made a forced march to meet them. According to the sagas, the following exchange took place before the battle began: Harald Hardrada asked Godwinson, "How much of England will you give to me?", and Godwinson replied, "Six feet, and perhaps an extra foot, since you are taller than other men."

The Battle of Stamford Bridge then began, and after fierce fighting, Harald Hardrada was killed. Harold Godwinson and his army then made another forced march to meet William of Normandy at Hastings. Perhaps exhausted by the two forced marches, they were defeated at the Battle of Hastings, and Harold Godwinson was killed.



Figure 5.17: Elisiv of Kiev, wife of King Harald Hardrada and Queen of Norway.



Figure 5.18: **The Battle of Stamford Bridge, 25 September, 1066. King Harald of Norway was killed in the battle by the forces of King Harold Godwinson of England. However, less than three weeks later, Harold Godwinson was defeated killed by the army of William of Normandy at the Battle of Hastings.)**

5.7 William of Normandy

William of Normandy (1028-1087), also known as William the Conqueror or William the Bastard, was the illegitimate son of Robert I, Duke of Normandy, by his mistress Herleva. Despite his illegitimate status and his youth, he succeeded his father in 1035.

In 1050, William married Matilda of Flanders, thus obtaining a powerful ally in the neighboring country of Flanders.

William was the first cousin, once removed, of King Edward the Confessor, and he claimed that Edward had promised him the English crown, also maintaining that Harold Godwinson had sworn to support that claim. Thus when the childless King Edward died, William claimed a right to the English throne. He built a powerful fleet, and in September, 1066, he invaded England, decisively defeating and killing Harold Godwinson at the Battle of Hastings.

The Normans were Vikings, although they had been living in France so long that they had adopted the French language. When they conquered England, they brought the French language with them as the language of the aristocracy. Thus English often has two words for the same thing, the word of French origin being the finer of the two, while that of Scandinavian or Germanic origin is less fine. For example “mansion” is derived from the French word “maison”, and implies something finer than “house”, which is related to the Scandinavian word “hus” and the German word “hause”.



Figure 5.19: *Harold Rex Interfectus Est: King Harold was killed.* Scene from the Bayeux Tapestry depicting the Battle of Hastings and the death of Harold.



Figure 5.20: Norman knights and archers at the Battle of Hastings.



Figure 5.21: A scene from the Bayeux Tapestry depicting Odo, Bishop of Bayeux, rallying Duke William's troops during the Battle of Hastings in 1066. Odo was the half-brother of William the Conqueror, and it was probably he who commissioned the Bayeux Tapestry.

5.8 Erik the Red

Erik the Red (c.950-c.1003) was born in Norway. He was the son of Thorvald Asvaldsson. When Thorvald was forced to flee from Norway to avoid murder charges, Erik moved with him to Iceland. After his father's death, Erik the Red established a farm in Iceland, married, and had three sons and a daughter. However, he became involved in a dispute during which several people were killed. As a result, Erik the Red was banished from Iceland for three years. He and his followers sailed northward to Greenland, which had been discovered a century earlier, but never successfully colonized.

Concerning Erik's stay in Greenland, Wikipedia says the following: **"During his exile, around 982, Erik sailed to a somewhat mysterious and little-known land that Snæbjörn galti Hölmsteinsson had unsuccessfully attempted to settle four years before. He rounded the southern tip of the island, later known as Cape Farewell, and sailed up the western coast. Eventually, he reached a part of the coast that, for the most part, seemed ice-free and consequently had conditions - similar to those of Iceland - that promised growth and future prosperity. According to the Saga of Erik the Red, he spent his three years of exile exploring this land. The first winter he spent on the island of Eiriksey, the second winter he passed in Eiriksholmar (close to Hvarfsgnipa). In the final summer he explored as far north as Snaefell and into Hrafnfjörður."**

Erik the Red returned to Iceland after the period of his banishment had expired with stories about a wonderful country to the north, *Greenland*. He deliberately gave it this

attractive name in order to persuade Icelanders to follow him to settle there. Many did, but out of 25 ships that left to colonize Greenland, 11 were lost at sea, and only 14 arrived safely.

Erik's wife had converted to Christianity, and she commissioned the building of a small church, the remains of which can still be seen today. However, Erik himself stayed loyal to the Norse gods. This caused a rift between husband and wife.

The Norse colony in Greenland was a success, and it lasted for many centuries, finally dying out, for unknown reasons, between 1450 and 1500.

5.9 Leif Erikson

Bjarni Herjólfsson

During their voyages, the Vikings could tell their latitude by observing the sun and stars. However, they had no way of determining longitude. If they wanted to sail from Norway to Iceland, they went to a certain point on the Norwegian coast, and just sailed westward until they reached land.

According to *Grønlandia Saga*, this method was used by a man named Bjarni Herjólfsson, who attempted to reach Iceland in order to spend the winter there with his father. However, he was blown off course by a storm. Not realizing that he had missed Iceland, Bjarni continued to sail westward, finally reaching the North American continent. He returned, and finally settled in Greenland.

Leif Erikson's expedition

According to *Grónlandia Saga*, Erik the Red's son, Leif Erikson, became interested in Bjarne's discovery, and bought a ship from him. Leif tried to persuade his father to lead the expedition westward, but Erik the Red complained that he was too old. Finally persuaded, Erik mounted his horse to ride down to the ship. The horse stumbled and Erik was thrown to the ground, hurting his foot. He took this as a bad omen, and said, "I am not meant to discover more countries than that which we now inhabit." Leif Erikson was forced to lead the expedition alone.

Sailing westward, Leif Erikson and his men first reached Labrador, which they called "Markland". They then sailed southward along the coast, finally reaching Newfoundland, which they called "Vinland".

In the sagas, there is an account of a hostile encounter between Leif and his men and three North American Indians, in which the Vikings killed two, but one escaped. That night (according to the story) Erik the Red appeared to his son in a dream, and said, "Get up, Leif Erikson! Get up and take your sword in your hand! Get up and wake your men! Get up if you want to live!". Leif followed his father's advice, just as a large band of Indians attacked. Whether or not this story is true, the fact the Vikings never made peace



Figure 5.22: A reconstruction of Norse buildings at the UNESCO listed L'Anse aux Meadows site in Newfoundland, Canada. Archaeological evidence demonstrates that iron working, carpentry, and boat repair were conducted at the site.

with the Indians is the reason why they never colonized North America. However, they used Labrador as a source of timber, and there was some temporary settlement there.

Suggestions for further reading

1. Beamish, North Ludlow (1841). *The discovery of America by the Northmen, in the tenth century*. London: T. & W. Boone.
2. Magnus Magnusson; Hermann Pálsson (2004) [1965]. *The Vinland Sagas*. Penguin Books.
3. Reeves, Arthur M. (Middleton), tr., ed. (1895) [1890]. *The Wineland History of the Flatey Book. The Finding of Wineland the Good: The History of the Icelandic Discovery of America*. Oxford University Press.
4. Reeves, Arthur M. (Middleton); Beamish, North Ludlow; Anderson, Rasmus B. (1906). Buel, J. W. (ed.). *The Norse Discovery of America: A Compilation in Extensó of All the Sagas, Manuscripts, and Inscriptive Memorials Relating to the Finding and Settlement of the New World in the Eleventh Century*. New York: Norræna Society.
5. Örnólfur Thorsson (ed.) (2001). *The Sagas of Icelanders*. Penguin Books.
6. Sturlason, Snorre. (2004) *Heimskringla Or The Lives Of The Norse Kings*, Kessinger Publishing.
7. Sullivan, Steve & Stephen Krensky. (1991) *Who Really Discovered America?*, Hastingshouse/Daytrips Publ.
8. Oleson, T.J. *Bjarni, Hejólfsson*, Dictionary of Canadian Biography vol. 1, University of Toronto/Université Laval, 1979.

9. Kudeba, N. (2014, April 19). Chapter 5 - *Norse Explorers from Erik the Red to Leif Erikson* - Canadian Explorers.
10. Oleson, Tryggvi J., *The Norsemen in America* (Ottawa: Canadian Historical Association, 1963) (CHA Historical Booklet No. 14).
11. Oleson, Tryggvi J., *Early Voyages and Northern Approaches 1000-1632*, Volume 1 of the Canadian Centenary Series (Toronto: McClelland & Stewart, 1963; re-issue with additional material, 1968).
12. Downham, Clare *England and the Irish-Sea Zone in the Eleventh Century* in Gillingham, John (ed) (2004) *Anglo-Norman Studies XXVI: Proceedings of the Battle Conference 2003*. Woodbridge. Boydell Press.
13. Etchingham, Colman (2001) *North Wales, Ireland and the Isles: the Insular Viking Zone*. Peritia.
14. Howorth, Henry H. (January 1911). *Ragnall Ivarson and Jarl Otir*. The English Historical Review. 26 (101): 1-19.
15. Ó Corráin, Donnchadh (Mar 1979) *High-Kings, Vikings and Other Kings*. Irish Historical Studies 22 No. 83 pp. 283-323. Irish Historical Studies Publications.
16. Woolf, Alex *The Age of the Sea-Kings: 900-1300* in Omand, Donald (ed.) (2006) *The Argyll Book*. Edinburgh. Birlinn.
17. Woolf, Alex (2007) *From Pictland to Alba, 789-1070*. Edinburgh. Edinburgh University Press.
18. Woolf, Alex (ed.) (2009) *Scandinavian Scotland - Twenty Years After*. St Andrews. St Andrews University Press.
19. Blair, Peter Hunter (2003). *An Introduction to Anglo-Saxon England (3rd ed.)*. Cambridge, UK and New York City, USA: Cambridge University Press.
20. Crawford, Barbara E. (1987). *Scandinavian Scotland*. Atlantic Highlands, New Jersey: Leicester University Press.
21. DeVries, Kelly (2003). *The Norwegian Invasion of England in 1066*. Woodbridge, Suffolk: Boydell Press.
22. Graham-Campbell, James & Batey, Colleen E. (1998). *Vikings in Scotland: An Archaeological Survey*. Edinburgh: Edinburgh University Press.
23. Horspool, David (2006). *Why Alfred Burned the Cakes*. London: Profile Books.
24. Howard, Ian (2003). *Swein Forkbeard's Invasions and the Danish Conquest of England, 991-1017 (illustrated ed.)*. Boydell Press.
25. Richards, Julian D. (1991). *Viking Age England*. London: B. T. Batsford and English Heritage.
26. Keynes, Simon (1999). Lapidge, Michael; Blair, John; Keynes, Simon; Scragg, Donald (eds.). "Vikings". *The Blackwell Encyclopaedia of Anglo-Saxon England*. Oxford: Blackwell.
27. Panton, Kenneth J. (2011). *Historical Dictionary of the British Monarchy*. Plymouth: Scarecrow Press.
28. Pearson, William (2012). *Erik Bloodaxe: His Life and Times: A Royal Viking in His Historical and Geographical Settings*. Bloomington, IN: AuthorHouse.
29. Starkey, David (2004). *The Monarchy of England*. I. London: Chatto & Windus.

30. Downham, Clare (2007). *Viking kings of Britain and Ireland: the dynasty of Ívarr to A.D. 1014*. Dunedin Academic Press.
31. Downham, Clare (2011). *Viking Ethnicities. A Historiographic Overview*, History Compass 10.1 (2012).
32. Hadley, Dawn (2006). *The Vikings in England: Settlement, Society and Culture*. Manchester University Press.
33. Heide, Eldar (2008). *Viking, week, and Widsith. A reply to Harald Bjorvand* (PDF). Arkiv för nordisk filologi. 123. C.W.K. Gleerup.
34. Hodges, Richard (2006). *Goodbye to the Vikings: Re-Reading Early Medieval Archaeology*. Gerald Duckworth & Company Limited.
35. Svanberg, Fredrik (2003). *Decolonizing the Viking Age*. Almqvist & Wiksell International.
36. Wamers, Egon (1985). *Insularer Metallschmuck in wikingerzeitlichen Gräbern Nordeuropas. Untersuchungen zur skandinavischen Westexpansion*. Neumünster: Karl Wachholtz.
37. Wamers, Egon (1998). *Insular Finds in Viking Age Scandinavia and the State Formation of Norway*. In Clarke, H.B.; Mhaonaigh, M. NÁ; Floinn, R. Ó. (eds.). *Ireland and Scandinavia in the Early Viking Age*. Dublin: Four Courts Press.
38. Wawn, M.A. (2000). *The Vikings and the Victorians: Inventing the Old North in Nineteenth Century Britain*. Woodbridge: Boydell and Brewer.

Chapter 6

MARCO POLO

6.1 Family and early life

Marco Polo (1254-1324) was born in Venice, into a very successful family of merchants. At the time of his birth, his father Niccolò Polo (c.1230-c.1294) and his uncle, Maffeo Polo (c.1230-c.1309) were away from Venice on a long journey during which they spent many years in the court of the Chinese emperor, Kublai Khan. Niccolò Polo did not see his son Marco until the boy was about 15 years old.

The two Polo brothers, Niccolò and Maffeo, had established trading companies Constantinople, and in Sudak in the Crimea, which was then in the western part of the Mongol Empire. They lived in the Venetian quarter of Constantinople, where Venetians then enjoyed tax advantages and other privileges. However, in 1259 or 1260, judging the political situation in Constantinople to be precarious, they moved their business to the Crimea. This decision proved to be very fortunate, since the government in Constantinople soon changed, and Venetians in the city were then subject to terrible persecution.

The Crimea was at that time a part of the Golden Horde, the western end of of the Mongol empire. After spending some years there, the Polo brothers moved still further eastward to the city of Bukhara, where they spent three years and further increased their trading profits. While they were in Bukhara, the brothers were invited to visit the court of the great Chinese emperor, Kublai Khan.

Kublai Khan was very much interested in what the Polo brothers had to tell him about European civilization and Christianity. He wrote a letter to the pope, requesting 100 educated people and missionaries who would come and teach his people about western customs and Christianity. He also asked for oil from the lamp of the Holy Sepulchre.

When the Polo brothers returned to Venice in 1269 or 1270, they were distressed to find that there was no pope to whom they could deliver Kublai Khan's letter and request. However, in 1261, Pope Gregory X was elected, and the brothers were able to fulfil their commission. Pope Gregory sent a letter and gifts to the great Khan, but only two missionaries rather than 100. The Polo brothers took these with them when they returned to China. They also took Niccolò's young son, Marco Polo.



Figure 6.1: Niccolò and Maffeo Polo leaving Constantinople for the east, in 1259.



Figure 6.2: Niccolò and Maffeo in Bukhara, where they stayed for three years. They were invited by an envoy of Hulagu (right) to travel east to visit Kublai Khan.



Figure 6.3: Niccolò and Maffeo Polo remitting a letter from Kublai Khan to Pope Gregory X in 1271.



Figure 6.4: Rialto Bridge, Venice.



Figure 6.5: The Doge's Palace, Venice.

6.2 Marco travels to China with his father and uncle

In 1271, at the age of 17, Marco Polo set off with his his father and uncle on an epic journey to the court of Kublai Khan. It would be 24 years before they returned to Venice.

In the service of Kublai Khan

Once again they were welcomed by the great Khan, who took a special interest in the young Marco Polo, who by this time was 21 years old, because of his intelligence and humility. Marco Polo also entertained the emperor with stories of the countries which he had visited. Kublai Khan was so pleased that he decided to appoint Marco as a diplomat to the various parts of his empire, for example present-day Burma, India, Indonesia, Sri Lanka, and Vietnam.

In addition to these diplomatic missions, Marco Polo also lived and travelled extensively inside China (then known as Cathay). He observed many things that were previously unknown to Europeans, for example, the use of paper money and coal.

Return to Europe

Kublai Khan several times refused to allow the Polos to return to Europe because they were useful to him. However, in 1291 he granted the Polos permission, as their last service, to accompany the Mongol princess Kōkōchin, to Persia, where she was to marry Arghun Khan. After performing this mission, the Polos finally returned to Venice, arriving there with many riches 24 years after they had departed on their epic journey.



Figure 6.6: Marco Polo dressed as a Tartar.



Figure 6.7: Mosaic of Marco Polo displayed in the Palazzo Doria-Tursi, in Genoa, Italy.

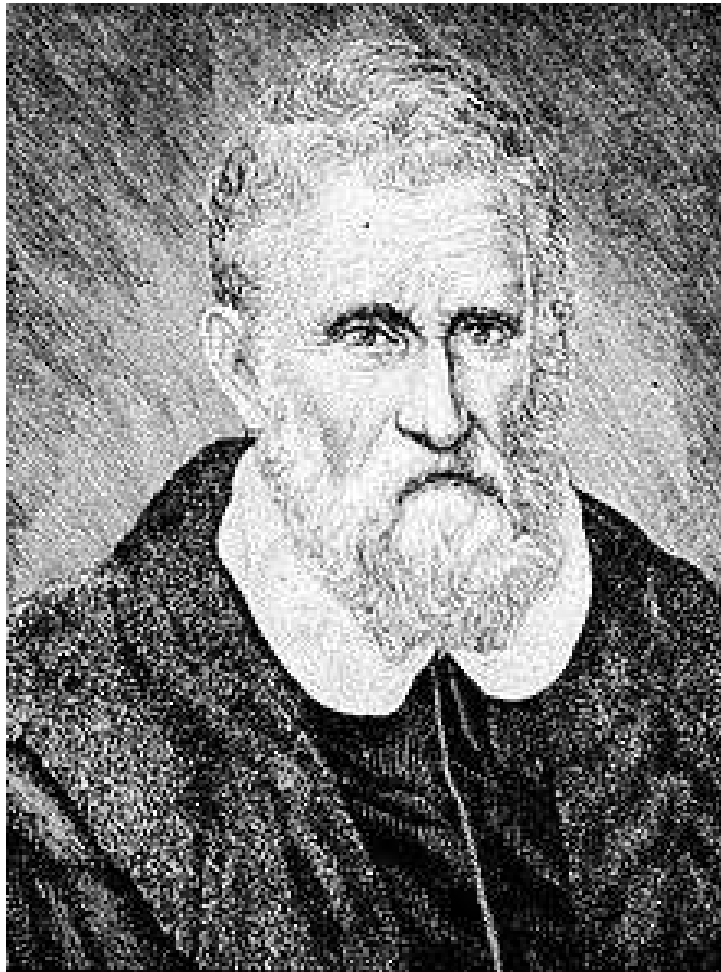


Figure 6.8: 16th century portrait of Marco Polo.



Figure 6.9: Portrait of Kublai Khan (1215-1294). His white robes are those of a shaman. He was the grandson and heir of Genghis Khan.



Figure 6.10: **Portrait of young Kublai by Anige, a Nepali artist in Kublai's court.**



Figure 6.11: The Yuan Dynasty of China, over which Kublai Khan became emperor.

6.3 Return to Venice and capture by the Genoans

When Marco Polo returned to Venice in 1295, the city was at war with Genoa. Marco purchased a ship and participated in the naval war. However, he was captured and imprisoned for three years.

Marco dictates his book to a cell-mate

While in prison, Marco Polo dictated a book of his recollections from his epic travels in Asia to a cell-mate, Rustichello da Pisa, who happened to be a successful author of romances. The result was the famous book whose English title is *The Travels of Marco Polo*, while the French title was *Livre des merveilles*. The book became immensely popular, and it opened the eyes of Europeans to the great wealth and knowledge of countries in Asia, thus initiating the Age of Exploration.

Xanadu (Shangdu)

In Marco Polo's book describing of his travels, he gives the following description of Kublai Khan's summer palace:

“And when you have ridden three days from the city last mentioned, between north-east and north, you come to a city called Chandu, which was built by the Khan now reigning. There is at this place a very fine marble palace, the rooms of which are all gilt and painted with figures of men and beasts and birds, and with a variety of trees and flowers, all executed with such exquisite art that you regard them with delight and astonishment.

“Round this Palace a wall is built, inclosing a compass of 16 miles, and inside the Park there are fountains and rivers and brooks, and beautiful meadows, with all kinds of wild animals (excluding such as are of ferocious nature), which the Emperor has procured and placed there to supply food for his gerfalcons and hawks, which he keeps there in mew. Of these there are more than 200 gerfalcons alone, without reckoning the other hawks. The Khan himself goes every week to see his birds sitting in mew, and sometimes he rides through the park with a leopard behind him on his horse’s croup; and then if he sees any animal that takes his fancy, he slips his leopard at it, and the game when taken is made over to feed the hawks in mew. This he does for diversion.

“Moreover at a spot in the Park where there is a charming wood he has another Palace built of cane, of which I must give you a description. It is gilt all over, and most elaborately finished inside. It is stayed on gilt and lacquered columns, on each of which is a dragon all gilt, the tail of which is attached to the column whilst the head supports the architrave, and the claws likewise are stretched out right and left to support the architrave. The roof, like the rest, is formed of canes, covered with a varnish so strong and excellent that no amount of rain will rot them. These canes are a good 3 palms in girth, and from 10 to 15 paces in length. They are cut across at each knot, and then the pieces are split so as to form from each two hollow tiles, and with these the house is roofed; only every such tile of cane has to be nailed down to prevent the wind from lifting it. In short, the whole Palace is built of these canes, which I may mention serve also for a great variety of other useful purposes. The construction of the Palace is so devised that it can be taken down and put up again with great celerity; and it can all be taken to pieces and removed whithersoever the Emperor may command. When erected, it is braced against mishaps from the wind by more than 200 cords of silk.

“The Khan abides at this Park of his, dwelling sometimes in the Marble Palace and sometimes in the Cane Palace for three months of the year, to wit, June, July and August; preferring this residence because it is by no means hot; in fact it is a very cool place...”

Coleridge’s poem

In 1797, after reading a description of Shangdu, Samuel Taylor Coleridge fell asleep, and while asleep composed the poem which starts with the lines:

In Xanadu did Kublai Khan
A stately pleasure-dome decree:
Where Alph, the sacred river, ran
Through caverns measureless to man
Down to a sunless sea.



Figure 6.12: French *Livre des merveilles* front page. At a time before printed books, it nevertheless became a best-seller!

So twice five miles of fertile ground
 With walls and towers were girdled round:
 And there were gardens bright with sinuous rills,
 Where blossomed many an incense-bearing tree;
 And here were forests ancient as the hills,
 Enfolding sunny spots of greenery...



Figure 6.13: Handwritten notes by Christopher Columbus on the Latin edition of Marco Polo's *Le livre des merveilles*. By making Europeans conscious of the wealth and knowledge of eastern civilizations, Marco Polo's book initiated the Age of Exploration.

6.4 History of the Silk Road

China's impact on western civilization

It was during the T'ang period that the Chinese made an invention of immense importance to the cultural evolution of mankind. This was the invention of printing. Together with writing, printing is one of the key inventions which form the basis of human cultural evolution.

Printing was invented in China in the 8th or 9th century A.D., probably by Buddhist monks who were interested in producing many copies of the sacred texts which they had translated from Sanskrit. The act of reproducing prayers was also considered to be meritorious by the Buddhists.

The Chinese had for a long time followed the custom of brushing engraved official seals with ink and using them to stamp documents. The type of ink which they used was made from lamp-black, water and binder. In fact, it was what we now call "India ink". However, in spite of its name, India ink is a Chinese invention, which later spread to India, and from there to Europe.

Paper of the type which we now use was invented in China in the first century A.D.. Thus, the Buddhist monks of China had all the elements which they needed to make printing practical: They had good ink, cheap, smooth paper, and the tradition of stamping documents with ink-covered engraved seals. The first block prints which they produced date from the 8th century A.D.. They were made by carving a block of wood the size of a printed page so that raised characters remained, brushing ink onto the block, and pressing this onto a sheet of paper.

The oldest known printed book, the "Diamond Sutra", is dated 868 A.D., and it consists of only six printed pages. It was discovered in 1907 by an English scholar who

obtained permission from Buddhist monks in Chinese Turkestan to open some walled-up monastery rooms, which were said to have been sealed for 900 years. The rooms were found to contain a library of about 15,000 manuscripts, among which was the Diamond Sutra.

Block printing spread quickly throughout China, and also reached Japan, where wood-block printing ultimately reached great heights in the work of such artists as Hiroshige and Hokusai. The Chinese made some early experiments with movable type, but movable type never became popular in China, because the Chinese written language contains 10,000 characters. However, printing with movable type was highly successful in Korea as early as the 15th century A.D..

The unsuitability of the Chinese written language for the use of movable type was the greatest tragedy of the Chinese civilization. Writing had been developed at a very early stage in Chinese history, but the system remained a pictographic system, with a different character for each word. A phonetic system of writing was never developed.

The failure to develop a phonetic system of writing had its roots in the Chinese imperial system of government. The Chinese empire formed a vast area in which many different languages were spoken. It was necessary to have a universal language of some kind in order to govern such an empire. The Chinese written language solved this problem admirably. The invention of printing, transmitted to the west along the Silk Road, led to the rise of science and the Industrial Revolution in Europe.

During the period when the Polo family visited China, the Mongols ruled not only China, but also southern Russia and Siberia, central Asia and Persia. They were friendly towards Europeans, and their control of the entire route across Asia opened direct contacts between China and the west. The Silk Road became a corridor for the exchange of ideas between east and west. The Chinese inventions, knowledge of which passed along the Silk Road, revolutionized European society-

The first Chinese text clearly describing the magnetic compass dates from 1088 A.D.. However, the compass is thought to have been invented in China at a very much earlier date. The original Chinese compass was a spoon carved from lodestone, which revolved on a smooth diviner's board. The historian Joseph Needham believes that sometime between the 1st and 6th centuries A.D. it was discovered in China that the directive property of the lodestone could be transferred to small iron needles. These could be placed on bits of wood and floated in water. It is thought that by the beginning of the Sung dynasty, the Chinese were also aware of the deviation of the magnetic north from the true geographical north. By 1190 A.D., knowledge of the compass had spread to the west, where it revolutionized navigation and led to the great voyages of discovery which characterized the 15th century.

Other Chinese inventions which were transmitted to the west include metallurgical blowing engines operated by water power, the rotary fan and rotary winnowing machine, the piston bellows, the draw-loom, the wheel-barrow, efficient harnesses for draught animals, the cross bow, the kite, the technique of deep drilling, cast iron, the iron-chain suspension bridge, canal lock-gates, the stern-post rudder and gunpowder. Like paper, printing and the magnetic compass, gunpowder and its use in warfare were destined to have an enormous social and political impact.



Figure 6.14: Xi'an retains its Ming Dynasty city wall. This image shows one of the gates.

Some personal memories of the Silk Road

In 1985, I spent two months lecturing on quantum theory at Northwestern University in Xi'an, the eastern end of the Silk Road. Every weekend, the university arranged a tour for all of the foreign lecturers. and on one of these tours, we travelled a long distance westward into the mountains, following the Silk Road. Interestingly, the farther westward we travelled, the lighter complexioned people became. Instead of having dark hair, they became more and more blond. This was because of intermarriage with ethnic Russians.

Back in Xi'an, people urged me to see the Mosque and the Muslim ethnic minority group living nearby in the old part of the city. When I went to see them, they hardly seemed different from the Han Chinese people of the city, because of intermarriage over the centuries.



Figure 6.15: The Big Goose Pagoda at Xi'an.



Figure 6.16: The Great Mosque at Xi'an is a center for the Islamic minority group. Travel along the Silk Road led to mixing between ethnic groups, and today, members of the Islamic minority are almost indistinguishable from the Han Chinese.



Figure 6.17: Near to Xi'an is the famous site of the 8,000 terracotta warriors. The warriors were meant to guard the emperor in the afterlife. Each statue has a different face!



Figure 6.18: Tupopdan Peak, 20,033 feet (6,106 meters), also known as “Passu Cathedral,” just north of Gulmit village in the Hunza Valley region of Pakistan. The picturesque valley was one of several important passes along the ancient Silk Road, situated between China’s western Xinjiang region and Afghanistan’s Wakhan Corridor.



Figure 6.19: A view of the ruins of the ancient city of Jiaohe, seen at sunset on March 7, 2007 in Turpan, China. Jiaohe, built on a 98-foot-high loess plateau over 2,300 years ago, lies in the Yarnaz Valley and is protected by the natural fortification of the precipitous cliffs. The city has been a major passageway for communication between the East and West since the Han Dynasty and Tang Dynasty, and an important section of the ancient Silk Road.



Figure 6.20: Afghan children play in the old part of the northern town of Mazar-i-Sharif in Balkh province on March 27, 2012. Once known as the “mother of cities,” the ancient city of Balkh was a popular destination along the ancient Silk Road. Balkh was destroyed by Mongol conqueror Genghis Khan during his rule, and the city’s ruins remain a tourist attraction today.



Figure 6.21: Ancient columns stand at the Al-Mina archaeological site, Tyre, Lebanon. Tyre, on the Mediterranean Sea, served as one of several ports at the western end of the Silk Road. Traders, having reached this point, might unload their goods onto a waiting ship, or board the vessel themselves to continue westward.

6.5 Timeline for European exploration of Asia

Here is a timeline from a Wikipedia article entitled *Chronology of European exploration of Asia*:

- 515 BC: Scylax explores the Indus and the sea route across the Indian Ocean to Egypt.
- 330 BC: Alexander the Great conquers parts of Central Asia and parts of northwestern India
- 300 BC: Seleucus Nicator, founder of the Seleucid Empire, forays into northwestern India but is defeated by Chandragupta Maurya, founder of the Maurya Empire, and they become allies soon after.
- 250 - 120 BC: Greco-Bactrian states in parts of Central Asia and South Asia, including the Fergana Valley (Alexandria Eschate), Transoxiana (Alexandria on the Oxus) and Punjab (Alexandria on the Indus).
- 180 BC - 10 AD: The Indo-Greek Kingdom was located areas now part of Afghanistan, Pakistan and north-west India.
- 30 BC - 640 AD: With the acquisition of Ptolemaic Egypt, The Romans begin trading with India. The Empire now has a direct connection to the Spice trade Egypt had established beginning in 118 BC.
- 100 AD - 166 AD: Romano-Chinese relations begin. Ptolemy writes of the Golden Chersonese (i.e. Malay Peninsula) and the trade port of Kattigara, now identified as Óc Eo in southern Vietnam, then part of Jiaozhou, a province of the Chinese Han Empire. The Chinese historical texts describe Roman embassies, from a land they called Daqin.
- 2nd century: Roman traders reach Siam, Cambodia, Sumatra, and Java.
- 161: An embassy from Roman Emperor Antoninus Pius or his successor Marcus Aurelius reaches Chinese Emperor Huan of Han at Luoyang.
- 226: A Roman diplomat or merchant lands in northern Vietnam and visits Nanjing, China and the court of Sun Quan, ruler of Eastern Wu
- c.500-1000: The Radhanites were medieval Jewish merchants who dominated trade between the Christian and Islamic worlds during the early Middle Ages and travelled as far as Tang dynasty China.
- c.550: Byzantine traveler and author Cosmas Indicopleustes completes his work *Christian Topography* describing geographical features gleaned from his own travels to Eritrea, Ethiopia, India, and Sri Lanka.
- c.552: Two Persian monks (or perhaps emissaries disguised as monks), at the behest of Eastern Roman (Byzantine) emperor Justinian I, travel to China and smuggle silkworms back to the Eastern Roman Empire, thus enabling silk production in Europe and Asia Minor.
- 568: The Eastern Roman (Byzantine) general Zemarchus travels to Samarkand and the court of the Western Turkic Kaganate.

- 639-640: The Muslims subjugate Egypt, thus severing most direct Eastern-Roman (and hence European) trade with India and eastern Asia.
- 1160-1173: The Navarrese Jewish Rabbi Benjamin of Tudela visits Syria, Palestine, Baghdad, Persia, and the Arabian Peninsula.
- 1180-1186: Pethahiah of Regensburg goes to Baghdad.
- 13th century: Silk Road trade reaches its height during the height of the Pax Mongolica, the relative peace in Asia during the widespread unification under the Mongol Empire.
- 1245-1247: The Italian Franciscan Giovanni da Pian del Carpine appointed Papal Legate and accompanied by Stephen of Bohemia, and later by Benedykt Polak, reaches Karakorum present-day Mongolia. First European embassy to the Great Khan.
- 1245-1248: The Italian Ascelin of Lombardia, Simon of St Quentin and Andrew of Longjumeau go to Armenia and Persia.
- 1249-1251: Andrew of Longjumeau guide a French ambassador to the great Kuyuk Khan. His brother Guy and several others - John Goderiche, John of Carcassonne, Herbert "Le Sommelier", Gerbert of Sens, Robert (a clerk), a certain William, and an unnamed clerk of Poissy go with him. They reached Talas in northwestern Kyrgyzstan.
- c.1254: The Flemish William of Rubruck reached Mongolia through Central Asia.
- 1264-c.1269: First travel of the Italians Niccolò and Maffeo Polo to China. In 1266, they reach Kublai Khan's seat at Dadu, now known as Beijing, China.
- 1271-1295: Second trip of Niccolò and Maffeo Polo to China. This time with Marco, Niccolò's son, who would write a colourful account of their experiences. The details of their account are currently debated.
- 1275-1289 & 1289-1328: The Italian John of Montecorvino (1246-1328) was a Franciscan missionary, traveller and statesman, founder of the earliest Roman Catholic missions in India and China, and archbishop of Peking, and Patriarch of the Orient.
- c.1318-1329: Travels of the Franciscan friars, the Italian Odoric of Pordenone and James of Ireland via India and the Malay Peninsula to China where they stayed in Dadu (present day Beijing) for approximately three years before returning to Italy overland through Central Asia.
- c.1321-1330/1338(?): The French Dominican missionary Jordanus, made bishop over the whole Indian subcontinent in 1329, wrote down his travels through India and the Middle East in his book *Mirabilia*.
- 1338-1353: The Italian Giovanni de' Marignolli, one of four chief envoys sent by Pope Benedict XII to Peking.
- 1401-1402: Travel of Payo Gómez de Sotomayor, first ambassador of Henry III of Castile to the Timurid Empire.

- 1403-1404: Travel of Ruy Gonz lez de Clavijo, second ambassador of Henry III of Castile to the Timurid Empire. He passed along the Black Sea coast of Turkey to Trabzon and then overland through Armenia, Azerbaijan, Iran and Turkmenistan to Uzbekistan. He also visited Tehran.
- 1420-1436: Travels of the Italian explorer Niccol  de' Conti to India and Southeast Asia.
- 1436-1439: Travels of Pedro Tafur across Middle East.
- 1453: Constantinople falls to the Muslim Ottoman Turks, thus ending Christian rule in the Eastern Mediterranean.
- 1470: Travels of Afanasy Nikitin, the first Russian to visit India.
- 1471-1479: The Italian Venetian diplomats Caterino Zeno, Ambrogio Contarini and Giosafat Barbaro travel to Persia.
- 1487-1491: Portuguese explorer and spy P ro da Covilh  travels to the Near East and India under the orders of the King of Portugal, to gather information necessary for successfully establishing a sea route between Portugal and India.
- 1557-1572: The English Anthony Jenkinson travelled across the Caspian Sea to Bukhara and Persia.
- c.1580-1585: The Cossack Yermak Timofeyevich reaches the Siberian Tatar city of Qashliq near the right bank of Irtysh.
- 1583-1591: The English merchant Ralph Fitch, together with John Newberry and John Eldred, a jeweller named William Leedes and a painter, James Story, travelled via the Levant and Mesopotamia to India and Portuguese Malacca (in modern Malaysia). Eldred stayed in Basra, Iraq; Story joined the Jesuits in Goa; Leedes stayed in Agra to work for Akbar and Newberry decided to begin his return journey. Fitch went by himself to Burma and Malacca (today in Malaysia). He returned to London in 1591.

Suggestions for further reading

1. *Marco Polo, Marci Poli Veneti de Regionibus Orientalibus*, Simon Grynaeus Johannes Huttichius, *Novus Orbis Regionum ac Insularum Veteribus Incognitarum*, Basel, 1532, pp. 350-418.
2. Herbermann, Charles, ed. (1913). *Marco Polo*. Catholic Encyclopedia. New York: Robert Appleton Company.
3. Yule, Henry; Cordier, Henri (1923), *The Travels Of Marco Polo*, Mineola: Dover Publications.
4. Moule, Arthur Christopher; Pelliot, Paul (1938). *Marco Polo: The Description of the World*. 1. London: George Routledge & Sons Limited.
5. Nicol, Donald M. (1992), *Byzantium and Venice: a study in diplomatic and cultural relations*, Cambridge University Press,
6. Wood, Frances (1998), *Did Marco Polo Go To China?*, Westview Press.

7. *Marco Polo*, The New Encyclopædia Britannica Macropedia, 9 (15 ed.), Encyclopædia Britannica, Inc, 2002.
8. Parker, John (2004), *Marco Polo*, The World Book Encyclopedia, 15 (illustrated ed.), United States: World Book, Inc.
9. Olivier Weber, *Le grand festin de l'Orient*; Robert Laffont, 2004
10. Edwards, Mike (2005), *Marco Polo, Part 1*, Washington, D.C.: National Geographic Society
11. Falchetta, Piero (2006), *Fra Mauro's World Map*, Turnhout: Brepols.
12. McKay, John; Hill, Bennet; Buckler, John (2006), *A History of Western Society* (Eighth ed.), Houghton Mifflin Company.
13. Bergreen, Laurence (2007), *Marco Polo: From Venice to Xanadu*, Knopf Doubleday Publishing Group.
14. Power, Eileen Edna (2007), *Medieval People*, BiblioBazaar.
15. Winchester, Simon (2008), *The Man Who Loved China: Joseph Needham and the Making of a Masterpiece*, New York: HarperCollins.
16. Basil, Lubbock (2008), *The Colonial Clippers*, Read Books.
17. Brook, Timothy (2010), *The Troubled Empire: China in the Yuan and Ming Dynasties*, Harvard University Press.
18. Marco Polo (1918). Marsden, William (ed.). *The Travels of Marco Polo*. London: J.M. Dent & Sons.
19. Hart, H. Henry (1948). *Marco Polo, Venetian Adventurer*. Kessinger Publishing.
20. Dalrymple, William (1989). *In Xanadu*.
21. Daftary, Farhad (1994). *The Assassin legends: myths of the Isma'ilis (2 ed.)*. I.B. Tauris.
22. Otfinoski, Steven (2003). *Marco Polo: to China and back*. New York: Benchmark Books.
23. Polo, Marco & Rustichello of Pisa (January 1, 2004). *The Travels of Marco Polo - Volume 1*. Project Gutenberg.
24. Polo, Marco & Rustichello of Pisa (May 1, 2004). *The Travels of Marco Polo - Volume 2*. Project Gutenberg.
25. Olivier Weber, *Sur les routes de la soie (On the Silk Roads) (with Reza)*, Hoëbeke, 2007
26. Yang, Dori Jones (2011). *Daughter of Xanadu*. Delacorte Press Books for Young Readers.

Chapter 7

EUROPEAN VOYAGES OF DISCOVERY

7.1 Prince Henry the Navigator, (1394-1460)

Infante Dom Henrique of Portugal, Duke of Viseu is better known as Prince Henry the Navigator. He used his position as the son of King John I of Portugal, and his financial resources Grand Master of the Military Order of Christ (the successor to the Knights Templar) to encourage an era of Portuguese shipbuilding and exploration.

When John I died, Prince Henry's elder brother Edward became king. Edward granted Henry all the profits from trading within the areas that his expeditions discovered. Henry also was given a monopoly on tuna fishing within the Algarve, thus further increasing his financial resources.

Prince Henry was fascinated with Africa, not only because it was a source of gold, but also because of the legend of Prester John, who was said to have ruled a Christian country in Africa. Henry encouraged Portugal to conquer the Moorish port of Ceuta in Northern Morocco, the terminus of a trade route.

Henry also encouraged the design of new types of ships, notable the caravel, which was very seaworthy and maneuverable, and able to sail close to the wind. The "trade winds" had been discovered by Prince Henry's expeditions. These were later used by Columbus on his voyages but the caravel's ability to sail close to the wind made it to some extent independent of the trade winds.

Expeditions sponsored by Prince Henry searched for the "Western Nile" and discovered the Senegal River in about 1444. This was south of the Moslem trade routes. Both gold and slaves began to pour into Portugal, enriching the country at the expense of the Moslem traders in Algiers and Tunis, who were ruined. It can be seen that Portuguese explorations were motivated by greed as much as by curiosity, and that cruelty to indigenous peoples also played a role. Sadly, the same can be said about much of European exploration.



Figure 7.1: **Prince Henry the Navigator**, (1394-1460).

7.2 Christopher Columbus, (1451-1506)

Christopher Columbus. or in Italian, Cristoforo Colombo, was born in Genoa. Italy. He was largely self-educated, but very widely read on many subjects, including geography, astronomy, and history. He possessed a copy of Marco Polo's book, and made enthusiastic comments in the margins.

As a young man, Columbus participated in a number of voyages, which took him to the British Isles, possibly to Iceland, and possibly as far south as what is now Ghana. He married a Portuguese noblewoman named Filipa Moniz Perestrelo, with whom he had a son.

Inspired by Marco Polo's book, Columbus dreamed of reaching China and India by sailing westward. He was encouraged in this plan by his correspondence with the astronomer and geographer Paolo Toscanelli. In a letter to Columbus, Toscanelli wrote:

"The said voyage is not only possible, but it is true, and certain to be honourable and to yield incalculable profit, and very great fame among all Christians. But you cannot know this perfectly save through experience and practice, as I have had in the form of the most copious and good and true information from distinguished men of great learning who have come from the said parts, here in the court of Rome, and from others being merchants who have had business for a long time in those parts, men of high authority."

After failing to receive support for his proposed westward voyages in Portugal, Columbus moved to Spain, and there he was more successful. After much campaigning by Columbus, Queen Isabella and King Ferdinand agreed to sponsor a voyage. In the end, Columbus made four voyages in the name of the crown of Castile,

In August, 1492, Columbus sailed westward with three ships under his command. After a stopover in the Canary Islands, the ships continued westward, carried by westerly trade winds. They made landfall on an island somewhere in the Caribbean. The exact identity of this island is uncertain. Believing that he had reached India, Columbus called the natives of the island "Indians".

Wikipedia says of him:

"Columbus made three further voyages to the New World, exploring the Lesser Antilles in 1493, Trinidad and the northern coast of South America in 1498, and the eastern coast of Central America in 1502. Many of the names he gave to geographical features - particularly islands - are still in use. He continued to seek a passage to the East Indies, and the extent to which he was aware that the Americas were a wholly separate landmass is uncertain. He never clearly renounced his belief that he had reached the Far East and gave the name indios ("Indians") to the indigenous peoples he encountered. Columbus's strained relationship with the Spanish crown and its appointed colonial administrators in America led to his arrest and removal from Hispaniola in 1500, and later to protracted litigation over the benefits that he and his heirs claimed were owed to them by the crown. Columbus's expeditions inaugurated a period of exploration, conquest, and colonization that lasted for



Figure 7.2: Christopher Columbus, (1451-1506).

centuries, helping create the modern Western world. The transfers between the Old World and New World that followed his first voyage are known as the Columbian exchange, and the period of human habitation in the Americas prior to his arrival is referred to as the Pre-Columbian era.

“Columbus’s legacy continues to be debated. He was widely venerated in the centuries after his death, but public perceptions have changed as recent scholars have given greater attention to negative aspects of his life, such as his enslavement of the indigenous population in his quest for gold and his brutal subjugation of the Taíno people, leading to their near-extinction, as well as allegations of tyranny towards Spanish colonists. Many landmarks and institutions in the Western Hemisphere bear his name, including the country of Colombia and the name Columbia, which is used as a personification for the United States, and appears in many place names there.”

7.3 John Cabot, (c.1450-c.1500)

John Cabot (Giovanni Caboto) was born in Genoa, Italy. He later moved to Venice, where he married and had three sons, Ludovico, Sebastian and Sancto. However, in about 1480 he appears to have got into financial trouble, and he was forced to flee with his family to Spain. Even in Spain, his creditors attempted (unsuccessfully) to have him arrested.

After attempting to find Spanish sponsorship for an Atlantic expedition of discovery, Cabot moved to England, where he was more successful. English friends put him into contact with King Henry VII, the first Tudor monarch.

Luckily the king was interested in exploration, and he granted Cabot and his three sons letters of patent giving them **“... free authority, faculty and power to sail to all parts, regions and coasts of the eastern, western and northern sea, under our banners, flags and ensigns, with five ships or vessels of whatsoever burden and quality they may be, and with so many and with such mariners and men as they may wish to take with them in the said ships, at their own proper costs and charges, to find, discover and investigate whatsoever islands, countries, regions or provinces of heathens and infidels, in whatsoever part of the world placed, which before this time were unknown to all Christians.”**

The expeditions were to sail from the English port of Bristol, and Bristol was to have a monopoly on trade to any regions discovered. Cabot's first voyage was unsuccessful. However, his second voyage, in a single small ship called the *Mathew*, reached the shores of Canada.

The chronicle of the city of Bristol states that **“This year, on St. John the Baptist's Day [24 June 1497], the land of America was found by the Merchants of Bristow in a shippe of Bristowe, called the Mathew; the which said the ship departed from the port of Bristowe, the second day of May, and came home again the 6th of August next following.”**

On his return from the voyage, John Cabot rode to London to report to King Henry VII. Besides considerable financial rewards from the king, Cabot received much adulation. A contemporary named Soncino wrote that Cabot **“is called the Great Admiral, and vast honour is paid to him and he goes dressed in silk, and these English run after him like mad”**.

In May, 1498, John Cabot led a large expedition of five ships, which sailed westward from Bristol. They carried with them “cloth, caps, lace points and other trifles”. Seemingly the intention was to use these in trade. One of the ships was forced to seek shelter from a storm, and remained in an Irish port. John Cabot died, either on this expedition, or else shortly afterward.

Wikipedia states that **“The historian Alwyn Ruddock worked on Cabot and his era for 35 years. She suggested that Cabot and his expedition successfully returned to England in the spring of 1500. She claimed their return followed an epic two-year exploration of the east coast of North America, south into the Chesapeake Bay area and perhaps as far as the Spanish territories in the Caribbean. Her evidence included the well-known world map of the Spanish**



Figure 7.3: John Cabot, (c.1450-c.1500).

cartographer Juan de la Cosa. His chart included the North American coast and seas ‘discovered by the English’ between 1497 and 1500...”

“The Cabot Project at the University of Bristol was organized in 2009 to search for the evidence on which Ruddock’s claims rest, as well as to undertake related studies of Cabot and his expeditions. The lead researchers on the project, Evan Jones and Margaret Condon, claim to have found further evidence to support aspects of Ruddock’s case, including some of the information she intended to use to argue for a successful return of the 1498 expedition to Bristol. These appear to place John Cabot in London by May 1500, albeit Jones and Condon have yet to publish their documentation.”



Figure 7.4: A replica of Cabot's ship, the Matthew, in Bristol.

7.4 Amerigo Vespucci, (1454-1512)

Amerigo Vespucci, after whom the continents of North and South America are named, was born in Florence into a family with political connections to Lorenzo di Medici, the de facto ruler of the city-state. He was educated by his uncle, a famous humanist scholar who gave Amerigo a broad education including not only literature, philosophy, rhetoric, and Latin, but also geography and astronomy, subjects that were to be important to his future career.

In 1488, Lorenzo di Pierfrancesco de' Medici, a younger member of the powerful Medici family, sent Amerigo Vespucci to Seville in Spain to investigate some business relationships with which he was dissatisfied. Lorenzo asked Amerigo to investigate the Florentine merchant Gianotto Berardi, whom Lorenzo was thinking of hiring. In this way, Amerigo Vespucci became involved in the voyages of discovery that were then taking place, since Berardi had invested heavily in the voyages of Columbus.

Vespucci personally sailed on several voyages, both for Spain and for Portugal. He wrote colorful accounts of these voyages which were very widely printed and read throughout Europe. Whether or not everything in Vespucci's writings is true is questionable, but the fact that his writings made Europeans highly aware of the voyages of exploration and discovery is beyond dispute.

In 1502 or 1503, Amerigo wrote in a letter to Lorenzo di Pierfrancesco de' Medici:

"A few days ago I wrote you at some length about my return from those new regions we searched for and found with the fleet, at the expense and by the command of the most serene King of Portugal, and which can properly be called a *New World*, since our forebears had absolutely no knowledge of it, nor do any of those who are hearing about it today...On 7 August 1501, we dropped our anchor off the shores of that new land, thanking God with solemn prayers and the celebration of the Mass. Once there, we determined that the new land was not an island but a continent..."

Amerigo Vespucci's accounts of his voyages came to the attention of a group of humanist scholars in France, who included Matthias Ringmann and Martin Waldseemüller. In 1507, they published their *Introduction to Cosmography*. In a preface to this very popular publication, Ringman wrote:

"I see no reason why anyone could properly disapprove of a name derived from that of Amerigo, the discoverer, a man of sagacious genius. A suitable form would be Amerige, meaning Land of Amerigo, or America, since Europe and Asia have received women's names."

In February, 1505, Amerigo Vespucci was back in Spain, where he was summoned to an audience by King Ferdinand, who wished to know more about matters of navigation and a possible route to India. Over the next months, he received large payments from the crown, and he was made a citizen of Castile and Leon by royal proclamation. He continued to work as a Chandler, supplying ships bound for the newly discovered lands. In 1508, Amerigo Vespucci was named Chief Pilot of the House of Commerce, a body which regulated Spain's trade with its overseas possessions. After Vespucci's death in 1512, his



Figure 7.5: Amerigo Vespucci, (1454-1512), in a posthumous portrait in the Giovio Series at the Uffizi in Florence, attributed to Cristofano dell'Altissimo.

wife was awarded a yearly pension of 10,000 “maravedis”, to be deducted from the pay of the new Chief Pilot.

7.5 Vasco da Gama, (c.1460-1524)

Wikipedia says of him: “His initial voyage to India (1497-1499) was the first to link Europe and Asia by an ocean route, connecting the Atlantic and the Indian oceans and therefore, the West and the Orient. This is widely considered a milestone in world history, as it marked the beginning of a sea-based phase of global multiculturalism. Da Gama’s discovery of the sea route to India opened the way for an age of global imperialism and enabled the Portuguese to establish a long-lasting colonial empire in Asia. Traveling the ocean route allowed the Portuguese to avoid sailing across the highly disputed Mediterranean and traversing the dangerous Arabian Peninsula. The sum of the distances covered in the outward and return voyages made this expedition the longest ocean voyage ever made until then, far longer than a full voyage around the world...”



Figure 7.6: Vasco da Gama, (c.1460-1524), Viceroy of Portuguese India.

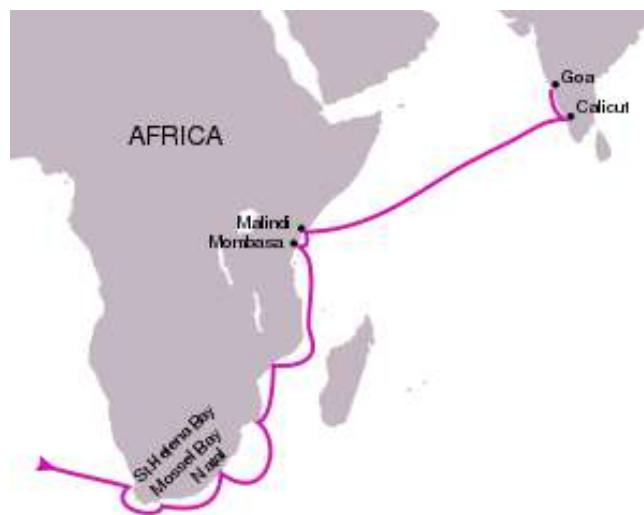


Figure 7.7: The route followed in Vasco da Gama's first voyage (1497-1499).

7.6 Ferdinand Magellan, (1480-1521)

Ferdinand Magellan, born into a family of minor Portuguese nobility, became a skilled officer in the navy of King Manuel I of Portugal. However, when Manuel I rejected Magellan's proposal for a voyage to reach India by sailing around the southern tip of South America, Fernando Magellan went to Spain with the plan and appealed to Spain's ruler, Charles I (who later became Holy Roman Emperor and Archduke of Austria).

This time, Magellan was successful, and Charles I sponsored an expedition of five ships and 250 men. On the 20th of December, 1519, the fleet sailed westward, making landfall at Rio de Janeiro. They then sailed southward, searching for a passage through to the (not yet named) Pacific Ocean. Deteriorating weather conditions forced the explorers to spend the winter in a natural harbor which they had discovered.

During the winter, there was a mutiny. Despite losing control of three of his five ships at one point, Magellan managed to quell the mutiny, beheading one of its leaders and marooning another.

The next spring, the expedition succeeded in finding a route around the southern tip of South America. After the stormy conditions that they had experienced on what is now known as the Strait of Magellan, the ocean on the other side seemed peaceful. Magellan named it the *Pacific Ocean*.

They thought that the remaining voyage across the Pacific to the Spice Islands could be accomplished in a few days, but in fact the voyage took three months and twenty days. When the ships finally made landfall on the island of Guam, supplies of food and water were exhausted and many of the crew members had died of scurvy.

During conflicts with the natives of Guam, Magellan was killed. His body was retained by the natives, who wished to keep it as a trophy. Magellan had previously reached this region on another expedition, and so he can be thought of as having completed a personal circumnavigation of the globe.

Out of the five ships that started the expedition, only one, the *Victoria*, eventually limped back to England; and of the 250 men who started the journey, only 18 or 19 survivors returned.

Wikipedia says of him:

“In the immediate aftermath of the circumnavigation, few celebrated Magellan for his accomplishments, and he was widely discredited and reviled in Spain and his native Portugal. The Portuguese regarded Magellan as a traitor for having sailed for Spain. In Spain, Magellan’s reputation suffered due to the largely unflattering accounts of his actions given by the survivors of the expedition...”

“Magellan has come to be renowned for his navigational skill and tenacity. The first circumnavigation has been called ‘the greatest sea voyage in the Age of Discovery’, and even ‘the most important maritime voyage ever undertaken’. Appreciation of Magellan’s accomplishments may have been enhanced over time by the failure of subsequent expeditions which attempted to retrace his route...”



Figure 7.8: Ferdinand Magellan, (1480-1521) in an anonymous portrait.



Figure 7.9: A 1561 map of America showing Magellan's name for the pacific, Mare pacificum, and the Strait of Magellan, labelled Frenum Magaliani.



Figure 7.10: *Victoria*, the sole ship of Magellan's fleet to complete the circumnavigation.

7.7 Sir Francis Drake, (c.1540-1596)

Sir Francis Drake was a British naval officer and privateer, commissioned and later knighted by Queen Elizabeth I. He was second in command with the rank of Vice Admiral at the sea battle in which the English fleet defeated the Spanish Armada. In England, Drake was regarded as a hero, while in Spain he was seen as a dangerous and bloodthirsty pirate. King Phillip II of Spain is said to have offered a reward of 20,000 ducats (about \$10,000,000 in today's currency) to anyone who could kill or capture him.

In 1577, Queen Elizabeth sent Drake on a mission to challenge the Spanish claim to the west coast of North America. The expedition suffered great attrition: Of the six ships under Drake's command that started the voyage, only one remained to sail north along the west coast of South America. This lone ship, renamed *The Golden Hind*, reached the western coast of and North America. and stopped for repairs before continuing its voyage of circumnavigation. Drake claimed part of present-day California for Queen Elizabeth and her successors before continuing his voyage of circumnavigation.

According to Wikipedia,

"On 26 September, *Golden Hind* sailed into Plymouth with Drake and 59 remaining crew aboard, along with a rich cargo of spices and captured Spanish treasures. The Queen's half-share of the cargo surpassed the rest of the crown's income for that entire year. Drake was hailed as the first Englishman to circumnavigate the Earth (and the second such voyage arriving with at least one ship intact)..."

"Drake presented the Queen with a jewel token commemorating the circumnavigation. Taken as a prize off the Pacific coast of Mexico, it was made of enamelled gold and bore an African diamond and a ship with an ebony hull."



Figure 7.11: Sir Francis Drake, (c.1540-1596), in an oil painting by Marcus Gheeraerts the Younger.



Figure 7.12: A map of Drake's route around the world. The northern limit of Drake's exploration of the Pacific coast of North America is still in dispute.

7.8 Abel Tasman, (1603-1659)

Abel Tasman was born in the province of Groningen, Netherlands. He became a navigator and sea captain employed by the Dutch East India Company to explore the southern part of the Indian Ocean. He lead two major voyages of discovery.

Tasman's first voyage, 1642-1643

In August, 1642, the Dutch East India Company chose Abel Tasman and Franchoijs Jacobszoon Visscher to lead an expedition to explore the uncharted region east of the Cape of Good Hope, west of the southern tip of South America, and south of the Solomon Islands. Because of a mistake in copying Marco Polo's maps, it was believed that an undiscovered land, rich in gold and named "Provinces of Beach", lay somewhere in this region.

The expedition, consisting of two small sailing ships, stopped at the island of Mauritius in the Indian Ocean for several months to repair the ships and to allow the crew to enjoy the plentiful food of the island.

On 24 November, 1642, the expedition sighted the west coast of the large island now known as Tasmania. Tasman and his two ships spent some time exploring the newly discovered land, but the weather suddenly worsened, and he turned southward, continuing his main mission.

On 13 December, 1642, after enduring some extremely rough weather, Tasman and his expedition sighted what is now known as the South Island of New Zealand. They were the first Europeans to reach the island.

Tasman's second voyage, 1644

On 30 January, 1644, Tasman left Batavia in the Dutch East Indies, in command of three ships. for his second major voyage of exploration. He mapped the northern coast of Australia ("New Holland"), making observations on its nature and people.

Tasman's achievements

Wikipedia says of him:

"From the point of view of the Dutch East India Company, Tasman's explorations were a disappointment: he had neither found a promising area for trade nor a useful new shipping route. Although received modestly, the company was upset to a degree that Tasman did not fully explore the lands he found, and decided that a more 'persistent explorer' should be chosen for any future expeditions. For over a century, until the era of James Cook, Tasmania and New Zealand were not visited by Europeans - mainland Australia was visited, but usually only by accident."



Figure 7.13: Abel Tasman, (1603-1659), detail from portrait by Jacob Gerritsz.



Figure 7.14: Routes taken by Tasman in the Australasian region, on his first and second voyages.

7.9 James Cook, (1728-1779)

Wikipedia says of him:

“James Cook FRS was a British explorer, navigator, cartographer, and captain in the British Royal Navy. He made detailed maps of Newfoundland prior to making three voyages to the Pacific Ocean, during which he achieved the first recorded European contact with the eastern coastline of Australia and the Hawaiian Islands, and the first recorded circumnavigation of New Zealand.

“Cook joined the British merchant navy as a teenager and joined the Royal Navy in 1755. He saw action in the Seven Years’ War and subsequently surveyed and mapped much of the entrance to the Saint Lawrence River during the siege of Quebec, which brought him to the attention of the Admiralty and Royal Society. This acclaim came at a crucial moment in his career and the direction of British overseas exploration, and led to his commission in 1766 as commander of HM Bark Endeavour for the first of three Pacific voyages.

“In these voyages, Cook sailed thousands of miles across largely uncharted areas of the globe. He mapped lands from New Zealand to Hawaii in the Pacific Ocean in greater detail and on a scale not previously charted by Western explorers. He surveyed and named features, and recorded islands and coastlines on European maps for the first time. He displayed a combination of seamanship, superior surveying and cartographic skills, physical courage, and an ability to lead men in adverse conditions.

Cook was attacked and killed in 1779 during his third exploratory voyage in the Pacific while attempting to kidnap the Island of Hawaii’s monarch, Kalani’opu’u, in order to reclaim a cutter stolen from one of his ships. He left a legacy of scientific and geographical knowledge that influenced his successors well into the 20th century, and numerous memorials worldwide have been dedicated to him.”

James Cook can also be thought of as a polar explorer. As Wikipedia notes, during his second voyage:

“Cook’s expedition circumnavigated the globe at an extreme southern latitude, becoming one of the first to cross the Antarctic Circle on 17 January 1773. In the Antarctic fog, Resolution and Adventure became separated. Furneaux made his way to New Zealand, where he lost some of his men during an encounter with Maori, and eventually sailed back to Britain, while Cook continued to explore the Antarctic, reaching 71°10’S on 31 January 1774. Cook almost encountered the mainland of Antarctica but turned towards Tahiti to resupply his ship.”



Figure 7.15: James Cook, (1728-1779).

Suggestions for further reading

1. Abu-Lughod, Janet (1991). *Before European Hegemony: The World System A.D. 1250-1350*. Oxford University Press US.
2. Anderson, James Maxwell (2000). *The history of Portugal*. Greenwood Publishing Group.
3. Arciniegas, Germán (1978). *Amerigo and the New World: The Life & Times of Amerigo Vespucci*. Octagon Books.
4. Armesto, Felipe Fernandez (2006). *Pathfinders: A Global History of Exploration*. W.W. Norton & Company.
5. Arnold, David (2002). *The Age of Discovery, 1400-1600*, Lancaster pamphlets. Routledge.
6. Boxer, Charles Ralph (1969). *The Portuguese Seaborne Empire 1415-1825*. Hutchinson.
7. Boxer, Charles Ralph (1977). *The Dutch seaborne empire, 1600-1800*. Taylor & Francis.
8. Braudel, Fernand (1992) [1979]. *The Wheels of Commerce, vol. II of Civilization and Capitalism 15th-18th Century*. University of California Press.
9. Braudel, Fernand (1992) [1985]. *The perspective of the world*. University of California Press.
10. Brook, Timothy (1998). *The Confusions of Pleasure: Commerce and Culture in Ming China*. University of California Press.
11. Burns, William E. (2001). *The scientific revolution: an encyclopædia*. ABC-CLIO.
12. Butel, Paul (1999). *The Atlantic*. Routledge.
13. Cole, Juan Ricardo (2002). *Sacred Space and Holy War*. I.B.Tauris.
14. Cook, Noble David (1998). *Born to die: disease and New World conquest, 1492-1650*. Cambridge University Press.
15. Crosby, Alfred W., Jr (2003) [1972]. *The Columbian Exchange: Biological and Cultural Consequences of 1492 (30th Anniversary ed.)*. Greenwood Publishing Group.
16. Cromer, Alan (1995). *Uncommon Sense: The Heretical Nature of Science*. Oxford University Press US.
17. Dymytryshyn, Basil, E.A.P. Crownhart-Vaughan, Thomas Vaughan (1985). *Russia's conquest of Siberia, 1558-1700: a documentary record (in Russian)*. Western Imprints, The Press of the Oregon Historical Society.
18. Donkin, R.A. (2003). *Between east and west: the Moluccas and the traffic in spices up to the arrival of Europeans*. Memoirs of the American Philosophical Society, Diane Publishing.
19. Dunn, Ross E. (2004). *The adventures of Ibn Battuta, a Muslim traveler of the fourteenth century*. University of California Press.
20. Dunton, Larkin (1896). *The World and Its People*. Silver, Burdett.
21. Ebrey, Patricia Buckley, Anne Walthall, James B. Palais (2006-2008). *East Asia: A Cultural, Social, and Political History*. Houghton Mifflin.
22. Fisher, Raymond H. (1981). *The Voyage of Semen Dezhnev in 1648*. The Hakluyt Society.

23. Fiske, John (1892-2009). *The Discovery of America: With Some Account of Ancient America and the Spanish Conquest*. Houghton Mifflin.
24. Forbes, Jack D. (1993). *Africans and Native Americans: the language of race and the evolution of Red-Black peoples*. University of Illinois Press.
25. Gernet, Jacques (1962). *Daily life in China, on the eve of the Mongol invasion, 1250-1276*. Stanford University Press. p. 1.
26. Gitzen, Garry (2011). *Francis Drake in Nehalem Bay 1579, Setting the Historical Record Straight*.
27. Goodrich, Luther Carrington, Chao-ying Fang, Ming Biographical History Project Committee - Association for Asian Studies. (1976). *Dictionary of Ming biography, 1368-1644*. Columbia University Press.
28. Gutierrez, Ramon A, and Richard J. Orsi (1998). *Contested Eden: California before the Gold Rush*. University of California Press.
29. Hacquebord, Louwrens (September 1995). *In Search of Het Behouden Huys: A Survey of the Remains of the House of Willem Barentsz on Novaya Zemlya* (PDF). Arctic. 48 (3): 250. CiteSeerX 10.1.1.505.5702.
30. Hochstrasser, Julie (2007). *Still life and trade in the Dutch golden age*. Yale University Press.
31. Howard, David and John Ayers (1978). *China for the West: Chinese Porcelain and other Decorative Arts for Export, Illustrated from the Mottahedeh Collection*. London and New York: Sotheby Parke Bernet.
32. Lach, Donald F., Edwin J. Van Kley (1998). *Asia in the Making of Europe, Volume III: A Century of Advance. Book 3: Southeast Asia*. University of Chicago Press.
33. Boxer, Charles (1991). *The Portuguese Seaborne Empire, 1415-1825 (2nd rev. ed.)*. Carcanet Press.
34. Castro, F.; Fonseca, N.; Vacas, T.; Ciciliot, F. (2008), *A Quantitative Look at Mediterranean Lateen- and Square-Rigged Ships (Part 1)*, The International Journal of Nautical Archaeology, 37 (2), pp. 347-359.
35. Diffie, Bailey; George D. Winius (1977). *Foundations of the Portuguese empire, 1415-1580*. University of Minnesota Press.
36. Fern andez-Armesto, Felipe (1987). *Before Columbus: Exploration and Colonisation from the Mediterranean to the Atlantic, 1229-1492*. London: MacMillan Education.
37. Major, Richard Henry (1877). *The discoveries of Prince Henry, the Navigator, and their results*. London: Sampson, Low, Marston, Searle and Rivington.
38. Martins, J.P. Oliveira (1914). *The golden age of Prince Henry the Navigator*. London: Chapman and Hall.
39. Russell, Peter E. (2000). *Prince Henry "the Navigator": a life*. New Haven: Yale University Press.
40. Zurara, Gomes Eanes de, trans. Edgar Prestage (1896). *Chronica do Descobrimento e Conquista da Guin e, vol. 1 (The chronicle of discovery and conquest of Guinea)*. Hakluyt Society.
41. Zurara, Gomes Eanes de, trans. Edgar Prestage (1896). *Chronica do Descobrimento e Conquista da Guin e, vol. 2*. Printed for the Hakluyt Society.

42. Lawson, Edward W. (2007). *The Discovery of Florida and Its Discoverer Juan Ponce de Leon*. Kessinger Publishing.
43. Locke, John (1824). *The works of John Locke: in nine volumes, Volume 9, The history of navigation*. C. and J. Rivington.
44. Mancall, Peter C. (1999). *The Age of Discovery in The Challenge of American History*, ed. Louis Masur. Johns Hopkins University Press.
45. Medina (1974) [1918]. *El Piloto Juan Fernandez descubridor de las islas que ilevan su hombre, y Juan Jufre, armador de la expedicion que hizo en busca de otras en el mar del zur (in Spanish)*. Gabriela Mistral.
46. Milton, Giles (1999). *Nathaniel's Nutmeg*. London: Sceptre.
47. Morison, Samuel Eliot (2007) [1942]. *Admiral of the Ocean Sea: The Life of Christopher Columbus*. Read Books.
48. Mutch, T.D. (1942). *The First Discovery of Australia*. Sydney: Journal of the Royal Australian Historical Society.
49. Newitt, Malyn D.D. (2005). *A History of Portuguese Overseas Expansion, 1400-1668*. Routledge.
50. Nowell, Charles E. (1947). *The Discovery of the Pacific: A Suggested Change of Approach*. The Pacific Historical Review" (Volume XVI, Number 1).
51. Otfinoski, Steven (2004). *Vasco Nunez de Balboa: explorer of the Pacific*. Marshall Cavendish.
52. Pacey, Arnold (1991). *Technology in world civilization: a thousand-year history*. MIT Press.
53. Paine, Lincoln P. (2000). *Ships of discovery and exploration*. Houghton Mifflin Harcourt.
54. Parry, J.H. (1981). *The age of reconnaissance*. University of California Press.
55. Parry, J.H. (1981). *The Discovery of the Sea*. University of California Press.
56. Penrose, Boies (1955). *Travel and Discovery in the Renaissance:1420-1620*. Harvard University Press.
57. Pfoundes, C. (1882). *Notes on the History of Eastern Adventure, Exploration, and Discovery, and Foreign Intercourse with Japan*. Transactions of the Royal Historical Society (Volume X).
58. Restall, Matthew (2004). *Seven Myths of the Spanish Conquest*. Oxford University Press.
59. Russell-Wood, A.J.R. (1998). *The Portuguese empire, 1415-1808: a world on the move*. JHU Press.
60. Spence, Jonathan D. (1999). *The Chan's Great Continent: China in Western Minds*. W.W. Norton & Co.
61. Spufford, Peter (1989). *Money and its Use in Medieval Europe*. Cambridge, UK: Cambridge University Press.
62. Bagrow, Leo, R.A. Skelton (1964). *History of cartography*. Transaction Publishers, 2009.
63. Synge, J.B. (2007) [1912]. *A Book of Discovery*. Yesterday's Classics.

64. Tamura, Eileen H.; Linda K. Mention; Noren W. Lush; Francis K.C. Tsui; Warren Cohen (1997). *China: Understanding Its Past*. University of Hawaii Press.
65. Tracy, James D. (1994). *Handbook of European History 1400-1600: Late Middle Ages, Renaissance, and Reformation*. Boston: Brill Academic Publishers.
66. Tsai, Shih-Shan Henry (2002). *Perpetual Happiness: The Ming Emperor Yongle*. University of Washington Press.
67. Volker, T. (1971). *Porcelain and the Dutch East India Company: as recorded in the Dagh-registers of Batavia Castle, those of Hirado and Deshima and other contemporary papers, 1602-1682*.
68. Walton, Timothy R. (1994). *The Spanish Treasure Fleets*. Pineapple Press (FL).
69. Weddle, Robert S. (1985). *Spanish Sea: the Gulf Of Mexico in North American Discovery, 1500-1685*. Texas A&M University Press.
70. Wilford, John Noble (1982). *The Mapmakers, the Story of the Great Pioneers in Cartography from Antiquity to Space Age*. Vintage Books, Random House.
71. Zweig, Stefan (2007) [1938]. *Conqueror of the Seas - The Story of Magellan*. Read Books.
72. Beazley, C. Raymond (1894). *Prince Henry the Navigator, the Hero of Portugal and of Modern Discovery, 1394-1460 A.D.: With an Account of Geographical Progress Throughout the Middle Ages As the Preparation for His Work*. London: G.P. Putnam's Sons.

Chapter 8

EXPLORATION OF NORTHERN AMERICA

8.1 Henry Hudson, (c.1565-c.1611)

Henry Hudson, after whom the Hudson River and Hudson Bay are named, was born in England. Little is known about his early life, but it is thought that he began his career at sea as a cabin boy, and gradually worked his way up to the rank of ship's captain.

He started his career as an explorer by making two voyages, in 1607 exploring Greenland and Spitsbergen, and in 1608 attempting to find a northeast passage to China through the sea north of Siberia. Like Berentsz, he reached the large island of Novaya Zemlya, but was forced to turn back by heavy sea ice.

In 1609, Hudson was chosen by the Dutch East India Company to lead an expedition attempting to find a northeast passage to China through the sea north of Siberia. Once more failing to complete the journey because of sea ice, Hudson changed course and sailed west, attempting instead to find a northwest passage, which was rumored to exist.

Hudson's ship, the *Halve Maen* (Dutch for Half Moon), first made landfall in Nova Scotia, as shown by the red line in Figure 8.2. The ship sailed south, reaching Cape Cod on the 4th of August, and then further south to the entrance of Chesapeake Bay. Afterwards, the *Halve Maen* sailed north to New York and up the Hudson River, thus establishing a Dutch presence which later developed into the colony of New Amsterdam.

During the years 1610 and 1611, Hudson led another expedition to North America. His route is shown by the blue arrows in Figure 8.2. This time he commanded a ship named *Discovery* under the English flag, and the voyage was sponsored by the British East India Company. Once more, he was searching for a northwest passage to India and China.

On the 25th of June, 1610, Hudson's ship passed through what is now called Hudson Strait and into Hudson Bay. Ice forced Hudson and his crew to go ashore and winter in James Bay. When the ice cleared in the spring, Hudson intended to continue exploring Hudson Bay. However, his homesick crew mutinied. Hudson and his son, together with seven other crew members, were set adrift in a small boat. They were never seen again.



Figure 8.1: Henry Hudson, (c.1565-c.1611).

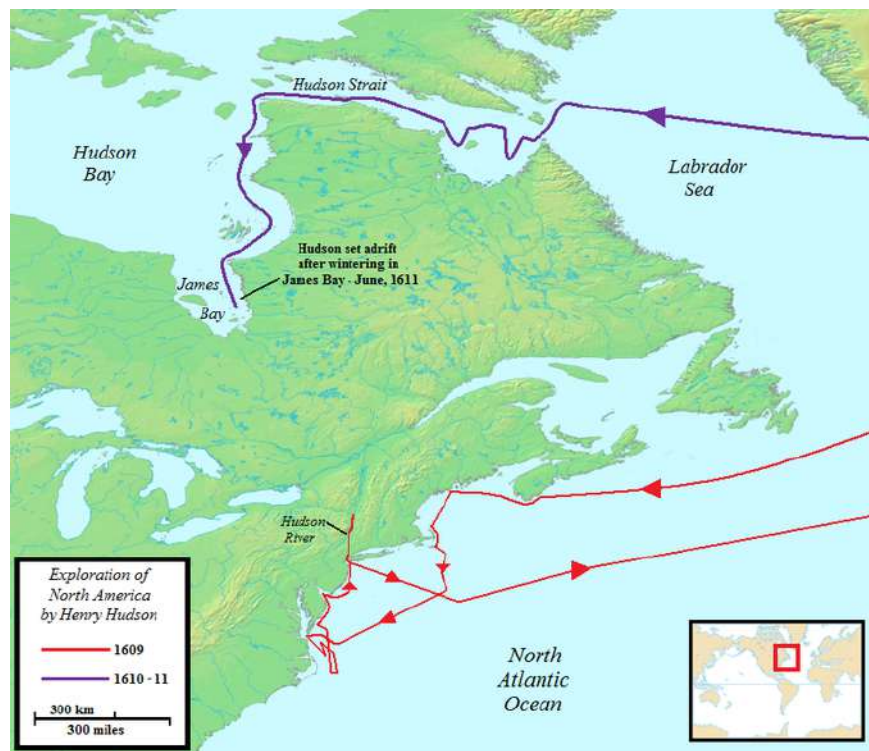


Figure 8.2: Hudson's voyages to North America.

8.2 Samuel de Champlain, (1567-1635)

Wikipedia says of him:

“Samuel de Champlain was a French colonist, navigator, cartographer, draftsman, soldier, explorer, geographer, ethnologist, diplomat, and chronicler. He made between 21 and 29 trips across the Atlantic Ocean, and founded Quebec, and New France, on 3 July 1608. An important figure in Canadian history, Champlain created the first accurate coastal map during his explorations, and founded various colonial settlements.

“Born into a family of mariners, Champlain began exploring North America in 1603, under the guidance of his uncle, Francois Gravé Du Pont. After 1603, Champlain’s life and career consolidated into the path he would follow for the rest of his life. From 1604 to 1607, he participated in the exploration and settlement of the first permanent European settlement north of Florida, Port Royal, Acadia (1605), as well as the first European settlement that would become Saint John, New Brunswick (1604). In 1608, he established the French settlement that is now Quebec City. Champlain was the first European to describe the Great Lakes, and published maps of his journeys and accounts of what he learned from the natives and the French living among the Natives.

“He formed relationships with local Montagnais and Innu, and, later, with others farther west - tribes of the (Ottawa River, Lake Nipissing, and Georgian Bay), and with Algonquin and Wendat; he also agreed to provide assistance in the Beaver Wars against the Iroquois. Late in the year of 1615, Champlain returned to the Wendat and stayed with them over the winter, which permitted him to make the first ethnographic observations of this important nation, the events of which form the bulk of his book *Voyages et Descouvertes faites en la Nouvelle France, depuis l’année 1615*, published in 1619.

“In 1620, Louis XIII of France ordered Champlain to cease exploration, return to Quebec, and devote himself to the administration of the country.[Note 4] In every way but formal title, Samuel de Champlain served as Governor of New France, a title that may have been formally unavailable to him owing to his non-noble status. He established trading companies that sent goods, primarily fur, to France, and oversaw the growth of New France in the St. Lawrence River valley until his death, in 1635.”

Many places, geographical features, streets and structures are named after Champlain, for example Lake Champlain. He is remembered as an important figure in Canadian history, and has been called “The Father of New France” and “The Father of Acadia”.



Figure 8.3: Samuel de Champlain, (1567-1635), in an inauthentic portrait. No authentic portrait of him is known to exist.



Figure 8.4: Chaleur Bay and Gulf of Saint Lawrence - extract of Champlain's 1612 map.

8.3 Vitus Bering, (1681-1741)

Vitus Bering was a Danish cartographer, sea captain and explorer in the service of Peter the Great of Russia. Peter commissioned Bering to lead two expeditions to explore the seas east of Siberia and to determine whether Russia and America were connected by a land bridge.

The First Kamchatka expedition, 1725-1730

The expedition, lead by Bering, spent the first two years travelled overland from St. Petersburg to Okhotsk in the far east of Russia. In the meantime, two ships were being built for them. In these ships, Bering and his crew members sailed northward and confirmed that Russia and North America are separated by a strait which was later named the Bering Strait. The Bering sea is also named after him. The expedition was highly praised and Bering was ennobled when the men returned to St. Petersburg in 1730.

The Second Kamchatka expedition, 1733-1741

The second Kamchatka expedition was much more ambitious than the first. Peter the Great had died, and so Bering appealed to his successor, Empress Anna Ioannovna. Plans for the expedition involved 600 people at the outset, with hundreds more recruited later on. The purpose of the expedition was to sail to North America, but many scientists were included to study ecology and ethnology of the regions which they aimed to reach. Sadly, this second expedition met with shipwreck and disaster, and many died, including Bering himself.



Figure 8.5: **Vitus Bering, (1681-1741).**

8.4 Meriwether Lewis (1774-1809) and William Clark, (1770-1838)

Wikipedia's timeline for the Lewis and Clark expedition

1803

- January 18: President Jefferson sends a secret message to the U.S. Congress proposing an expedition to the Pacific Northwest.
- February 22: The House and Senate approve Jefferson's request.
- March 15: Lewis travels to the U.S. Army arsenal in Harper's Ferry, Virginia (later West Virginia) to procure arms and ammunition for the expedition.
- April 19: Lewis arrives in Lancaster, Pennsylvania where he studies the use of the sextant and chronometer for celestial navigation.
- April 30: James Madison, Secretary of State, and Robert R. Livingston, U.S. Minister to France, reach an agreement to purchase the Louisiana Territory from France for \$15 million.
- May 17: Lewis leaves Lancaster and travels to Philadelphia to study medicine, anatomy and botany under the day's leading experts. During his three-week stay, he buys supplies and equipment as well as gifts for the Indians he expects to encounter.
- June 19: Lewis writes to William Clark inviting him to co-lead the expedition.
- June 20: President Jefferson sends Lewis instructions for exploring the Louisiana Territory.
- July 4: The proposed Louisiana Purchase Treaty is announced in Washington, D.C.
- July 15: Lewis arrives in Pittsburgh, Pennsylvania, to direct the construction of a 55-foot keelboat with a 32-foot mast and benches for 22 oarsmen. He also purchases a pirogue over 40 feet long.
- July 18: Clark writes to Lewis accepting his invitation.
- August 31: After more than a month of delays, the keelboat is completed and immediately loaded. With a crew of 11, Lewis heads down the Ohio River.
- September 1: Lewis documents the first day of travel, beginning what becomes the Journals of the Lewis & Clark Expedition.
- October 15: Lewis rendezvous with Clark in Clarksville, Indiana territory. Clark is accompanied by his African-American slave York. Over the next two weeks, they select nine civilians from a field of volunteers.
- October 20: The U.S. Senate ratifies the treaty for the Louisiana Purchase.
- November 15: While the Corps camps at the confluence of the Ohio and Mississippi Rivers, Lewis and Clark practice determining longitude and latitude using their surveying instruments.



Figure 8.6: Meriwether Lewis (1774-1809), leader of the Lewis and Clark Expedition, and later Governor of Louisiana Territory. When he chose Lewis, US President Thomas Jefferson commented: “It was impossible to find a character who to a complete science in botany, natural history, mineralogy & astronomy, joined the firmness of constitution & character, prudence, habits adapted to the woods & a familiarity with the Indian manners and character, requisite for this undertaking. All the latter qualifications Capt. Lewis has.” Before the expedition, Lewis spent much time at Jefferson’s home in Monticello, studying books and maps related to the journey, which he found in Jefferson’s very large library.



Figure 8.8: William Clark, (1770-1838). He was a close friend of Meriwether Lewis, who chose him as co-leader of the Expedition of Discovery. In 1807 he was appointed to the post of Agent for Indian Affairs in the Louisiana Territory, and later became the Governor of Missouri Territory.

- November 28: The expedition arrives at the U.S. Army post at Kaskaskia, Illinois, where they recruit more men.
- December 6: Lewis travels by horseback to St. Louis in present-day Missouri intending to spend the winter procuring more supplies.
- December 12: Clark arrives at the site of the expedition's winter encampment on the Mississippi River above St. Louis in Illinois. The construction of Camp Dubois begins the next day.
- December 20: France transfers the Louisiana Territory to the U.S., which takes possession on December 30.

1804

- March 9: Lewis attends ceremonies in St. Louis witnessing the formal transfer of the new U.S. territory.
- March 26: To his bitter disappointment, Lewis learns that Clark's commission has been approved but as a lieutenant rather than captain. Despite the difference in rank, a fact withheld from the men, the two share command equally throughout the expedition.
- March 29: Pvts. Shields and Colter are tried for mutiny following a fight in which they threaten Sgt. Ordway's life. Their pleas for forgiveness are accepted.
- March 31: Lewis and Clark hold a ceremony formally inducting 25 recruits into the Corps. Another five men are designated to return on the keelboat the next spring before the "permanent party" crosses the Rocky Mountains.
- April 7: Lewis and Clark travel to St. Louis by canoe to attend a dinner and ball.
- May 14: The Corps of Discovery departs Camp Dubois under Clark's command, its crew more than 40 strong.
- May 16: They reach St. Charles on the Missouri River to await Lewis's return from St. Louis.
- May 17: Pvts. Collins, Hall and Werner are court martialed for being AWOL. Collins, who is convicted of additional charges, receives 50 lashes. The other two have their sentences of 25 lashes suspended.
- May 21: With Lewis and Clark in command, the Corps embarks on the keelboat and two pirogues. During their 2,300 mile trip to the Rockies, the men struggle against the Missouri's current. While sails help when the winds are favorable, most progress is by rowing and either pushing or pulling the heavily-laden keelboat.
- May 25: About 50 miles from St. Charles, the party passes La Charette, the westernmost Euro-American settlement on the Missouri.
- June 26: The expedition encamps at Kaw Point near the Missouri's confluence with the Kansas River in present-day Kansas, 400 river miles into

their journey. As a precaution against a possible attack by the region's Kansa tribe, the men build a temporary defense, but otherwise they spend several days resting and repairing their boats.

- June 29: During the Corps' stay at Kaw Point, Pvt. Collins is court martialed on charges of stealing whiskey while on guard duty. His sentence is severe, 100 lashes. Pvt. Hall, who is tried for drinking with Collins, receives 50 lashes.
- July 4: To honor Independence Day, Lewis and Clark name Independence Creek near modern-day Atchison, Kansas.
- July 11: The Corps enters present-day Nebraska. Pvt. Willard is caught sleeping on guard duty, a capital offense. He is sentenced the next day to receive 100 lashes in four equal installments.
- July 21: The expedition reaches the confluence of Nebraska's Platte River, 640 miles from St. Louis.
- July 30: The Corps camps near today's Fort Calhoun, Nebraska, on a hill they name Council Bluff.
- August 3: Lewis and Clark meet at Council Bluff with chiefs of the Oto and Missouri tribes. While the chiefs want weapons more than token gifts, the Corps' first attempt at diplomacy is for the most part a success.
- August 4: The party departs, but Pvt. Reed deserts. Two days later, the captains determine Reed is to be brought back dead or alive.
- August 18: Reed is captured and returned for trial. In addition to being sentenced to a flogging in which he is required to run the guantlet four times, Reed is expelled from the Corps. Since banishment to the wilds would be a death sentence, he is allowed to remain with the expedition through the winter.
- August 20: Sgt. Floyd dies, probably from a ruptured appendix. He is the sole casualty of the two-year expedition.
- August 26: The men elect Pvt. Gass sergeant. Pvt. Shannon, the Corps' youngest member, becomes lost while searching for horses stolen by the Indians.
- August 27: The Corps strikes camp in Yankton Sioux territory on the Nebraska side of the Missouri near the mouth of South Dakota's James River.
- August 30: Lewis and Clark hold talks with the Yanktons, who want rifles and whiskey. Instead, the tribe is invited to send a delegation to meet with the Great White Father in Washington, D.C.
- September 11: Pvt. Shannon is found on the bank of the Missouri starving and out of ammunition after being lost 16 days.
- September 20: They reach the Missouri's Big Bend in central South Dakota, nearly 1,300 miles from their starting point.

- September 25: Weapons are drawn in a confrontation with the Lakota Sioux near modern-day Pierre, South Dakota. Elder Chief Black Buffalo diplomatically intervenes, averting bloodshed.
- October 13: Pvt. Newman is convicted of mutinous talk and expelled. As with Pvt. Reed, he is permitted to remain with the expedition until the spring.
- October 24: The Corps reaches Mandan Indian territory near present-day Washburn, North Dakota. Over the next few days, they meet with Mandan and Hidatsa chiefs and begin looking for a site for a winter fort.
- November 2: A location for their winter fortification is selected across the river from the main Mandan village. They name the encampment Fort Mandan to honor the tribe. Construction begins.
- November 4: Toussaint Charbonneau, a French fur trader living with the Mandans, is hired as an interpreter. One of Charbonneau's wives, a pregnant 16-year-old Lemhi Shoshone named Sacagawea, is also hired.
- December 24: Fort Mandan is completed.
- December 25: The Corps celebrates Christmas with special food, rum and dancing.

1805

- February 9: Pvt. Howard returns after dark and scales the fort's wall instead of asking the guard to open the gate. An Indian happens to see this and scales the wall himself. In the last disciplinary trial of the expedition, Howard is charged with a breach of security and is ordered to receive 50 lashes, but Lewis suspends the sentence.
- February 11: Sacagawea gives birth to a son, Jean Baptiste Charbonneau. The boy is nicknamed "Pompy" by Clark.
- April 7: With the arrival of spring, the Corps resumes its journey. The keelboat is sent back down the Missouri with a crew of a dozen men and a shipment for President Jefferson. The "permanent party" travels west in the two pirogues and six dugout canoes.
- April 25: The expedition reaches the confluence of the Yellowstone River in northwestern North Dakota, the Missouri's principal northern tributary.
- April 27: They enter present-day Montana. In the ensuing days, the men sight herds of up to 10,000 buffalo. They also encounter and kill their first grizzly bear.
- May 14: A sudden storm tips a pirogue and many items, including the Corps' journals, spill into the river. Sacagawea calmly recovers most of the items, earning Clark's praise for her quick thinking.
- May 26: Lewis sees the Rocky Mountains for the first time. His initial reaction is joy, but he then considers the serious challenges the snow-covered mountains will pose for his men.

- June 1: In north-central Montana, the Corps comes to an unexpected fork in the river, with one branch flowing from the north, the other from the south. They take a vote on which is the Missouri. Only Lewis and Clark favor the southern route. After days of debate and explorations, another vote yields the same result. Despite their doubts, the men agree to follow the leaders.
- June 13: A scouting party led by Lewis reaches the Great Falls of the Missouri. The discovery proves they have taken the correct course.
- June 17: The men circumnavigate the falls, dragging their canoes and equipment across 18 miles of rough terrain, a month-and-a-half ordeal.
- July 25: The expedition reaches the headwaters of the Missouri in southwestern Montana.
- August 8: Sacagawea recognizes a natural formation from her childhood, Beaverhead Rock, indicating they are in the area where the Shoshone spend their summers.
- August 12: Lewis and three other men cross the Continental Divide at Lemhi Pass on the Montana-Idaho border. Meanwhile, the expedition's shipment arrives at the President's house in Washington.
- August 13: While Clark is on a scouting expedition, Lewis meets up with 60 warriors of the Shoshone nation. Once he establishes their peaceful intentions, he and his men are welcomed into the tribe's village.
- August 16: When the Shoshone become fearful of being led into a trap, Lewis lends his rifle to the Chief and his men follow suit. The gesture helps gain the Shoshone's trust.
- August 17: Sacagawea has a tearful reunion with her brother, now a Shoshone chief. Clark returns, and with Sacagawea's help, the Corps is able to negotiate for the horses needed to cross the Rockies.
- September 11: The Corps begins crossing the Bitterroot Mountains, the most dangerous leg of the entire journey. Over the next 11 days, the men struggle through deep snow. Starving, they resort to eating some of their colts.
- September 22: Emerging from the mountains, the expedition is taken in by the Nez Perce Indians. In the days ahead, everyone becomes sick from overeating the dried fish and boiled roots served by their hosts.
- September 26: The party travels down Idaho's Clearwater River to set up an encampment for building canoes. Work proceeds slowly as the men recover.
- October 7: The journey resumes.
- October 10: The expedition enters present-day Washington state at the Clearwater's confluence with the Snake River. They follow the Snake, the Columbia River's largest tributary.

- October 16: The Corps reaches the Columbia. A few miles to the south, the Columbia begins to follow the border between modern-day Oregon and Washington.
- October 18: Clark sights Mount Hood through the fog some 45 miles in the distance.
- October 22: The Corps descends Celilo Falls, the beginning of a treacherous 55-mile stretch of the Columbia.
- November 7: Clark writes in his journal, "Great joy in camp we are in View of the Ocean". His elation is premature. They have sighted the Columbia River's estuary and are still 20 miles from the Pacific.
- November 8: The waves in the estuary become too hazardous for the canoes, so they set up camp.
- November 10: The men attempt to make progress by hugging the shoreline, but the dangerous conditions again force them to shore.
- November 12: A violent thunderstorm strikes with hail, heavy rain and gale force winds. After burying all but one of their canoes under rocks to prevent them from being crushed by the waves and floating logs, they retreat by land to a cove up river. They are pinned down here for several days as the inclement weather continues.
- November 15: With a break in the weather, the estuary becomes navigable, enabling the Corps to reach the Pacific. The men land on a sandy beach that they name Station Camp. They spend the next 10 days here hunting, trading with the Chinook and Clatsop Indians and exploring the surrounding coastline.
- November 24: The Corps' members vote on a site for their winter encampment. Sacagawea and York, Clark's slave, participate in the vote. Following the recommendations of the local Indians, they pick a site on the Oregon side of the river where game is more plentiful.
- December 8: They begin building Fort Clatsop near modern-day Astoria, Oregon.
- December 30: The expedition's log fortress is completed, but the winter proves miserable as it rains during all but 12 days of their three-month stay.

1806

- March 23: The Corps departs Fort Clatsop, eager to begin their journey home.
- April 18: The expedition reaches the Columbia's Great Falls. They need horses for re-crossing the Rockies, but the Indians demand steep prices so they buy only four.
- April 28: They leave Oregon, following the Columbia to the Snake River in southeastern Washington.

- May 3: After enduring a heavy snow storm, the Corps meets up with a familiar Nez Perce chief and 10 of his men.
- May 5: The expedition reaches present-day Idaho, where they pick up the Clearwater River.
- May 14: Having started their journey too early, the Corps must wait for the mountain snows to melt. The men camp for nearly a month in what is now the Nez Perce Reservation.
- June 10: They pull up camp and four days later reach the Bitterroot Mountains.
- June 24: The Corps starts to cross the Bitterroots. With the help of three Nez Perce guides, they cut 300 miles off the journey.
- June 29: The expedition enters western Montana through Lolo Pass.
- July 3: The Corps is divided in two to enable them to explore additional lands. Lewis leads one group down the Missouri, while Clark's takes a northern route following the Yellowstone River. Along the way, they break into smaller exploratory groups.
- July 25: Clark names a rock formation on the Yellowstone for Sacagawea's son, a site now known as Pompeys Pillar. Clark incribes his name and the date on the rock face, the only remaining physical evidence of the Corps' journey.
- July 26: Traveling on horseback, Lewis and his men encounter a small band of Blackfeet warriors. They spend the night together, but in the morning two Blackfeet braves are killed while trying to steal the group's guns and horses. Afraid of reprisals, the men ride for nearly 24 hours.
- August 2: Clark's group reaches the Missouri and enters present-day North Dakota.
- August 11: Lewis is accidentally shot in the buttocks by one of his men.
- August 12: The Corps reunites on the Missouri in western North Dakota near the mouth of Knife River.
- August 14: The expedition returns to a warm welcome by the Hidatsa and Mandan tribes.
- August 17: The men continue down the Missouri, leaving Charbonneau, Sacagawea and their son with the Mandans. Clark offers to raise the boy, who is now 19 months old. With the Missouri's current in their favor, they are able to cover over 70 miles a day.
- September 23: The Corps arrives in St. Louis, successfully concluding their 8,000-mile journey after two years, four months and 10 days.
- December 28: Lewis arrives in Washington, D.C. At the end of February, Jefferson nominates him as Governor of Upper Louisiana.

1807

- January 15: Clark arrives in Washington, D.C. He is appointed Agent for Indian Affairs in the Louisiana Territory.

Suggestions for further reading

1. Asher, G. M. (1860). *Henry Hudson, the navigator: the original document in which his career is recorded*. London: Hakluyt Society.
2. Conway, W. M. (1906). *No Man's Land: a history of Spitsbergen from its discovery in 1596*. Cambridge University Press.
3. Hacquebord, L. (2004). *The Jan Mayen Whaling Industry*. Jan Mayen Island in Scientific Focus. By Skreslet, S. Dordrecht: Kluwer Academic.
4. Hunter, D. (2009). *Half Moon: Henry Hudson and the voyage that redrew the map of the New World*. New York: Bloomsbury Press.
5. Juet, Robert (1609), *Juet's Journal of Hudson's 1609 Voyage from the 1625 edition of Purchas His Pilgrimes* transcribed 2006 by Brea Barthel, *Juet's Journal of Hudson's 1609 Voyage* (PDF). Archived from the original (PDF) on 28 June 2011. Retrieved 22 October 2009. .
6. Mancall, Peter (2009). *Fatal Journey: The Final Expedition of Henry Hudson, A Tale of Mutiny and Murder in the Arctic*. New York: Basic Books.
7. Purchas, S. 1625. *Hakluytus Posthumus or Purchas His Pilgrimes: Contayning a History of the World in Sea Voyages and Lande Travells by Englishmen and others. Volumes XIII and XIV*, (Reprint 1906 J. Maclehose and sons).
8. Shorto, R. (2004). *The Island at the Center of the World: the epic story of Dutch Manhattan*. New York: Doubleday.
9. Wordie, J.M. (1922). *Jan Mayen Island*, The Geographical Journal. Vol 59 (3).
10. Champlain, Samuel de (2005). *Voyages of Samuel de Champlain, 1604-1918: with a map and two plans*. Elibron Classics.
11. Dix, Edwin Asa. (1903). *Champlain, the Founder of New France*, IndyPublish.
12. Fischer, David Hackett (2008). *Champlain's Dream*. USA: Simon & Schuster.
13. Morganelli, Adrianna (2006). *Samuel de Champlain: from New France to Cape Cod*. Crabtree Pub.
14. Morison, Samuel Eliot, (1972). *Samuel de Champlain: Father of New France*, Little Brown,
15. Sherman, Josepha (2003). *Samuel de Champlain, Explorer of the Great Lakes Region and Founder of Quebec*. Group's Rosen Central.
16. Armstrong, Terence (1982), *Vitus Bering*, Polar Record, United Kingdom, 21 (131): 161-163.
17. Debenham, Frank (1941), *Bering's last Voyage*, Polar Record, United Kingdom, 3 (22): 421-426.
18. Frost, Orcutt William, ed. (2003), *Bering: The Russian Discovery of America*, New Haven, Connecticut: Yale University Press.
19. Lauridsen, Peter (1885), *Bering og de Russiske Opdagelsesrejser* (in Danish), Copenhagen
20. Müller, Gerhard Friedrich (1758), *Sammlung russischer Geschichten* (in German), iii, St Petersburg: Kayserl. Academie der Wissenschaften
21. Oliver, James A. (2006), *The Bering Strait Crossing*, United Kingdom: Information Architects,

22. Lind, Natasha Okhotina; Møller, Peter Ulf, eds. (2002), *Under Vitus Bering's Command: New Perspectives on the Russian Kamchatka Expeditions*, Beringiana, Aarhus, Denmark: Aarhus University Press,
23. Egerton, Frank N. (2008), *A History of the Ecological Sciences, Part 27: Naturalists Explore Russia and the North Pacific During the 1700s*, Bulletin of the Ecological Society of America, 89 (1): 39-60.
24. Chisholm, Hugh, ed. (1911). *Bering, Vitus*. Encyclopædia Britannica. 3 (11th ed.). Cambridge University Press.
25. Frost, Orcutt William, ed. (2003), *Bering: The Russian Discovery of America*, New Haven, Connecticut: Yale University Press.
26. Debenham, Frank (1941), *Bering's last Voyage*, Polar Record, United Kingdom, 3 (22): 421-426.
27. Lauridsen, Peter (1885), *Bering og de Russiske Opdagelsesrejser* (in Danish), Copenhagen
28. Müller, Gerhard Friedrich (1758), *Sammlung russischer Geschichten* (in German), iii, St Petersburg: Kayserl. Academie der Wissenschaften
29. Oliver, James A. (2006), *The Bering Strait Crossing*, United Kingdom: Information Architects.
30. Lind, Natasha Okhotina; Møller, Peter Ulf, eds. (2002), *Under Vitus Bering's Command: New Perspectives on the Russian Kamchatka Expeditions*, Beringiana, Aarhus, Denmark: Aarhus University Press.
31. Egerton, Frank N. (2008), *A History of the Ecological Sciences, Part 27: Naturalists Explore Russia and the North Pacific During the 1700s*, Bulletin of the Ecological Society of America, 89 (1): 39-60,

Chapter 9

THE VOYAGE OF THE BEAGLE

9.1 Charles Darwin's life and work

Family background and early life

It was Erasmus Darwin's grandson Charles (1809-1882) who finally worked out a detailed and correct theory of evolution and supported it by a massive weight of evidence.

As a boy, Charles Darwin was passionately fond of hunting and collecting beetles, but he was a mediocre student. His father once said to him in exasperation: "You care for nothing but shooting, dogs and rat-catching; and you will be a disgrace to yourself, and to all your family!"

Darwin's father, a wealthy physician, sent him to Edinburgh University to study medicine; but Charles did not enjoy his studies there. "Dr. Duncan's lectures on *Materia Medica* at 8 o'clock on a winter's morning are something fearful to remember", he wrote later. "I also attended the operating theatre in the hospital at Edinburgh and saw two very bad operations, one on a child, but I rushed away before they were completed. Nor did I ever attend again, for hardly any inducement would have been strong enough to make me do so; this being long before the blessed days of chloroform. The two cases fairly haunted me for many a long year."

The time at Edinburgh was not entirely wasted, however, because several of Darwin's friends at the university were natural philosophers¹, and contact with them helped to develop his interest in natural history. One of the most important of these scientific friends was Dr. R.E. Grant, an expert on marine invertebrate zoology with whom Darwin often collected small sea slugs in the cold waters of the Firth near Edinburgh. On one of these expeditions, Grant suddenly began to praise the evolutionary views of Lamarck, while Darwin listened in silent astonishment. Charles Darwin had previously read his own grandfather's book *Zoonomia* and had greatly admired it; but after a few years he had read it again in a more critical spirit; and after the second reading he had decided that *Zoonomia* was too speculative and contained too few facts. Grant's praise of Lamarck may

¹ Today we would call them scientists.



Figure 9.1: Painting of the seven-year-old Charles Darwin in 1816, by Ellen Sharples. He was passionately fond of collecting. His father once said to him in exasperation: “You care for nothing but shooting, dogs and rat-catching; and you will be a disgrace to yourself, and to all your family!”

have helped Darwin to become, later in his life, an advocate of evolution in a different form.

Darwin's father finally gave up the idea of making him into a doctor, and sent him instead to Cambridge to study for the clergy. At Cambridge, Darwin made many friends because of his unfailing good nature, enthusiasm and kindness. A friend from university days remembers that "at breakfast, wine or supper parties he was ever one of the most cheerful, the most popular and the most welcome... He was the most genial, warmhearted, generous and affectionate of friends."

Darwin's best friend during his last two years at Cambridge was the Reverend John Stevens Henslow, Professor of Botany. Darwin was often invited to Henslow's family dinner; and on most days he accompanied the professor on long walks, so that he became known as "the man who walks with Henslow". This friendship did much to develop Darwin's taste for natural history. Henslow's knowledge of botany, zoology and geology was vast; and he transmitted much of it to his enthusiastic young student during their long walks through the beautiful countryside near to the university. At Cambridge Darwin collected beetles; and the hobby became almost a passion for him. "One day, on tearing off some old bark", he wrote later, "I saw two rare beetles, and seized one in each hand. Then I saw a third kind, which I could not bear to lose, so I popped the one held in my right hand into my mouth. Alas! It ejected some intensely acrid fluid which burnt my tongue, so that I was forced to spit the beetle out, which was lost, as was the third one."

During his last year at Cambridge, Darwin read Alexander von Humboldt's famous *Personal Narrative of Travels to the Equinoctial Regions of South America During the Years 1799-1804*, a book which awakened in him "a burning zeal to add even the most humble contribution to the noble structure of Natural Science". Darwin longed to visit the glorious tropical forests described so vividly by von Humboldt.

Henslow persuaded Darwin to begin to study geology; and during the spring of 1831, Darwin joined the Professor of Geology, Adam Sedgwick, on an expedition to study the ancient rock formations in Wales. This expedition made Darwin realize that "science consists in grouping facts in such a way that general laws or conclusions may be drawn from them." When Darwin returned from Wales, he found a letter from Professor George Peacock, forwarded by Henslow. "My dear Henslow", Peacock's letter read, "Captain Fitz-Roy is going out to survey the southern coast of Tierra del Fuego, and afterwards to visit many of the South Sea Islands, and to return by the Indian Archipelago... An offer has been made to me to recommend a proper person to go out as a naturalist with the expedition. He will be treated with every consideration. The Captain is a young man of very pleasant manners (a nephew of the Duke of Grafton), of great zeal in his profession and highly spoken of..."

In forwarding this letter to Darwin, Henslow added: "I have stated that I consider you to be the best qualified person I know of who is likely to undertake such a situation... The voyage is to last two years and if you take plenty of books with you, anything you please may be done... In short, I suppose that there never was a finer chance for a young man of zeal and spirit..."

Darwin was beside himself with joy at this chance to follow in the foot-steps of his hero,

Alexander von Humboldt; but his plans were immediately squelched by the opposition of his father, who considered it “a wild scheme”, unsuitable for a future clergyman. “If you can find any man of common sense who advises you to go”, his father added, “I will give my consent.” Crushed by his father’s refusal, Charles Darwin visited his uncle’s family. Darwin’s favorite “Uncle Jos” was the son of the famous potter, Josiah Wedgewood, and the nearby Wedgewood estate at Maer was always a more relaxing place for him than his own home - a relief from the overpowering presence of his father. (His uncle’s many attractive daughters may also have had something to do with Darwin’s fondness for Maer.)

The Wedgewood family didn’t seem to think that sailing on the *Beagle* as naturalist would be a “wild scheme”, and Darwin’s Uncle Jos offered to drive him over to see whether the verdict could be changed. “My father always maintained that my uncle was one of the most sensible men in the world”, Darwin wrote later, “and he at once consented in the kindest manner.” Darwin had been rather extravagant while at Cambridge, and to console his father he said: “I should be deuced clever to spend more than my allowance whilst on board the *Beagle*.” His father answered with a smile: “But they tell me you are very clever.”

9.2 Aboard the Beagle

Thus it happened that on December 27, 1831, Charles Darwin sailed from Devonport on *H.M.S. Beagle*, a small brig of the British navy. The *Beagle*’s commander, Captain FitzRoy, was twenty-seven years old (four years older than Darwin), but he was already an excellent and experienced sailor. He had orders to survey the South American coast and to carry a chain of chronological measurements around the world. It was to be five years before the *Beagle* returned to England.

As the brig plowed through rough winter seas, Darwin lay in his hammock, miserably seasick and homesick, trying bravely to read a new book which Henslow had given to him as a sending-off present: Sir Charles Lyell’s *Principles of Geology*. It was an exciting and revolutionary book - so revolutionary, in fact, that Henslow had found it necessary to warn Darwin not to believe Lyell’s theories, but only to trust his observations. According to Lyell, “No causes have ever acted (in geology) but those which now are acting, and they have never acted with different degrees of energy from that which they now exert.”²

Lyell’s hypothesis was directly opposed to the Catastrophist school of geology, a school which included deeply religious men like Cuvier, Henslow and Sedgwick, as well as most other naturalists of the time. The Catastrophists admitted that geological evidence shows the earth to be much older than the six thousand years calculated on the basis of the Bible, but they explained this by saying that the Bible describes only the most recent era. Before this, according to the Catastrophists, life on earth had been created many times, and just as many times destroyed by cataclysms like Noah’s flood.³ In this way they explained the

² This is the famous Principle of Uniformitarianism first formulated by Hutton and later developed in detail by Lyell.

³ One group of Catastrophists, the Neptunists, believed that gigantic floods shaped the earth’s features.



Figure 9.2: The voyage of the *Beagle*, 1831-1836.

fossils embedded in ancient rocks: These they believed were the remains of antediluvian creatures destroyed by the wrath of God. The Swiss naturalist Charles Bonnet (1720-1793) even predicted a future catastrophe after which apes would become men and men would become angels. The Catastrophists believed that periodic cataclysms had created the earth's great mountain ranges, deserts and oceans.

Lyell's book contradicted this whole picture. He believed the earth to be immensely old, and asserted that over thousands of millions of years, the same slow changes which we can still see taking place have accumulated to produce the earth's great geological features. Over long ages, Lyell believed, gradual changes in the level of the land built up even the highest mountain ranges, while the slow action of rain and frost cut the peaks into valleys and planes.

By the time the *Beagle* reached the volcanic island of St. Jago, Darwin had become ardently converted to Lyell's "wonderfully superior method of treating geology"; and after studying the structure of the island, he realized that he could understand it on the basis of Lyell's principles. The realization that he might perhaps write a book on the geology of the various countries visited by the *Beagle* made Darwin's spirits soar; and he was thrilled also by the sight of so many totally new species of birds, insects and flowers.

"It has been a glorious day", he wrote, "like giving a blind man eyes: He is overwhelmed by what he sees and cannot easily comprehend it." Later, when the *Beagle* reached Brazil, Darwin was greatly moved by the experience of standing for the first time among the cathedral-like arches of a tropical rain forest. "My mind has been, since leaving England,

A rival group, the Plutonists, attributed most geological features to volcanic action, rather than flood.

in a perfect hurricane of delight and astonishment", he wrote, "The glorious pleasure of walking amongst such flowers and such trees cannot be comprehended by those who have not experienced it... Here (the naturalist) suffers a pleasant nuisance of being fairly tied to the spot by some new and wondrous creature... twiners entwining twiners - tresses like hair - beautiful Lepidoptera - silence - hosanna... I am at present fitted for nothing but to read Humboldt: He is like another sun, illuminating all that I behold."

While Captain FitzRoy sailed the *Beagle* slowly southward towards Tierra del Fuego, Darwin followed the ship on horseback, studying the geology of the Argentine Pampas and collecting specimens to send back to Cambridge. Darwin's companions on these expeditions were gauchos, wild Argentine horsemen, expert at throwing the lazo and bolas while galloping at full speed. On one of his rides across the Pampas, Darwin came across the bones of an enormous animal, half buried in a bank of mud and ancient seashells. In a state of great excitement he dug in the surrounding area, and in a few days he succeeded in unearthing the remains of nine huge extinct animals. He was struck by the fact that the bones resembled those of various living South American animals, except for their colossal size. Among them was a guanaco (a wild llama) as big as a camel, a huge armadillo-like creature and a giant sloth-like animal, both as big as elephants. What was the relationship between these extinct animals and living South American species? This problem was to haunt Darwin for many years.

On its way to Tierra del Fuego, the *Beagle* stopped at the Falkland Islands, and Darwin was fascinated by the strange flightless "steamer" ducks found there. He noted that their wings were too small and weak to allow flight. The ducks seemed to paddle with their right and left wings alternately in swimming along the surface of the water; and in this way they were able to move very fast. Darwin reflected that in the South American region there were three species of birds which used their wings for purposes other than flight: the steamer ducks used their wings as paddles, penguins used them as fins, and ostriches used them as sails. Did the ancestors of these birds use their wings for flying? Had the function of the wings changed over a period of time?

On the Falkland Islands, Darwin also noticed that the wild horses had become much smaller than their ancestors, the European horses released there almost three centuries earlier. If the Falkland horses had become noticeably smaller during only a few centuries, then perhaps, over millions of years, the giant armadillo and sloth could have shrunk from the monstrous size of the bones discovered by Darwin to their present size. Perhaps also the wings of the steamer duck, the penguin and the ostrich had become smaller, so that the birds had lost the power of flight. Recalling Lyell's belief in the immense age of the earth, Darwin began to wonder whether small changes, continued over long periods of time, could ultimately produce large changes in living things as well as in geology.

The *Beagle* rounded Cape Horn, lashed by freezing waves so huge that it almost foundered. After the storm, when the brig was anchored safely in the channel of Tierra del Fuego, Darwin noticed how a Fuegian woman stood for hours and watched the ship, while sleet fell and melted on her naked breast, and on the new-born baby she was nursing. He was struck by the remarkable degree to which the Fuegians had adapted to their frigid environment, so that they were able to survive with almost no shelter, and with no clothes



Figure 9.3: As HMS Beagle surveyed the coasts of South America, Darwin theorised about geology and extinction of giant mammals.

except a few stiff, untanned animal skins, which hardly covered them, in weather which would have killed ordinary people.

In 1835, as the *Beagle* made its way slowly northward, Darwin had many chances to explore the Chilean coast - a spectacularly beautiful country, shadowed by towering ranges of the Andes. On January 15, the watch on the *Beagle* noticed something resembling a large star, which gradually increased in size and brilliance. Looking through their telescope, the officers of the *Beagle* could see that the volcano of Osorno was erupting. Darwin was later surprised to learn that on the same night several other volcanos, spread along three thousand miles of coast, had simultaneously erupted.

On February 20, Darwin felt the shock of a severe earthquake, which totally destroyed the towns of Talcahuano and Concepcion. Near the Bay of Concepcion, he could see that the level of the land had been raised three feet by the earthquake; and on the nearby island of St. Maria, Captain FitzRoy found banks of decaying mussel-shells on rocks ten feet above the water line. After the earthquake, it was easy for Darwin to visualize the process by which, over millions of years, the Andes had been raised from the ocean. The sea shells which he found high in the mountains showed that even the highest peaks had once been under the Pacific. Later, high in the Andes, Darwin observed the opposing process - the process by which mountain ranges are torn down. Beside a rushing torrent he stood listening to the rattling noise of stones carried downward by the water. "The sound spoke eloquently to the geologist", he wrote, "The thousands and thousands of stones, which striking against each other made one dull uniform sound, were all hurrying in one direction. It was like thinking on time... As often as I have seen beds of mud, sand and shingles, accumulated to the thickness of many thousands of feet, I have felt inclined to exclaim that causes such as present rivers and present beaches could never have ground down and produced such masses. But on the other hand, while listening to the

rattling noise of these torrents and calling to mind that whole races of animals have passed away from the face of the earth, and that during this whole period, night and day, these stones have gone rattling in their course, I have thought to myself, can any mountains, any continent, withstand such a waste?"

After charting the Chilian coast, the *Beagle* sailed westward into the Pacific; and on September 15, 1835, the brig arrived at the Galapagos Archipelago, a group of strange volcanic islands about 500 miles from the mainland. Most of the species of plants, birds and animals which Darwin found on these islands were aboriginal species, found nowhere else in the world; yet in studying them he was continually reminded of species which he had seen on the South American continent. For example, a group of aboriginal finches which Darwin found on the Galapagos Islands were related to South American finches. The Galapagos finches were later shown to belong to thirteen separate species, all closely similar to each other, but differing in their habits and in the structure of their beaks.⁴

The geology of the islands showed that they had been pushed up from the bed of the sea by volcanic action in fairly recent times. Originally each island must have been completely bare of plants and animals. How had it been populated? The fact that the Galapagos species resembled those of the South American mainland made it seem probable to Darwin that the islands had become the home of chance wanderers from the continent. Seeds had perhaps drifted onto the shore and germinated, or perhaps they had been brought to the islands in the stomachs of birds. Land birds, like the Galapagos finches, could have been blown there by storms. Perhaps a flock of a single species of finch had arrived, storm-driven, on the black volcanic shores of the islands. Over the centuries, as the finches multiplied, their beaks could have become adapted to the various forms of food available. "The most curious fact", Darwin wrote later, "is the perfect gradation in the size of the beaks in the various species... Seeing this gradation and diversity in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends.. Here... we seem to be brought somewhat near to that great fact - that mystery of mysteries - the first appearance of new beings on this earth".

The idea of the gradual modification of species could also explain the fact, observed by Darwin, that the fossil animals of South America were more closely related to African and Eurasian animals than were the living South American species. In other words, the fossil animals of South America formed a link between the living South American species and the corresponding animals of Europe, Asia and Africa. The most likely explanation for this was that the animals had crossed to America on a land bridge which had since been lost, and that they had afterwards been modified.

The *Beagle* continued its voyage westward, and Darwin had a chance to study the plants and animals of the Pacific Islands. He noticed that there were no mammals on these islands, except bats and a few mammals brought by sailors. It seemed likely to Darwin

⁴ Darwin was not even aware at the time that they were finches. It was on his return to London that an ornithologist friend identified them, noted their close relationship to an Ecuadorian finch, and Darwin came to understand their significance.



Figure 9.4: While still a young man, Charles Darwin joined the scientific elite. Portrait by George Richmond.

that all the species of the Pacific Islands had reached them by crossing large stretches of water after the volcanic islands had risen from the ocean floor; and this accounted for the fact that so many classes were missing. The fact that each group of islands had its own particular species, found nowhere else in the world, seemed to Darwin to be strong evidence that the species had been modified after their arrival. The strange marsupials of the isolated Australian continent also made a deep impression on Darwin.

9.3 Work in London and Down

The *Beagle* was now on its way home, and Darwin impatiently counted the days and miles which separated him from his family and friends. To his sisters he wrote: "I feel inclined to write about nothing else but to tell you, over and over again, how I long to be quietly seated among you"; and in a letter to Henslow he exclaimed: "Oh the degree to which I long to be living quietly, without one single novel object near me! No one can imagine it until he has been whirled around the world, during five long years, in a Ten Gun Brig."

Professor Sedgwick had told Darwin's father that he believed that Charles would take his place among the leading scientific men of England. This encouraging news from home reached Darwin on Ascension Island. "After reading this letter", Darwin wrote, "I clambered over the mountains with a bounding step and made the rocks resound under my geological hammer."

On October 2, 1836, the *Beagle* docked at Falmouth, and Darwin, "giddy with joy and confusion", took the first available coach to The Mount, his family's home in Shrewsbury. After a joyful reunion with his family, he visited the Wedgwood estate at Maer, where his Uncle Jos and his pretty cousins were equally impatient to see him. To Henslow he wrote: "I am in the clouds, and neither know what to do or where to go... My chief puzzle is about the geological specimens - who will have the charity to help me in describing their mineralogical nature?"

Soon Darwin found a collaborator and close friend in none other than Sir Charles Lyell, the great geologist whose book had so inspired him. One of Lyell's best characteristics was his warmth in encouraging promising young scientists. Darwin's theory of the formation of coral barrier reefs and atolls had supplanted Lyell's own theory, but far from being offended, Lyell welcomed Darwin's ideas with enthusiasm. According to Lyell's earlier theory, coral atolls are circular in shape because they are based on the circular rims of submerged volcanos. However, Darwin showed that any island gradually sinking beneath the surface of a tropical ocean can develop into an atoll. He showed that the reef-building organisms of the coral are poisoned by the stagnant water of the central lagoon, but they flourish on the perimeter, where new water is constantly brought in by the waves. Darwin was able to use the presence of coral atolls to map whole regions of the Pacific which are gradually sinking. He pointed out that in the subsiding regions there are no active volcanos, while in regions where the land is rising, there is much volcanic activity.

The years between 1836 and 1839 were busy ones for Darwin. He found lodgings in London, and he worked there with Lyell on his geological collection. During these years

he edited a five-volume book on the zoological discoveries of the voyage; and in 1839 his *Journal of Researches into the Geology and Natural History of Various Countries Visited by the H.M.S. Beagle* was published. Originally Darwin's journal formed part of a multi-volume work edited by Captain FitzRoy, but the publisher, John Murray, recognized the unusual interest of Darwin's contribution, bought up the copyright, and republished the journal. It immediately became a best-seller, making Darwin famous. Under the shortened title, *The Voyage of the Beagle*, Darwin's journal has been reprinted more than a hundred times.

In 1839 Darwin married his pretty cousin, Emma Wedgwood, the youngest daughter of his much-admired Uncle Jos. She was a charming and light-hearted girl who has studied piano under Chopin. Emma and Charles Darwin were to have ten children together (of whom three were knighted for their contributions to science⁵) and thirty years later he wrote of her: "I can declare that in my whole life I have not heard her utter one word which had rather had been left unsaid."

Darwin was beginning to show signs of the ill health which was to remain with him for the rest of his life, and to escape from the social life of the capital, he moved to the small country town of Down, about 16 miles south of London. Darwin's illness was probably due to a chronic infection - perhaps Chagas disease- , picked up in South America. For the remainder of his life, his strength was very limited, and his daily routine at Down followed an unvarying pattern which allowed him to work as much as possible within the limits imposed by his illness. The early mornings were devoted to writing (even Sunday mornings) while correspondence and experimental work were done in the afternoons and scientific reading in the evenings.

9.4 The Origin of Species

In 1837 Darwin had begun a notebook on Transmutation of Species. During the voyage of the *Beagle* he had been deeply impressed by the great fossil animals which he had discovered, so like existing South American species except for their gigantic size. Also, as the *Beagle* had sailed southward, he had noticed the way in which animals were replaced by closely allied species. On the Galapagos Islands, he had been struck by the South American character of the unique species found there, and by the way in which they differed slightly on each island.

It seemed to Darwin that these facts, as well as many other observations which he had made on the voyage, could only be explained by assuming that species gradually became modified. The subject haunted him, but he was unable to find the exact mechanism by which species changed. Therefore he resolved to follow the Baconian method, which his friend Sir Charles Lyell had used so successfully in geology. He hoped that by the wholesale collection of all facts related in any way to the variation of animals and plants

⁵ Among Darwin's grandchildren were Sir Charles Galton Darwin, a pioneer of relativistic quantum theory, and the artist and author, Gwen Raverat. One of his grand-nephews was the composer, Ralph Vaughn Williams.

under domestication and in nature, he might be able to throw some light on the subject. He soon saw that in agriculture, the key to success in breeding new varieties was selection; but how could selection be applied to organisms living in a state of nature?

In October 1838, 15 months after beginning his systematic enquiry, Darwin happened to read Malthus' book on population.⁶ After his many years as a naturalist, carefully observing animals and plants, Darwin was very familiar with the struggle for existence which goes on everywhere in nature; and it struck him immediately that under the harsh conditions of this struggle, favorable variations would tend to survive while unfavorable ones would perish. The result would be the formation of new species!

Darwin had at last got a theory on which to work, but he was so anxious to avoid prejudice that he did not write it down. He continued to collect facts, and it was not until 1842 that he allowed himself to write a 35-page sketch of his theory. In 1844 he enlarged this sketch to 230 pages, and showed it to his friend Sir Joseph Hooker, the Director of Kew Botanical Gardens. However, Darwin did not publish his 1844 sketch. Probably he foresaw the storm of bitter hostility which his heretical theory was to arouse. In England at that time, Lamarckian ideas from France were regarded as both scientifically unrespectable and politically subversive. The hierarchal English establishment was being attacked by the Chartist movement, and troops had been called out to suppress large scale riots and to ward off revolution. Heretical ideas which might undermine society were regarded as extremely dangerous. Darwin himself was a respected member of the establishment, and he was married to a conservative and devout wife, whose feelings he wished to spare. So he kept his work on species private, confiding his ideas only to Hooker and Lyell.

Instead of publishing his views on evolution, Darwin began an enormous technical study of barnacles, which took him eight years to finish. Hooker had told him that no one had the right to write on the question of the origin of species without first having gone through the detailed work of studying a particular species. Also, barnacles were extremely interesting to Darwin: They are in fact more closely related to shrimps and crabs than to molluscs.

Finally, in 1854, Darwin cleared away the last of his barnacles and began to work in earnest on the transmutation of species through natural selection, arranging the mountainous piles of notes on the subject which he had accumulated over the years. By 1858 he had completed the first part of a monumental work on evolution. If he had continued writing on the same scale, he would ultimately have produced a gigantic, unreadable multivolume opus. Fortunately this was prevented: A young naturalist named Alfred Russell Wallace, while ill with a fever in Malaya, also read Malthus on Population; and in a fit of inspiration he arrived at a theory of evolution through natural selection which was identical with Darwin's! Wallace wrote out his ideas in a short paper with the title: *On the Tendency of Varieties to Depart Indefinitely from the Original Type*. He sent this paper to Darwin with the request that if Darwin thought the paper good, he should forward it to Lyell.

Lyell had for years been urging Darwin to publish his own work on natural selection,

⁶ *An Essay on the Principle of Population, or, A View of its Past and Present Effects, with an Inquiry into our Prospects Respecting its Future Removal or Mitigation of the Evils which it Occasions*, 2nd edn, Johnson, London (1803)

telling him that if he delayed, someone else would reach the same conclusions. Now Lyell's warning had come true with a vengeance, and Darwin's first impulse was to suppress all his own work in favor of Wallace. In a letter to Lyell, Darwin wrote: "I would far rather burn my whole book than that he or any other man should think that I had behaved in a paltry spirit." Darwin's two good friends, Lyell and Hooker, firmly prevented this however; and through their intervention a fair compromise was reached: Wallace's paper, together with an extract from Darwin's 1844 sketch on natural selection, were read jointly to the Linnean Society (which listened in stunned silence).

At the urging of Lyell and Hooker, Darwin now began an abstract of his enormous unfinished book. This abstract, entitled *On The Origin of Species by Means of Natural Selection, or The Preservation of Favoured Races in the Struggle for Life*, was published in 1859. It ranks with Newton's *Principia* as one of the two greatest scientific books ever written.

Darwin's *Origin of Species* can still be read with enjoyment and fascination by a modern reader. His style is vivid and easy to read, and almost all of his conclusions are still believed to be true. Darwin begins his great book with a history of evolutionary ideas. He starts with a quotation from Aristotle, who was groping towards the idea of natural selection: "Wheresoever, therefore... all the parts of one whole happened like as if they were made for something, these were preserved, having been appropriately constituted by an internal spontaneity; and wheresoever things were not thus constituted, they perished, and still perish." Darwin lists many others who contributed to evolutionary thought, including the Chevalier de Lamarck, Geoffroy Saint-Hillaire, Alfred Russell Wallace, and his own grandfather, Erasmus Darwin.

Next, Darwin reminds us of the way in which mankind has produced useful races of domestic animals and plants by selecting from each generation those individuals which show any slight favorable variation, and by using these as parents for the next generation. A closely similar process occurs in nature, Darwin tells us: Wild animals and plants exhibit slight variations, and in nature there is always a struggle for existence. This struggle follows from the fact that every living creature produces offspring at a rate which would soon entirely fill up the world if no check ever fell on the growth of population. We often have difficulty in seeing the exact nature of these checks, since living organisms are related to each other and to their environment in extremely complex ways, but the checks must always be present.

Accidental variations which increase an organism's chance of survival are more likely to be propagated to subsequent generations than are harmful variations. By this mechanism, which Darwin called "natural selection", changes in plants and animals occur in nature just as they do under the artificial selection exercised by breeders.

If we imagine a volcanic island, pushed up from the ocean floor and completely uninhabited, we can ask what will happen as plants and animals begin to arrive. Suppose, for example, that a single species of bird arrives on the island. The population will first increase until the environment cannot support larger numbers, and it will then remain constant at this level. Over a long period of time, however, variations may accidentally occur in the bird population which allow the variant individuals to make use of new types

of food; and thus, through variation, the population may be further increased.

In this way, a single species “radiates” into a number of sub-species which fill every available ecological niche. The new species produced in this way will be similar to the original ancestor species, although they may be greatly modified in features which are related to their new diet and habits. Thus, for example, whales, otters and seals retain the general structure of land-going mammals, although they are greatly modified in features which are related to their aquatic way of life. This is the reason, according to Darwin, why vestigial organs are so useful in the classification of plant and animal species.

The classification of species is seen by Darwin as a genealogical classification. All living organisms are seen, in his theory, as branches of a single family tree. This is a truly remarkable assertion, since the common ancestors of all living things must have been extremely simple and primitive; and it follows that the marvelous structures of the higher animals and plants, whose complexity and elegance utterly surpasses the products of human intelligence, were all produced, over thousands of millions of years, by random variation and natural selection!

Each structure and attribute of a living creature can therefore be seen as having a long history; and a knowledge of the evolutionary history of the organs and attributes of living creatures can contribute much to our understanding of them. For instance, studies of the evolutionary history of the brain and of instincts can contribute greatly to our understanding of psychology, as Darwin pointed out.

Darwin then discusses the complex networks of relationships between living organisms⁷. For example, he discusses the way in which a certain kind of fly prevents horses, cattle and dogs from becoming feral (i.e. thriving as wild animals) in Paraguay. The fly lays its eggs in the navels of these animals when they are born. If the infestations are untreated, fewer of the newborns survive. In other parts of South America, to the north and south of Paraguay, the flies are less numerous, probably because of the presence of parasitic insects. Hence, Darwin concludes, if insect-eating birds were to decrease in Paraguay, the parasitic insects would increase, and this would lessen the number of navel-frequenting flies. Then cattle and horses would become feral, and this would alter the vegetation, which would affect the insects, and so on in ever-increasing circles of complexity.

Another interesting chain of ecological relationships involves clover, bumble-bees, mice, cats and cat-loving people: Red clover is much more common near to towns than elsewhere. Why should this be so? Darwin’s explanation is that this type of clover can only be pollinated by bumble-bees. The underground nests of bumble-bees are often destroyed by mice; but near to towns mice are kept in check by cats. Hence, Darwin notes, the presence of cats in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district.

Among the many striking observations presented by Darwin to support his theory, are facts related to morphology and embryology. For example, Darwin includes a quotation from the naturalist, von Baer, who stated that he had in his possession two embryos preserved in alcohol, which he had forgotten to label. Von Baer was completely unable to

⁷ Here we can see Darwin as the founder of the modern discipline of ecology.

tell by looking at them whether they were embryos of lizards, birds or mammals, since all these species are so similar at an early stage of development.

Darwin also quotes the following passage from G.H. Lewis: "The tadpole of the common Salamander has gills, and passes its existence in the water; but the *Salamandra atra*, which lives high up in the mountains, brings forth its young full-formed. This animal never lives in the water. Yet if we open a gravid female, we find tadpoles inside her with exquisitely feathered gills; and when placed in water, they swim about like the tadpoles of the common Salamander or water-newt. Obviously this aquatic organization has no reference to the future life of the animal, nor has it any adaptation to its embryonic condition; it has solely reference to ancestral adaptations; it repeats a phase in the development of its progenitors."

Darwin points out that, "...As the embryo often shows us more or less plainly the structure of the less modified and ancient progenitor of the group, we can see why ancient and extinct forms so often resemble in their adult state the embryos of existing species."

Darwin sets forth another line of argument in support of evolution based on "serial homologies", - cases where symmetrically repeated parts of an ancient progenitor have been modified for special purposes in their descendants. For example, the bones which fit together to form the brain case in reptiles, birds and mammals can be seen in fossil sequences to be modified vertebrae of an ancient progenitor. After discussing many examples, Darwin exclaims, "How inexplicable are these cases of serial homologies on the ordinary view of creation! Why should the brain be enclosed in a box composed of such numerous and extraordinarily-shaped pieces of bone?... Why should similar bones have been created to form the wing and leg of a bat, used as they are for totally different purposes, namely walking and flying? Why should one crustacean, which has an extremely complex mouth, formed of many parts, consequently have fewer legs; or conversely, those with many legs have simpler mouths? Why should the sepals, petals, stamens and pistils in each flower, though fitted for such distinct purposes, be all constructed on the same pattern?... On the theory of natural selection we can, to a certain extent, answer these questions.... An indefinite repetition of the same part is the common characteristic of all low or little-specialized forms... We have already seen that parts many times repeated are eminently liable to vary... Consequently such parts, being already present in considerable numbers, and being highly variable, would naturally afford materials for adaption to the most different purposes."

No abstract of Darwin's book can do justice to it. One must read it in the original. He brings forward an overwhelming body of evidence to support his theory of evolution through natural selection; and he closes with the following words:

"It is interesting to contemplate a tangled bank, clothed with many plants of many different kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us... There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning, endless forms most beautiful and wonderful

have been and are being evolved.”

9.5 The Descent of Man

Darwin's *Origin of Species*, published in 1859, was both an immediate success and an immediate scandal. Darwin had sent an advance copy of his book to *The Times* to be reviewed; and because of the illness of the usual reviewer, T.H. Huxley (1825-1895) was asked to comment on the book. Huxley, who was one of the most brilliant zoologists of the period, immediately recognized the validity and importance of Darwin's work and exclaimed: “How exceedingly stupid not to have thought of that!” He wrote a long and favorable review for *The Times*, and partly as a result of this review, the first edition of *The Origin of Species* (1200 copies) was sold out on the day of publication. A second edition, published six weeks later, also sold out quickly; and new editions, reprintings and translations have been published ever since in a steady stream.

Darwin had avoided emphasizing the emotionally-charged subject of man's ancestry, but he did not think that it would be honest to conceal his belief that the human race belongs to the same great family which includes all other living organisms on earth. As a compromise, he predicted in a single sentence that through studies of evolution “light would be thrown on the origin of man and his history”. This single sentence, and the obvious implications of Darwin's book, were enough to create a storm of furious opposition. One newspaper commented that “society must fall to pieces if Darwinism be true.”

The storm of scandalized opposition was still growing in June 1860, when three anti-Darwinian papers were scheduled for reading at an open meeting of the British Association for the Advancement of Science at Oxford. The meeting hall was packed with 700 people as Samuel Wilberforce, Bishop of Oxford, took the floor to “smash Darwin”. Darwin himself was too ill (or too diffident) to be present, but T.H. Huxley had been persuaded to attend the meeting to defend Darwin's ideas. After savagely attacking Darwin for half an hour, the bishop turned to Huxley and asked sneeringly, “Is it through your grandfather or your grandmother that you claim to be descended from an ape?”

Huxley, who was 35 at the time and at the height of his powers, rose to answer the bishop. He first gave scientific answers, point by point, to the objections which had been made to the theory of evolution. Finally, regarding the bishop's question about his ancestry, Huxley said: “If I had to choose between a poor ape for an ancestor and a man, highly endowed by nature and of great influence, who used those gifts to introduce ridicule into a scientific discussion and to discredit humble seekers after truth, I would affirm my preference for the ape.” Huxley later recalled: “My retort caused inextinguishable laughter among the people.”

Pandemonium broke out in the hall. Lady Brewster fainted, and Admiral FitzRoy, the former captain of the *Beagle*, rose to his feet, lifting a Bible in his hand, exclaiming that the Scriptures are the only reliable authority. Had he known Darwin's true nature, FitzRoy said, he would never have allowed him to sail on board the *Beagle*. As *Macmillan's Magazine* reported later, “Looks of bitter hatred were directed to those who were on

Darwin's side." However, later that evening, in the discussions of the events of the day which took place in the Oxford colleges, Darwin's ideas were given a surprisingly fair hearing.

The debate at Oxford marked the turning-point in the battle over evolution. After that, Huxley and Hooker defended Darwin's theories with increasing success in England, while in Germany most of the prominent biologists, led by Professor Ernst Haeckel, were soon on Darwin's side. In America the theory of evolution was quickly accepted by almost all of the younger scientists, despite the opposition of the aging "creationist" Louis Agassiz. However, opposition from religious fundamentalists continued in most parts of America, and in Tennessee a school teacher named John T. Scopes was brought to trial for teaching the theory of evolution. He was prosecuted by the orator and three-time presidential candidate William Jennings Bryan, and defended by the brilliant Chicago lawyer Clarence Darrow. In this famous "Monkey Trial", Scopes was let off with a small fine, but the anti-evolution laws remained in force. It was only in 1968 that the State Legislature of Tennessee repealed its laws against the teaching of evolution⁸.

In 1863 Huxley, who was not afraid of controversy, published a book entitled *Evidences of Man's Place in Nature*, and this was followed in 1871 by Darwin's book *The Descent of Man*. Huxley and Darwin brought forward a great deal of evidence to show that human beings are probably descended from an early ape-like primate which is now extinct. Darwin believed that the early stages of human evolution took place in Africa⁹. In order to show that men and apes represent closely-related branches of the same family tree, Darwin and Huxley stressed the many points of similarity - resemblances in structure, reproduction, development, psychology and behavior, as well as susceptibility to the same parasites and diseases.

9.6 The Expression of Emotions in Man and Animals; ethology

In *The Origin of Species*, Charles Darwin devoted a chapter to the evolution of instincts, and he later published a separate book on *The Expression of Emotion in Man and Animals*. Because of these pioneering studies, Darwin is considered to be the founder of the science of ethology - the study of inherited behavior patterns.

Behind Darwin's work in ethology is the observation that instinctive behavior patterns are just as reliably inherited as morphological characteristics. Darwin was also impressed by the fact that within a given species, behavior patterns have some degree of uniformity, and the fact that the different species within a family are related by similarities of instinctive

⁸ In 1999, the Kansas State School Board removed biological evolution from the curriculum followed by students within the state. Furthermore, cosmology was also removed from the curriculum because it presents evidence that the earth is extremely old, thus supporting evolution. Fortunately, the 1999 decision has now been reversed.

⁹ This guess has been confirmed by the recent discoveries of Broom, Dart and the Leakey family, among many others.

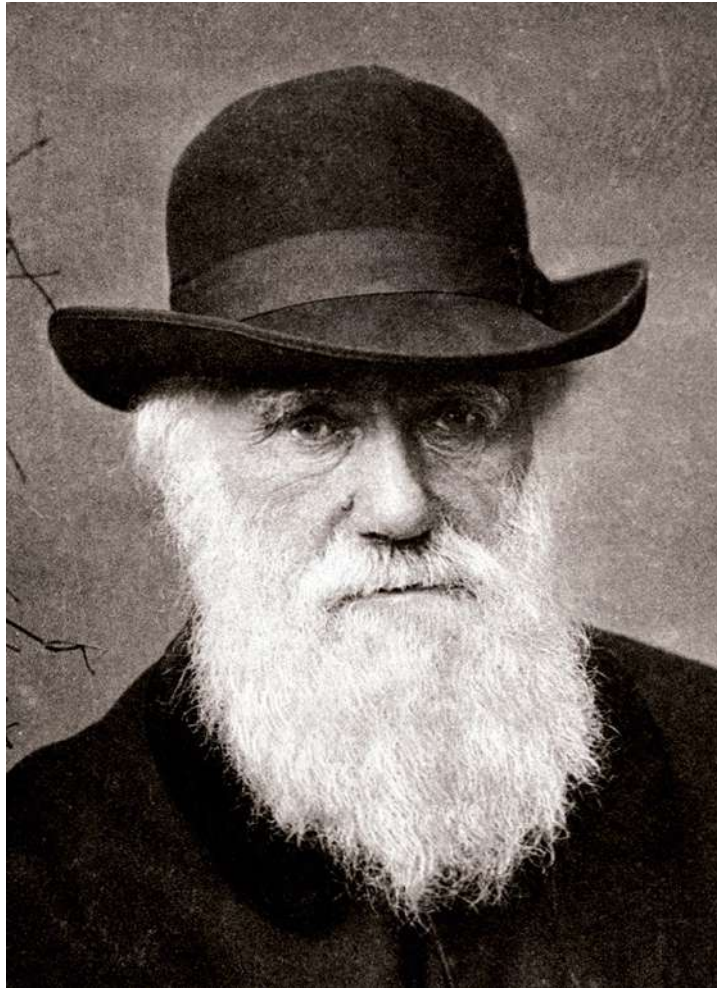


Figure 9.5: A photograph of Charles Darwin as an old man.

behavior, just as they are related by similarities of bodily form. For example, certain elements of cat-like behavior can be found among all members of the cat family; and certain elements of dog-like or wolf-like behavior can be found among all members of the dog family. On the other hand, there are small variations in instinct among the members of a given species. For example, not all domestic dogs behave in the same way.

“Let us look at the familiar case of breeds of dogs”, Darwin wrote in *The Origin of Species*, “It cannot be doubted that young pointers will sometimes point and even back other dogs the very first time they are taken out; retrieving is certainly in some degree inherited by retrievers; and a tendency to run round, instead of at, a flock of sheep by shepherd dogs. I cannot see that these actions, performed without experience by the young, and in nearly the same manner by each individual, and without the end being known - for the young pointer can no more know that he points to aid his master than the white butterfly knows why she lays her eggs on the leaf of the cabbage - I cannot see that these actions differ essentially from true instincts...”

“How strongly these domestic instincts habits and dispositions are inherited, and how curiously they become mingled, is well shown when different breeds of dogs are crossed. Thus it is known that a cross with a bulldog has affected for many generations the courage and obstinacy of greyhounds; and a cross with a greyhound has given to a whole family of shepherd dogs a tendency to hunt hares...”

Darwin believed that in nature, desirable variations of instinct are propagated by natural selection, just as in the domestication of animals, favorable variations of instinct are selected and propagated by kennelmen and stock breeders. In this way, according to Darwin, complex and highly developed instincts, such as the comb-making instinct of honey-bees, have evolved by natural selection from simpler instincts, such as the instinct by which bumble bees use their old cocoons to hold honey and sometimes add a short wax tube.

The study of inherited behavior patterns in animals was continued in the 20th century by such researchers as Nikolaas Tinbergen, Konrad Lorenz and Karl von Frisch, three scientists who shared the first Nobel Prize ever awarded in the field of ethology. Among the achievements for which Tinbergen is famous are his classic studies of instinct in herring gulls. He noticed that the newly-hatched chick of a herring gull pecks at the beak of its parent, and this signal causes the parent gull to regurgitate food into the gaping beak of the chick. Tinbergen wondered what signal causes the chick to initiate this response by pecking at the beak of the parent gull. Therefore he constructed a series of models of the parent in which certain features of the adult gull were realistically represented while other features were crudely represented or left out entirely. He found by trial and error that the essential signal to which the chick responds is the red spot on the tip of its parent's beak. Models which lacked the red spot produced almost no response from the young chick, although in other respects they were realistic models; and the red spot on an otherwise crude model would make the chick peck with great regularity.

Tinbergen called this type of signal a “sign stimulus”. He found by further studies that he could produce an even more frantic response from the young chick by replacing the red spot by several concentric black circles on a white background, a sign stimulus which he called “super-normal”

In his 1978 book on *Animal Behavior*, Tinbergen pointed out that the features of baby animals, with their large foreheads, round cheeks, and round eyes, all have a characteristic “baby” look. This, Tinbergen wrote, is a sign stimulus which draws a protective response from adults; and he calls attention to the exaggerated “baby” look of some of Walt Disney's animals as an example of a super-normal sign stimulus. Another example of a super-normal sign stimulus, Tinbergen wrote, is the red lipstick and dark eye makeup sometimes used by women.

In the case of a newly-hatched herring gull chick pecking at the red spot on the beak of its parent, the program in the chick's brain must be entirely genetically determined, without any environmental component at all. Learning cannot play a part in this behavioral pattern, since the pattern is present in the young chick from the very moment when it breaks out of the egg. On the other hand (Tinbergen pointed out) many behavioral patterns in animals and in man have both an hereditary component and an environmen-

tal component. Learning is often very important, but learning seems to be built on a foundation of genetic predisposition.

To illustrate this point, Tinbergen called attention to the case of sheep-dogs, whose remote ancestors were wolves. These dogs, Tinbergen tells us, can easily be trained to drive a flock of sheep towards the shepherd. However, it is difficult to train them to drive the sheep away from their master. Tinbergen explained this by saying that the sheep-dogs regard the shepherd as their "pack leader"; and since driving the prey towards the pack leader is part of the hunting instinct of wolves, it is easy to teach the dogs this maneuver. However, driving the prey away from the pack leader would not make sense for wolves hunting in a pack; it is not part of the instinctive makeup of wolves, nor is it a natural pattern of behavior for their remote descendants, the sheep-dogs.

Tinbergen also tells us that a Welsh shepherd who wishes to discipline his dog often bites it in the ear; and this is an extremely effective method of enforcing discipline with dogs. To explain the effectiveness of the ear bite, Tinbergen reminds his readers that the leader of a pack of wolves disciplines his subordinates by biting their ears.

As a further example of the fact that learning is usually built on a foundation of genetic predisposition, Tinbergen mentions the ease with which human babies learn languages. The language learned is determined by the baby's environment; but astonishing ease with which a human baby learns to speak and understand implies a large degree of genetic predisposition.

Suggestions for further reading

1. Sir Julian Huxley and H.B.D. Kettlewell, *Charles Darwin and his World*, Thames and Hudson, London, (1965).
2. Allan Moorehead, *Darwin and the Beagle*, Penguin Books Ltd., (1971).
3. Francis Darwin (editor), *The Autobiography of Charles Darwin and Selected Letters*, Dover, New York, (1958).
4. Charles Darwin, *The Voyage of the Beagle*, J.M. Dent and Sons Ltd., London, (1975).
5. Charles Darwin, *The Origin of Species*, Collier MacMillan, London, (1974).
6. Charles Darwin, *The Expression of Emotions in Man and Animals*, The University of Chicago Press (1965).
7. D.W. Forest, *Francis Galton, The Life and Work of a Victorian Genius*, Paul Elek, London (1974).
8. Ruth Moore, *Evolution*, Time-Life Books (1962).
9. L. Barber, *The Heyday of Natural History: 1820-1870*, Doubleday and Co., Garden City, New York, (1980).
10. A. Desmond, *Huxley*, Addison Wesley, Reading, Mass., (1994).
11. R. Owen, (P.R. Sloan editor), *The Hunterian Lectures in Comparative Anatomy*, May-June, 1837, University of Chicago Press, (1992).
12. C. Nichols, *Darwinism and the social sciences*, Phil. Soc. Scient. 4, 255-277 (1974).
13. M. Ruse, *The Darwinian Revolution*, University of Chicago Press, (1979).
14. A. Desmond and J. Moore, *Darwin*, Penguin Books, (1992).

15. R. Dawkins, *The Extended Phenotype*, Oxford University Press, (1982).
16. R. Dawkins, *The Blind Watchmaker*, W.W. Norton, (1987).
17. R. Dawkins, *River out of Eden: A Darwinian View of Life*, Harper Collins, (1995).
18. R. Dawkins, *Climbing Mount Improbable*, W.W. Norton, (1996).
19. S.J. Gould, *Ever Since Darwin*, W.W. Norton, (1977).
20. S.J. Gould, *The Panda's Thumb*, W.W. Norton, (1980).
21. S.J. Gould, *Hen's Teeth and Horse's Toes*, W.W. Norton, (1983).
22. S.J. Gould, *The Burgess Shale and the Nature of History*, W.W. Norton, (1989).
23. R.G.B. Reid, *Evolutionary Theory: The Unfinished Synthesis*, Croom Helm, (1985).
24. M. Ho and P.T. Saunders, editors, *Beyond Neo-Darwinism: An Introduction to a New Evolutionary Paradigm*, Academic Press, London, (1984).
25. J. Maynard Smith, *Did Darwin Get it Right? Essays on Games, Sex and Evolution*, Chapman and Hall, (1989).
26. E. Sober, *The Nature of Selection: Evolutionary Theory in Philosophical Focus*, University of Chicago Press, (1984).
27. B.K. Hall, *Evolutionary Developmental Biology*, Chapman and Hall, London, (1992).
28. J. Thompson, *Interaction and Coevolution*, Wiley and Sons, (1982).
29. N. Tinbergen, *The Study of Instinct*, Oxford University Press, (1951).
30. N. Tinbergen, *Social Behavior in Animals*, Methuen, London, (1953).
31. N. Tinbergen, *The Animal in its World: Explorations of an Ethologist*, Allan and Unwin, London, (1973).
32. K. Lorenz, *On the evolution of behavior*, Scientific American, December, (1958).
33. K. Lorenz, *Studies in Animal and Human Behavior. I and II.*, Harvard University Press, (1970) and (1971).
34. P.H. Klopfer and J.P. Hailman, *An Introduction to Animal Behavior: Ethology's First Century*, Prentice-Hall, New Jersey, (1969).
35. J. Jaynes, *The historical origins of "Ethology" and "Comparative Psychology"*, Anim. Behav. 17, 601-606 (1969).
36. W.H. Thorpe, *The Origin and Rise of Ethology: The Science of the Natural Behavior of Animals*, Heinemann, London, (1979).
37. R.A. Hinde, *Animal Behavior: A Synthesis of Ethological and Comparative Psychology*, McGraw-Hill, New York, (1970).
38. J.H. Crook, editor, *Social Behavior in Birds and Mammals*, Academic Press, London, (1970).
39. P. Ekman, editor, *Darwin and Facial Expression*, Academic Press, New York, (1973).
40. P. Ekman, W.V. Friesen and P. Ekworth, *Emotions in the Human Face*, Pergamon, New York, (1972).
41. N. Burton Jones, editor, *Ethological Studies of Child Behavior*, Cambridge University Press, (1975).
42. M. von Cranach, editor, *Methods of Inference from Animals to Human Behavior*, Chicago/Mouton, Haag, (1976); Aldine, Paris, (1976).
43. K. Lorenz, *On Aggression*, Bantam Books, (1977).

44. I. Eibl-Eibesfeld, *Ethology, The Biology of Behavior*, Holt, Rinehart and Winston, New York, (1975).
45. P.P.G. Bateson and R.A. Hinde, editors, *Growing Points in Ethology*, Cambridge University Press, (1976).
46. J. Bowlby, *By ethology out of psychoanalysis: An experiment in interbreeding*, *Animal Behavior*, **28**, 649-656 (1980).
47. B.B. Beck, *Animal Tool Behavior*, Garland STPM Press, New York, (1980).
48. R. Axelrod, *The Evolution of Cooperation*, Basic Books, New York, (1984).
49. J.D. Carthy and F.L. Ebling, *The Natural History of Aggression*, Academic Press, New York, (1964).
50. D.L. Cheney and R.M. Seyfarth, *How Monkeys See the World: Inside the Mind of Another Species*, University of Chicago Press, (1990).
51. F. De Waal, *Chimpanzee Politics*, Cape, London, (1982).
52. M. Edmunds, *Defense in Animals*, Longman, London, (1974).
53. R.D. Estes, *The Behavior Guide to African Mammals*, University of California Press, Los Angeles, (1991).
54. R.F. Ewer, *Ethology of Mammals*, Logos Press, London, (1968).

Chapter 10

POLAR EXPLORATION

10.1 Willem Barentsz, (c.1550-1597)

Willem Barentsz (or Barentszoon, meaning “son of Barent”) was a Dutch cartographer and Arctic explorer. He tried to find a passage to China by sailing eastward, along the north coast of Siberia. On his first two voyages, his ships reached as far as Novaya Zemlya, but on both voyages they were forced to turn back by polar ice. The Barents Sea is named after him.

First voyage

On this voyage the men captured a polar bear when it tried to board the ship. However, the bear’s behaviour was so violent that they were forced to kill it.

Second voyage

Prince Maurice of Orange was filled with enthusiasm by the success of the first voyage, and he sponsored a second voyage in which Barentsz commanded six ships. Hopes for reaching China were so high that the ships even carried goods to be traded with the Chinese. However, after reaching Novaya Zemlya, the expedition was once again forced to turn back by heavy sea-ice.

Third voyage

The second voyage was considered to be a failure, and the Dutch government refused to sponsor further expeditions. Instead, they announced a large reward for anyone who could sail to China by means of a Northeast Passage. The Town Council of Amsterdam then purchased and outfitted two ships, to be commanded by Barentsz. This time the expedition discovered Spitzbergen, but Barentsz died on the return voyage.



Figure 10.1: Willem Barentsz, (c.1550-1597).



Figure 10.2: A map of the Northeast Passage explored by Willem Barentsz. His first voyage reached Novaya Zemlya, the large island north of Siberia. On his third voyage, his ships discovered Spitsbergen, an island north of Norway.

10.2 Robert Peary, (1856-1920)

Peary's early life

After the death of Robert Peary's father, his mother moved with her son to Portland Maine. In 1877, Peary graduated from Bowden College, Maine, with a degree in civil engineering. He worked for some time as a draftsman and surveyor.

Expeditions to Greenland

In 1886, Robert Peary submitted a paper to the National Academy of Sciences, proposing two methods for crossing Greenland's ice cap. His subsequent expeditions to the northern part of Greenland proved for the first time that it is an island.

Did Peary reach the North Pole?

Wikipedia states that **“For his final assault on the pole, Peary and 23 men, including Ross Gilmore Marvin, set off from New York City on July 6, 1908, aboard the Roosevelt, commanded by Robert Bartlett...**

They reached what Peary believed to be the North Pole, but doubts have been thrown on this assertion. However, Wikipedia states that **“ Despite remaining doubts a committee of the National Geographic Society, as well as the Naval Affairs Subcommittee of the U.S. House of Representatives, credited Peary with reaching the North Pole”**

Peary's later life

Robert Peary was promoted to the rank of Rear Admiral in the Civil Engineering department of the US Navy. His home in Maine has been designated as an historic site, and is now a museum. Peary served twice as President of the Explorers Club. He also received many other honors in both Europe and America.



Figure 10.3: Robert Peary (1856-1920) at Cape Sheridan in 1909.



Figure 10.4: The party at what was assumed to be the North Pole.

10.3 Fridtjof Nansen, (1861-1930)

Fridtjof Nansen was born into a prominent Danish-Norwegian family, many members of which held high political positions. For example, Nansen's great uncle, Count Herman Wedel Jarlsberg was the Viceroy of Norway, and ruled Norway on behalf of the Swedish king. Nansen himself became a polar explorer, scientist, diplomat, humanitarian and Nobel Peace Prize laureate. As a scientist, he obtained a doctorate in zoology, and also studied oceanography. He was also a champion skier and ice skater.

The Greenland crossing

In an extremely difficult and very dangerous expedition, Nansen led a small party of expert skiers on the first crossing of the Greenland icecap. When the expedition returned to Norway on the ship, *Hvidbjørnen*. Nansen and his companions were given a hero's welcome. Wikipedia states that

“*Hvidbjørnen* reached Copenhagen on 21 May 1889. News of the crossing had preceded its arrival, and Nansen and his companions were feted as heroes. This welcome, however, was dwarfed by the reception in Christiania a week later, when crowds of between thirty and forty thousand - a third of the city's population - thronged the streets as the party made its way to the first of a series of receptions. The interest and enthusiasm generated by the expedition's achievement led directly to the formation that year of the Norwegian Geographical Society.”

Farthest north in the *Fram*

Wikipedia states that

“Nansen's *Fram* expedition of 1893-1896 was an attempt by the Norwegian explorer Fridtjof Nansen to reach the geographical North Pole by harnessing the natural east-west current of the Arctic Ocean. In the face of much discouragement from other polar explorers, Nansen took his ship *Fram* to the New Siberian Islands in the eastern Arctic Ocean, froze her into the pack ice, and waited for the drift to carry her towards the pole. Impatient with the slow speed and erratic character of the drift, after 18 months Nansen and a chosen companion, Hjalmar Johansen, left the ship with a team of dogs and sledges and made for the pole. They did not reach it, but they achieved a record Farthest North latitude of 86°13.6'N before a long retreat over ice and water to reach safety in Franz Josef Land. Meanwhile, *Fram* continued to drift westward, finally emerging in the North Atlantic Ocean.

Once again, Nansen was given an ecstatic welcome when he returned.



Figure 10.5: **Fridtjof Nansen, (1861-1930).**

Diplomacy, work with refugees, and the Nobel Peace Prize

As a diplomat in London, and as one of Norway's leading citizens, Nansen was instrumental in obtaining Norway's independence from Sweden.

In 1921 he became the League of Nations' High Commissioner for Refugees. He worked to save displaced victims of World War I, introducing the "Nansen passport" for stateless people. This passport was recognized by 50 nations, and Nansen was awarded the Nobel Peace Prize for his work.

10.4 Robert Falcon Scott, (1868-1912)

Scott's early life

Scott's father was a brewery owner and magistrate. Thus the family was in comfortable financial circumstances during the early part of his life. In 1881, Robert Scott began his naval career as a 13-year-old cadet on the training ship HMS *Brittania*. Later, he became

a naval officer. Scott's father sold his brewery, and invested the money from the sale unwisely, losing it all. This financial catastrophe made Scott's family entirely dependent on his income as a naval officer.

The Discovery Expedition

The Discovery Expedition (1901-1904) was jointly sponsored by the Royal Geographic Society and the Royal Society. Robert Falcon Scott was chosen to lead the expedition, and he was given leave from the navy on half pay to do so. King Edward VII was keenly interested in the expedition, and he visited the expedition's ship, *The Discovery* on the day of its departure.

In 1901, Scott, Shackleton and Wilson reached a point only 530 miles from the South Pole. During the second year of the expedition, a party led by Scott marched to the west, discovering the Polar Plateau. Scientifically, the expedition was a success, bringing home important biological, zoological and geological findings. Returning to England in 1904, Scott found himself famous - a popular hero. He was invited to dine at royal tables, not only in England, but also in other countries.

The Terra Nova Expedition

The Terra Nova Expedition (1910-1913) took its name from that of its supply ship. It was financed by public contributions, with backing from a government grant, the Admiralty, and the Royal Geographic Society.

Scott, who led the expedition, has some scientific objectives, but he also wanted to be the first to reach the geographical South Pole. On the 17th of January, 1912, he and his companions, Edward Wilson, Lawrence Oates, Henry Bowers and Edgar Evans, reached the South Pole, only to find that a Norwegian expedition, led by Roald Amundsen, had preceded them by five weeks. All of them died on the return journey. Scott left the following message:

"We took risks, we knew we took them; things have come out against us, and therefore we have no cause for complaint, but bow to the will of Providence, determined still to do our best to the last ... Had we lived, I should have had a tale to tell of the hardihood, endurance, and courage of my companions which would have stirred the heart of every Englishman. These rough notes and our dead bodies must tell the tale, but surely, surely, a great rich country like ours will see that those who are dependent on us are properly provided for."



Figure 10.6: Robert Falcon Scott, (1868-1912). Scientifically the expedition on which he died was a success, and Scott's memory is cherished in England.



Figure 10.7: Scott's party at the South Pole: Oates, Bowers, Scott, Wilson and Evans. Finding that Amundsen had been there first, Scott wrote: "The worst has happened... All the day dreams must go... Great God! This is an awful place!" All the men died on the return journey.

10.5 Roald Amundsen, (1872-1928)

Amundsen's family and early life

Roald Amundsen was born into a family of ship owners and ship captains. His mother wanted him to become a doctor, and he followed her wishes until her death when he was 21 years old. He then immediately switched to a sea career because he ardently wished to become a polar explorer.

The Northwest Passage Expedition

In 1903, at the age of 31, Amundsen led the first expedition to successfully traverse the Northwest Passage, across the Canadian Arctic coast between the Atlantic and Pacific oceans. He used a small 45 ton ship, the *Gjøa*, fitted with a single screw parafin engine, and a six-man crew. The entire journey took three years, and on the way, Amundsen had an opportunity to study the survival skills, dogsled techniques and animal skin clothing of the local Inuits. This knowledge proved invaluable to him on his later expedition to the South Pole.

Amundsen's expedition to the South Pole

Amundsen originally intended this expedition to be an assault on the North Pole, but he changed his mind and turned south instead, using Nansen's old ship, the *Fram*. Leaving Oslo for the south on 3 June, 1910, he telegraphed to Scott: **"Beg to inform you *Fram* proceeding Antarctic - Amundsen"**.

About six months later, the expedition arrived at the edge of what is now known as the Ross Ice Shelf. Here they set up a base camp. Using skis and dog sleds, and clothed in Inuit-style furs, they established a series of supply depots, farther and farther into Antarctica. On 25 January, 1912, Amundsen and his small team arrived at the South Pole, with 11 surviving dogs out of the 52 that had started. All of the men who reached the South Pole returned alive, thanks to careful planning, and the use of Inuit survival techniques.

The Northeast Passage Expedition

In this expedition, which began in 1918 and which lasted until 1922, the aim was to explore the polar seas north of Siberia, to gather scientific information, and hopefully to let the research ship *Maud* be frozen into the ice and drift farther north than Nansen had - perhaps even over the North Pole. However, the expedition encountered many difficulties. For example, Amundsen suffered a broken arm and was attacked by polar bears.

In 1926, Amundsen and 15 other men flew over the North Pole in an airship. Thus he may have been the first person at both the North Pole and the South Pole.



Figure 10.8: Roald Amundsen, (1872-1928). He disappeared in 1928 while on a rescue mission. Amundsen may have been the first person to reach both poles. However, the question of who was the first to reach the geographical North Pole is disputed.

10.6 Ernest Shackleton, (1874-1922)

Ernest Shackleton was born in Ireland to Anglo-Irish parents. His father was initially a farmer, but later studied medicine. In 1884, the family moved to a suburb of London, which offered better opportunities for medical practice. It had also become unsafe for Anglo-Irish families to live in Ireland.

At the age of 16, Shackleton entered the merchant navy, and sailed to many parts of the world, learning both seamanship, and the skill of making friends with many kinds of people. In 1894, he passed his examination for second mate, and took a post as third officer on a tramp steamer.

The Discovery Expedition and the Nimrod Expedition

Shackleton participated in Scott's Discovery Expedition (1901-1904), but he was sent home early because of health problems. There were also rumors of a clash of personalities between Scott and Shackleton.

Shackleton later led the Nimrod Expedition (1907-1909). whose main objective was to reach the geographical South Pole. Although they failed in this objective, Shackleton and his companions reached a point nearer the South Pole than anyone before them. The expedition carried out extensive geological, zoological and meteorological work. On his return to England, Shackleton was knighted by King Edward VII.

The Imperial Trans-Antarctic Expedition and Shackleton's incredible rescue operation

The Imperial Trans-Antarctic Expedition (1914-1917) was the last major expedition in the Heroic Age of Antarctic Exploration. Its aim was to make the first land crossing of the Antarctic continent. The plan was to send ships to opposite sides of the continent. Explorers from one side would cross, via the South Pole, and finally reach a train of supply depots established by the ship from the opposite side, it being impossible for an expedition to carry enough food for the entire journey.

That was the plan. However, what actually happened was that one of the ships, the *Endurance*, was crushed by pack ice, and sank, leaving its desperate crew, including Shackleton himself, stranded on the ice. The plans for an Antarctic land crossing were abandoned, and mere survival became the goal.

Using lifeboats salvaged from the *Endurance*, Shackleton and the crew members reached Elephant Island, but this island was uninhabited and almost never visited. Taking a few men with him, Shackleton sailed across 800 miles of open ocean in an open lifeboat, enduring enormous waves which drenched the party with freezing water. Finally they reached the inhabited island of South Georgia, but they were on the wrong side of the island. To reach the whaling station, Shackleton and two of his companions crossed an uncharted mountain range. After enormous efforts he succeeded in arranging for the rescue of all of his crew members, both those on the opposite side of South Georgia and those on Elephant Island.



Figure 10.9: Sir Ernest Shackleton, (1874-1922).



Figure 10.10: Jameson Adams, Frank Wild and Eric Marshall (from left to right) plant the Union Jack at their southernmost position, $88^{\circ} 23'$, on 9 January 1909. The photograph was taken by expedition leader Ernest Shackleton.

10.7 Knud Rasmussen, (1879-1933)

Knud Rasmussen was not only a great polar explorer, but also an anthropologist and a skillful and prolific author. He has been called “the father of Eskimology”. He was born in Greenland, where his father was a Danish missionary. His mother was an Inuit, so Knud Rasmussen’s heritage combined elements from both Danish and Inuit cultures.

Remembering his childhood, Rasmussen wrote:

“My playmates were native Greenlanders; from the earliest boyhood I played and worked with the hunters, so even the hardships of the most strenuous sledge-trips became pleasant routine for me.”

Later, Knud Rasmussen was educated in Denmark, and he married a Danish girl named Dagmer Andersen, with whom he had three children. His outstanding characteristics were his intelligence and charm. Everyone who met him liked him and was inspired by him.

Wikipedia says of him:

“Rasmussen’s greatest achievement was the massive Fifth Thule Expedition (1921-1924) which was designed to ‘attack the great primary problem of the origin of the Eskimo race.’ A ten volume account (The Fifth Thule Expedition 1921-1924 (1946)) of ethnographic, archaeological and biological data was collected, and many artifacts are still on display in museums in Denmark. The team of seven first went to eastern Arctic Canada where they began collecting specimens, taking interviews (including the shaman Aua, who told him of Uvavnuk), and excavating sites.

“Rasmussen left the team and traveled for 16 months with two Inuit hunters by dog sled across North America to Nome, Alaska - he tried to continue to Russia but his visa was refused. He was the first European to cross the Northwest Passage via dog sled. His journey is recounted in *Across Arctic America* (1927), considered today a classic of polar expedition literature. This trip has also been called the ‘Great Sled Journey’ and was dramatized in the Canadian film *The Journals of Knud Rasmussen* (2006).

“For the next seven years Rasmussen traveled between Greenland and Denmark giving lectures and writing. In 1931, he went on the Sixth Thule Expedition, designed to consolidate Denmark’s claim on a portion of eastern Greenland that was contested by Norway.

The Seventh Thule Expedition (1933) was meant to continue the work of the sixth, but Rasmussen contracted pneumonia after an episode of food poisoning attributed to eating kiviaq, dying a few weeks later in Copenhagen at the age of 54.

“In addition to several capes and glaciers, Knud Rasmussen Range in Greenland is named after him. He was awarded an Honorary Fellowship from the American Geographical Society in 1912, and its Daly Medal in 1924. The Royal Geographical Society awarded him their Founder’s Gold Medal in 1923 and the Royal Danish Geographical Society their Hans Egede Medal in 1924. He was made honorary doctor at the University of Copenhagen in 1924.



Figure 10.11: **Knud Rasmussen, (1879-1933).**



Figure 10.12: **A statue of Knud Rasmussen near the coast of Denmark at Gentofte.**

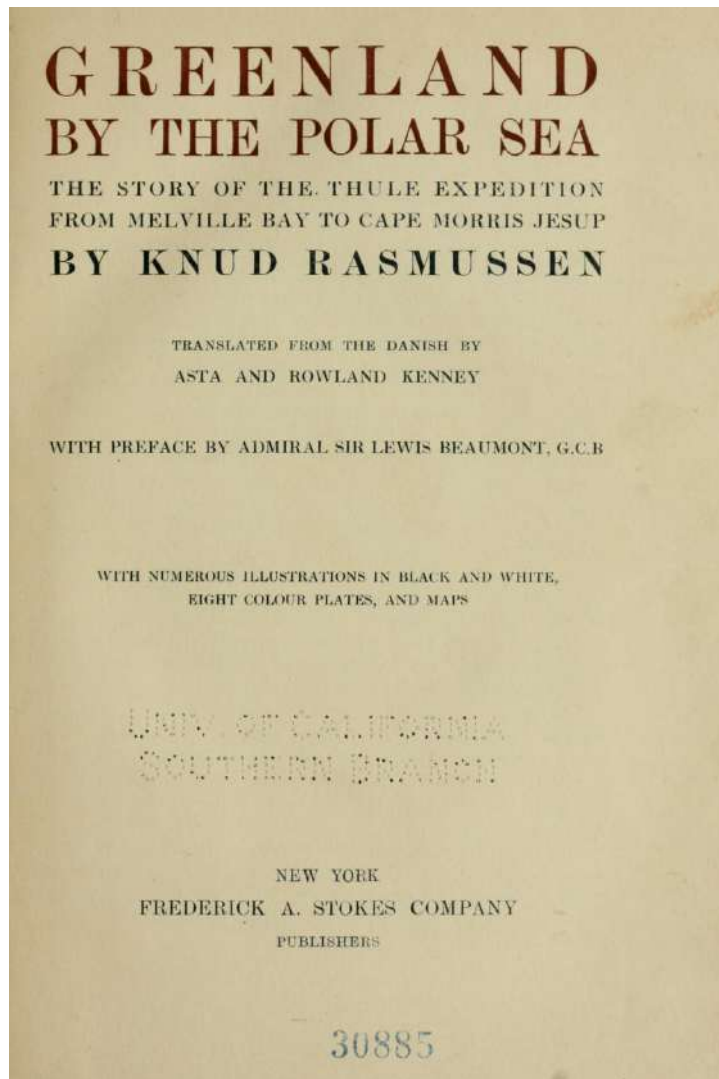


Figure 10.13: One of Knud Rasmussen's books.

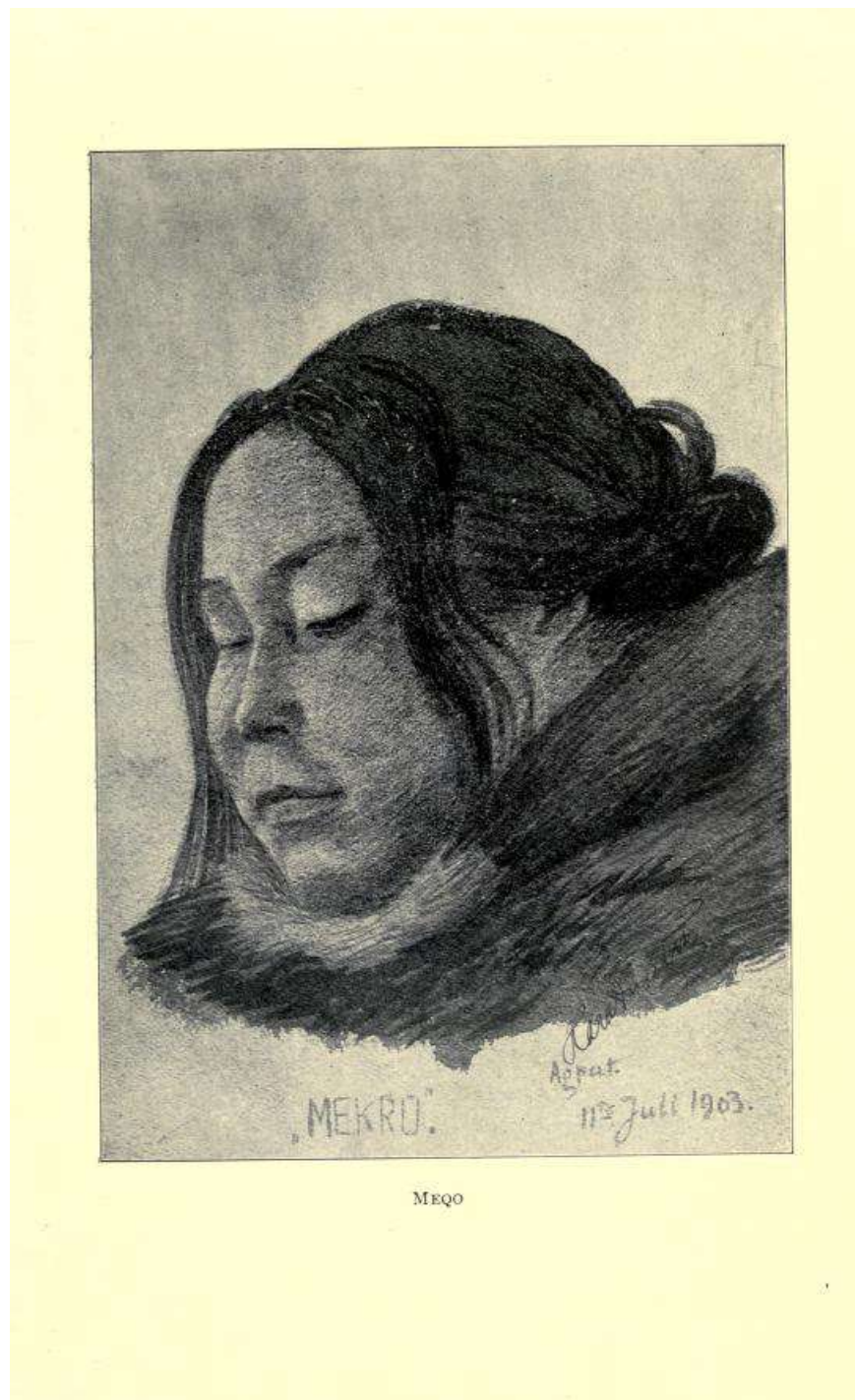
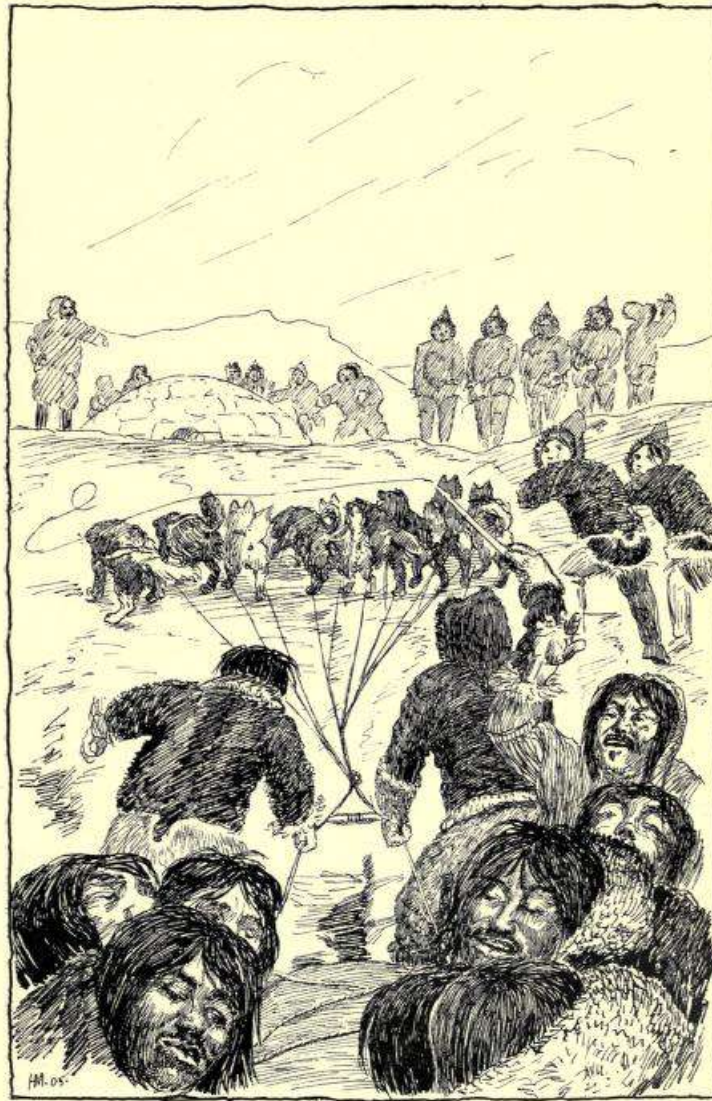


Figure 10.14: Image of an Inuit woman from Rasmussen's book, *The people of the Polar north*.



COUNT HARALD MOLTKE'S ARRIVAL AT AGPAT

Figure 10.15: Image of a dog-sled from Rasmussen's book, *The people of the Polar north*.



PANIGPAK

Figure 10.16: Portrait of an Inuit hunter from the same book.

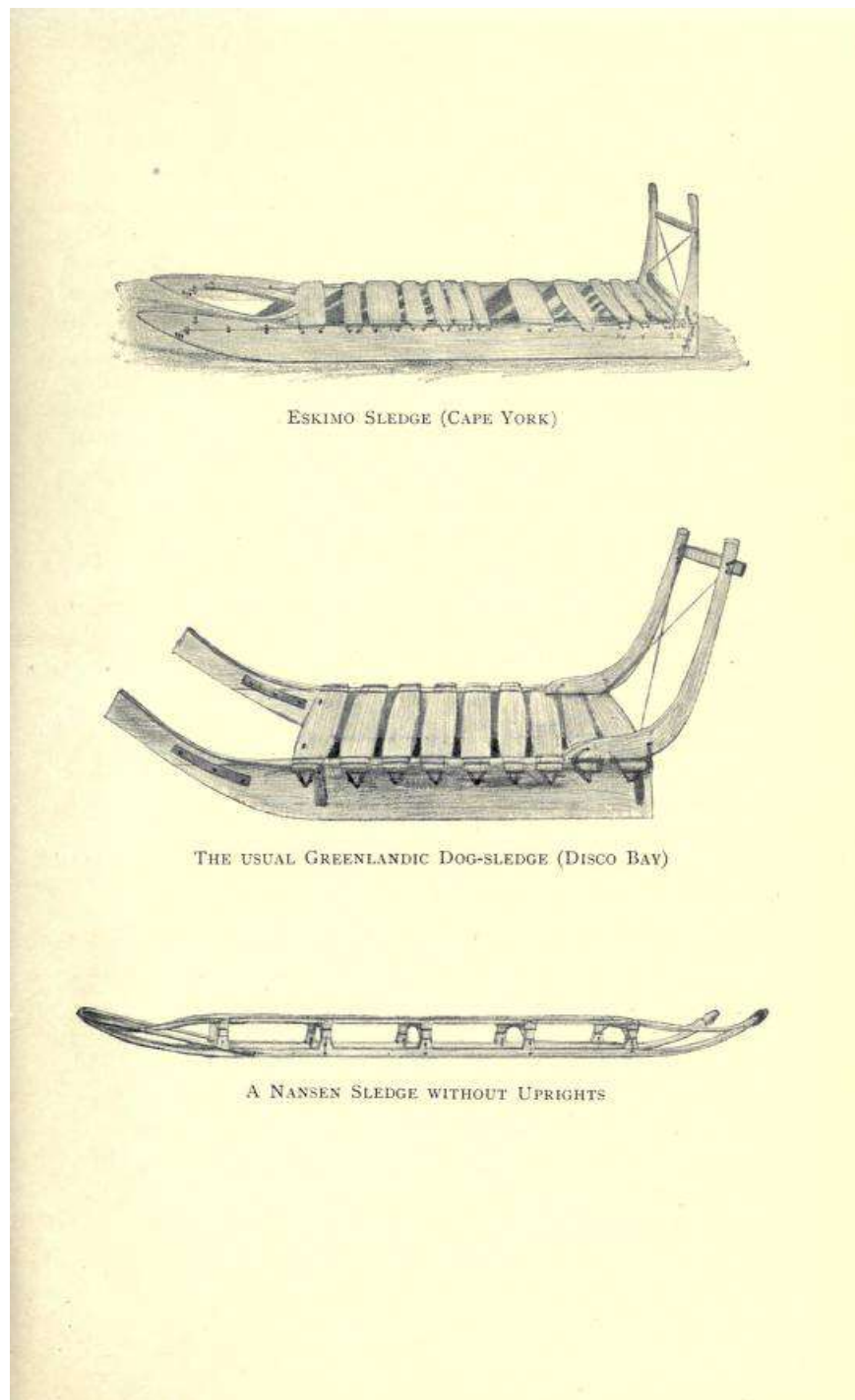


Figure 10.17: Another Knud Rasmussen illustration showing types of Inuit sleds.

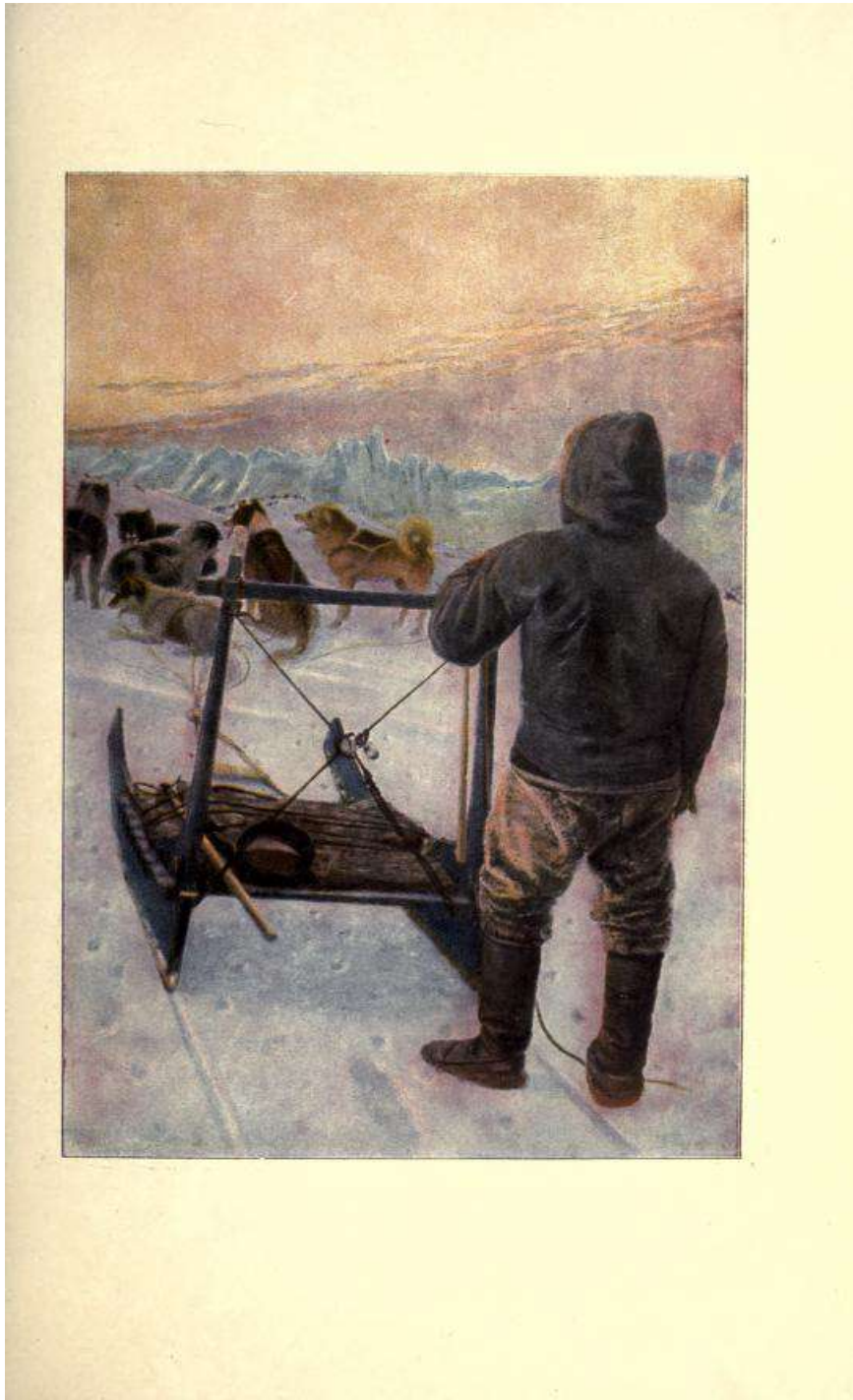
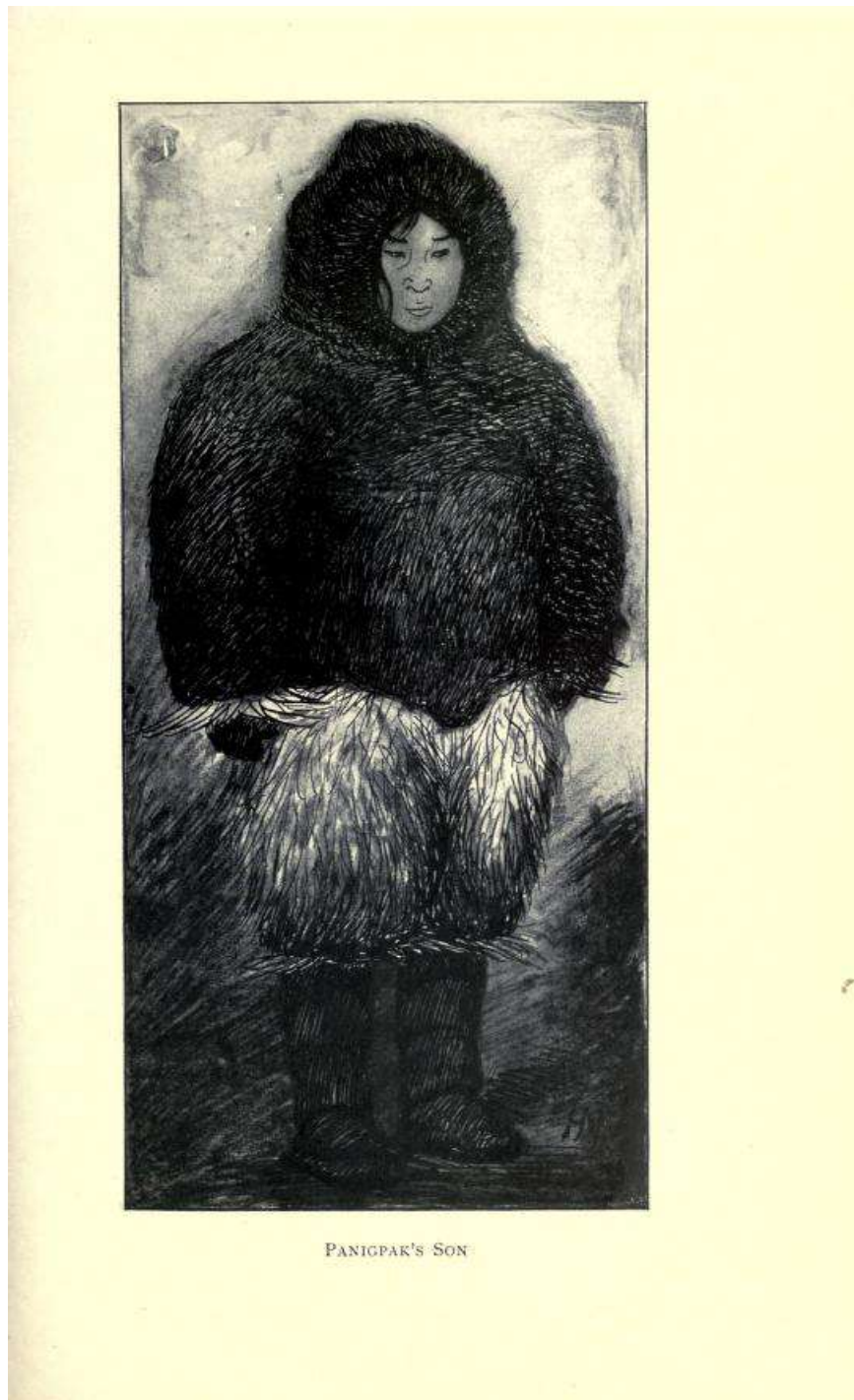


Figure 10.18: Across the polar ice.



PANIGPAK'S SON

Figure 10.19: A young man ready to brave the Arctic cold (another Rasmussen illustration).

Suggestions for further reading

1. Bown, Stephen R. *White Eskimo: Knud Rasmussen's Fearless Journey into the Heart of the Arctic*, (Da Capo, 2015).
2. Cruwys, Elizabeth (2003). *Rasmussen, Knud (1879-1933)*, in *Literature of Travel and Exploration: An Encyclopedia*, volume 3.
3. Malaurie, Jean (1982). *The Last Kings of Thule: With the Polar Eskimos, as They Face Their Destiny*, trans. Adrienne Folk.
4. Markham, Clements R. (1921). *The Lands of Silence: A History of Arctic and Antarctic Exploration*. Cambridge University Press.

Chapter 11

SPACE EXPLORATION

11.1 Astronautics

Rocket timeline from Wikipedia

- 11th century AD - The first documented record of gunpowder and the fire arrow, an early form of rocketry, appears in the Chinese text *Wujing Zongyao*.
- 1650 - *Artis Magnae Artilleriae pars prima* (“Great Art of Artillery, the First Part”) is printed in Amsterdam, about a year before the death of its author, Kazimierz Siemienowicz.
- 1664 - A “space rocket” is imagined as a future technology to be studied in France and its drawing is ordered by French finance minister Colbert; designed by Le Brun on a Gobelins tapestry.
- 1798 - Tipu Sultan, the King of the state of Mysore in India, develops and uses iron rockets against the British Army.
- 1801 - The British Army develops the Congreve rocket based on weapons used against them by Tipu Sultan.
- 1806 - Claude Ruggieri, an Italian living in France, launched animals on rockets and recovered them using parachutes. He was prevented from launching a child by police.
- 1813 - “A Treatise on the Motion of Rockets” by William Moore - first appearance of the rocket equation.
- 1818 - Henry Trengrouse demonstrates his rocket apparatus for projecting a lifeline from a wrecked ship to the shore, later widely adopted.
- 1844 - William Hale invents the spin-stabilized rocket
- 1861 - William Leitch publishes an essay “A Journey Through Space” as a humorous science fantasy story about a space gun launching a manned spacecraft equipped with rockets for landing on the Moon, but eventually used for another orbital maneuver.



Figure 11.1: A jet-driven steam engine invented by Hero of Alexandria in the 1st century A.D..



Figure 11.2: Rockets were used in warfare in China in the 11th century.



Figure 11.3: Congreve rockets were used in the bombardment of Copenhagen in 1807. It was a terror attack on the civilian population, carried out although no state of war existed between Denmark and England.



Figure 11.4: The Nazi V2 rocket, which launched the space age, was also used for the terror bombardment of civilians.

- 1902 - French cinema pioneer Georges Méliés directs *A Trip to the Moon*, the first film about space travel.
- 1903 - Konstantin Tsiolkovsky begins a series of papers discussing the use of rocketry to reach outer space, space suits, and colonization of the Solar System. Two key points discussed in his works are liquid fuels and staging.
- 1913 - Without knowing the work of Russian mathematician Konstantin Tsiolkovsky, French engineer Robert Esnault-Pelterie derived the equations for space flight, produced a paper that presented the rocket equation and calculated the energies required to reach the Moon and nearby planets.
- 1916 - first use of rockets (with the solid fuel Le Prieur rocket) for both air-to-air attacks, and air to ground.
- 1922 - Hermann Oberth publishes his scientific work about rocketry and space exploration: *Die Rakete zu den Planetenräumen* ("By Rocket into Planetary Space").
- 1924 - Society for Studies of Interplanetary Travel founded in Moscow by Konstantin Tsiolkovsky, Friedrich Zander and 200 other space and rocket experts
- 1926 - Robert Goddard launches the first liquid fuel rocket. This is considered by some to be the start of the Space Age.
- 1927 - Verein für Raumschiffahrt (VfR - "Spaceflight Society") founded in Germany.
- 1929 - *Woman in the Moon*, considered to be one of the first "serious" science fiction films.
- 1931 - Friedrich Schmiedl attempts the first rocket mail service in Austria
- 1933 - Sergei Korolev and Mikhail Tikhonravov launch the first liquid-fueled rocket in the Soviet Union.
- 1935 - Emilio Herrera Linares from Spain designed and made the first full-pressured astronaut suit, called the *escafandra estratonáutica*. The Russians then used a model of Herrera's suit when first flying into space of which the Americans would then later adopt when creating their own space program.
- 1936 - Research on rockets begins at the Guggenheim Aeronautical Laboratory at the California Institute of Technology (GALCIT), the predecessor to the Jet Propulsion Laboratory, under the direction of Frank Malina and Theodore von Kármán.
- 1937 - Peenemünde Army Research Center founded in Germany.
- 1938 - The Projectile Development Establishment founded at Fort Halstead for the United Kingdom's research into military solid-fuel rockets.
- 1939 - Katyusha multiple rocket launchers are a type of rocket artillery first built and fielded by the Soviet Union.

- 1941 - French rocket EA-41 is launched, being the first European liquid propellant working rocket[8](It was, however, preceded by the Peenemünde A5 and Soviet experiments.)
- 1941 - Jet Assisted Take Off JATO installed on US Army Air Corp Er-coupe aircraft occurred on 12 August in March Field, California.
- 1942 - Wernher von Braun and Walter Dornberger launch the first V-2 rocket at Peenemünde in northern Germany.
- 1942 - A V-2 rocket reaches an altitude of 85 km.
- 1944 - The V-2 rocket MW 18014 reaches an altitude of 176 km, becoming the first man-made object in space.
- 1945 - Lothar Sieber dies after the first vertical take-off manned rocket flight in a Bachem Ba 349 “Natter”.
- 1945 - Operation Paperclip takes 1,600 German rocket scientists and technicians to the United States.
- 1945 - Operation Osoaviakhim takes 2,000 German rocket scientists and technicians to the Soviet Union.
- 1946 - First flight of the Nike missile, later the first operational surface-to-air guided missile.
- 1947 - Chuck Yeager achieves the first manned supersonic flight in a Bell X-1 rocket-powered aircraft.
- 1949 - Willy Ley publishes *The Conquest of Space*.
- 1952 - 22 May, French Véronique 1 rocket is launched from the Algerian desert.
- 1952 - Wernher von Braun discusses the technical details of a manned exploration of Mars in *Das Marsprojekt*.
- 1953 - *Colliers* magazine publishes a series of articles on man’s future in space, igniting the interest of people around the world. The series includes numerous articles by Ley and von Braun, illustrated by Chesley Bonestell.
- 1956 - First launch of PGM-17 Thor, the first US ballistic missile and forerunner of the Delta space launch rockets.
- 1957 - Launch of the first ICBM, the USSR’s R-7 (8K71), known to NATO as the SS-6 Sapwood.
- 1957 - The USSR launches Sputnik 1, the first artificial satellite.
- 1958 - The U.S. launches Explorer 1, the first American artificial satellite, on a Jupiter-C rocket.
- 1958 - US launches their first ICBM, the Atlas-B (the Atlas-A was a test article only).
- 1961 - the USSR launches Vostok 1, Yuri Gagarin reached a height of 327 km above Earth and was the first man to orbit Earth.
- 1961 - US, a Mercury capsule named Freedom 7 with Alan B. Shepard, spacecraft was launched by a Redstone rocket on a ballistic trajectory suborbital flight. It was the first human space mission that landed with pilot still in spacecraft, thus the first complete human spaceflight by FAI definitions.

- 1962 - The US launches Mercury MA-6 (Friendship 7) on an Atlas D booster, John Glenn puts America in orbit.
- 1963 - The USSR launches Vostok 6, Valentina Tereshkova was the first woman (and first civilian) to orbit Earth. She remained in space for nearly three days and orbited the Earth 48 times.
- 1963 - US X-15 rocket-plane, the first reusable manned spacecraft (sub-orbital) reaches space, pioneering reusability, carried launch and glide landings.
- 1965 - USSR Proton rocket, highly successful launch vehicle with notable payloads, Salyut 6 and Salyut 7, Mir, and ISS components.
- 1965 - Robert Salked investigates various single stage to orbit spaceplane concepts.
- 1966 - USSR Luna 9, the first soft landing on the Moon.
- 1966 - USSR launches Soyuz spacecraft, longest-running series of spacecraft, eventually serving Soviet, Russian and International space missions.
- 1968 - USSR Zond 5, two tortoises and smaller biological Earthlings circle the Moon and return safely to Earth.
- 1968 - US Apollo 8, the first men to reach and orbit the Moon.
- 1969 - US Apollo 11, first men on the Moon, first lunar surface extravehicular activity.
- 1981 - US Space Shuttle pioneers reusability and glide landings.
- 1998 - US Deep Space 1 is first deep space mission to use an ion thruster for propulsion.
- 1998 - Russia launch Zarya module which is the first part of the International Space Station.
- 2001 - Russian Soyuz spacecraft sent the first space tourist Dennis Tito to International Space Station.
- 2004 - US-based, first privately developed, manned (suborbital) spaceflight, SpaceShipOne demonstrates reusability.
- 2008 - SpaceX - with their Falcon 1 rocket - became the first private entity to successfully launch a rocket into orbit.
- 2012 - The SpaceX Dragon space capsule - launched aboard a Falcon 9 launch vehicle - was the first private spacecraft to successfully dock with another spacecraft, and was also the first private capsule to dock at the International Space Station.
- 2014 - First booster rocket returning from an orbital trajectory to achieve a zero-velocity-at-zero-altitude propulsive vertical landing. The first-stage booster of Falcon 9 Flight 9 made the first successful controlled ocean soft touchdown of a liquid-rocket-engine orbital booster on April 18, 2014.
- 2015 - SpaceX's Falcon 9 Flight 20 was the first time that the first stage of an orbital rocket made a successful return and vertical landing.
- 2017 - SpaceX's Falcon 9 SES-10 was the first time a used orbital rocket made a successful return.



Figure 11.5: Cosmonaut Yuri Gagarin (1934-1968) was the first man in space. On 12 April, 1961, his space capsule, Vostok 1, completed an orbit of the Earth. Gagarin became an international celebrity, and was awarded many honors and medals. He died in the crash of a routine MIG-15UTI training flight.

11.2 Exploration of the Earth's Moon

In ancient times, the Greek philosopher Anaxagoras, who died in 428 BC, believed the Moon to be a giant spherical rock that reflects the light of the sun. This non-religious view of the heavens caused Anaxagoras to be persecuted and banished.

Aristarchus of Samos (c.310-c.230 BC), calculated the size of the Moon and its distance from the Earth (by observing the shadow of the Earth on the Moon during an eclipse, and the angles involved). He also calculated the distance from the Earth to the Sun. The values that he obtained were not very accurate, but they showed the Sun to be enormous in size in relation to the Earth and the Moon. As a result of his calculations he became the first person to suggest a sun-centered model for the solar system.

In our own era, the Soviet Union was the first to send a rocket to the Moon, the unmanned rocket Luna 2. which made a hard landing in September, 1959. Another Soviet rocket, Luna 3, photographed the far side of the moon in October of the same year.

These and other Soviet successes initiated a “space race” between the United States and the Soviet Union, and caused President John F. Kennedy to say to Congress, “...I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth. No single space project in this period will be more impressive to mankind, or more important in the long-range exploration of space; and none will be so difficult or expensive to accomplish.”

In December, 1968, the crew of Apollo 8 became the first humans to enter a lunar

orbit and to see the far side of the Moon. This success was followed by Apollo 11, in July, 1969, a manned spacecraft that made a soft landing on the Moon. Niel Armstrong, the commander of the mission, became, famously, the first human to set foot on the Moon.

In 1970, the first lunar robot vehicle landed on the Moon. It was sent by the Soviet Union and called “Lunokhod 1”.

The manned Apollo missions were eventually abandoned by the United States, but the National Aeronautics and Space Administration (NASA) has continued to send missions to photograph the Moon. Some of the photographs are shown below.

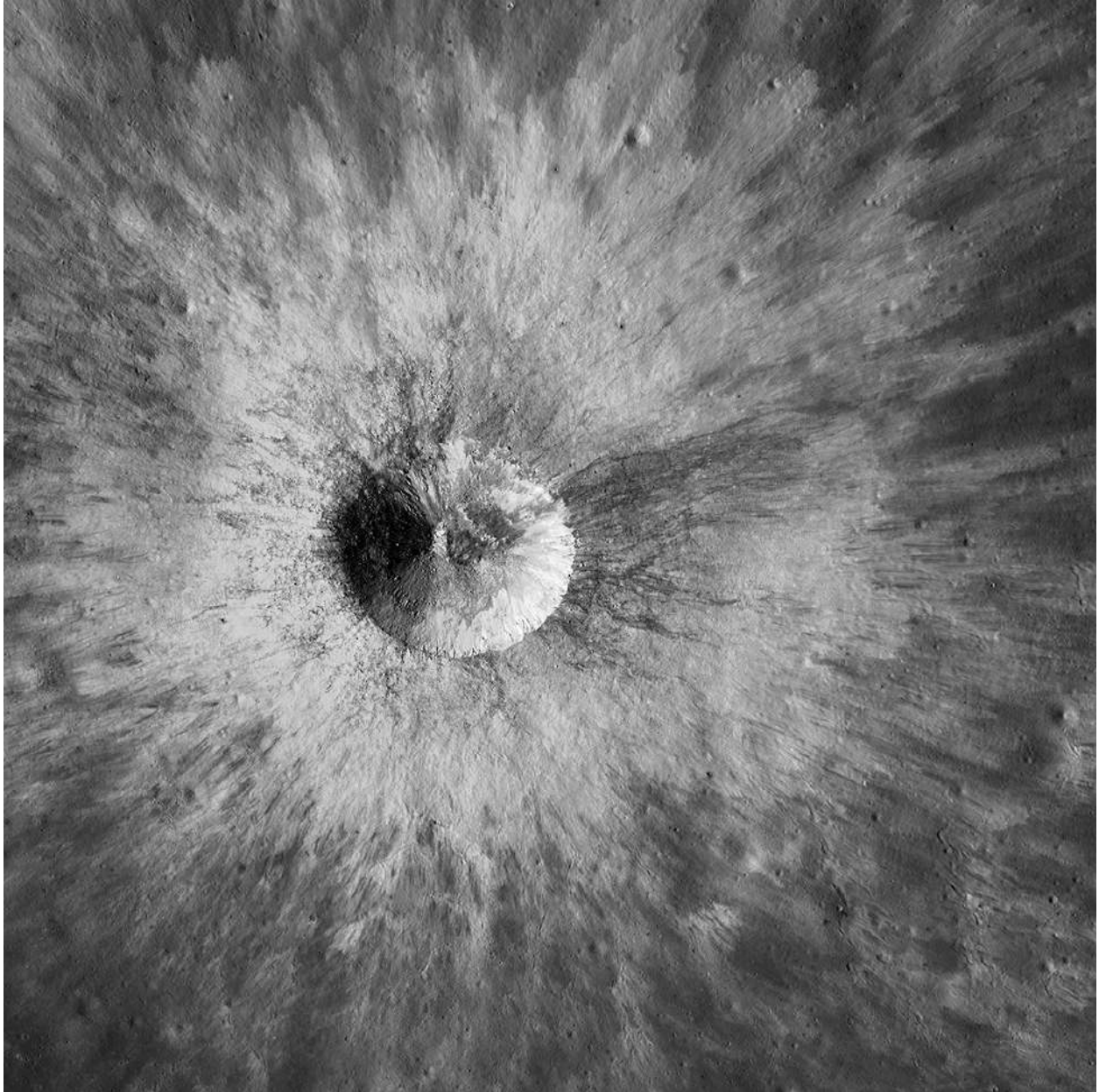


Figure 11.6: A young ray impact crater blasted in the eroded wall of the partly buried crater Hedin. It is distant from the starkly beautiful landscape Armstrong saw: the Apollo 11 landing site on Mare Tranquillitatis is more than 1000 kilometers to the east (NASA/GSFC/Arizona State University, November 3, 2018).

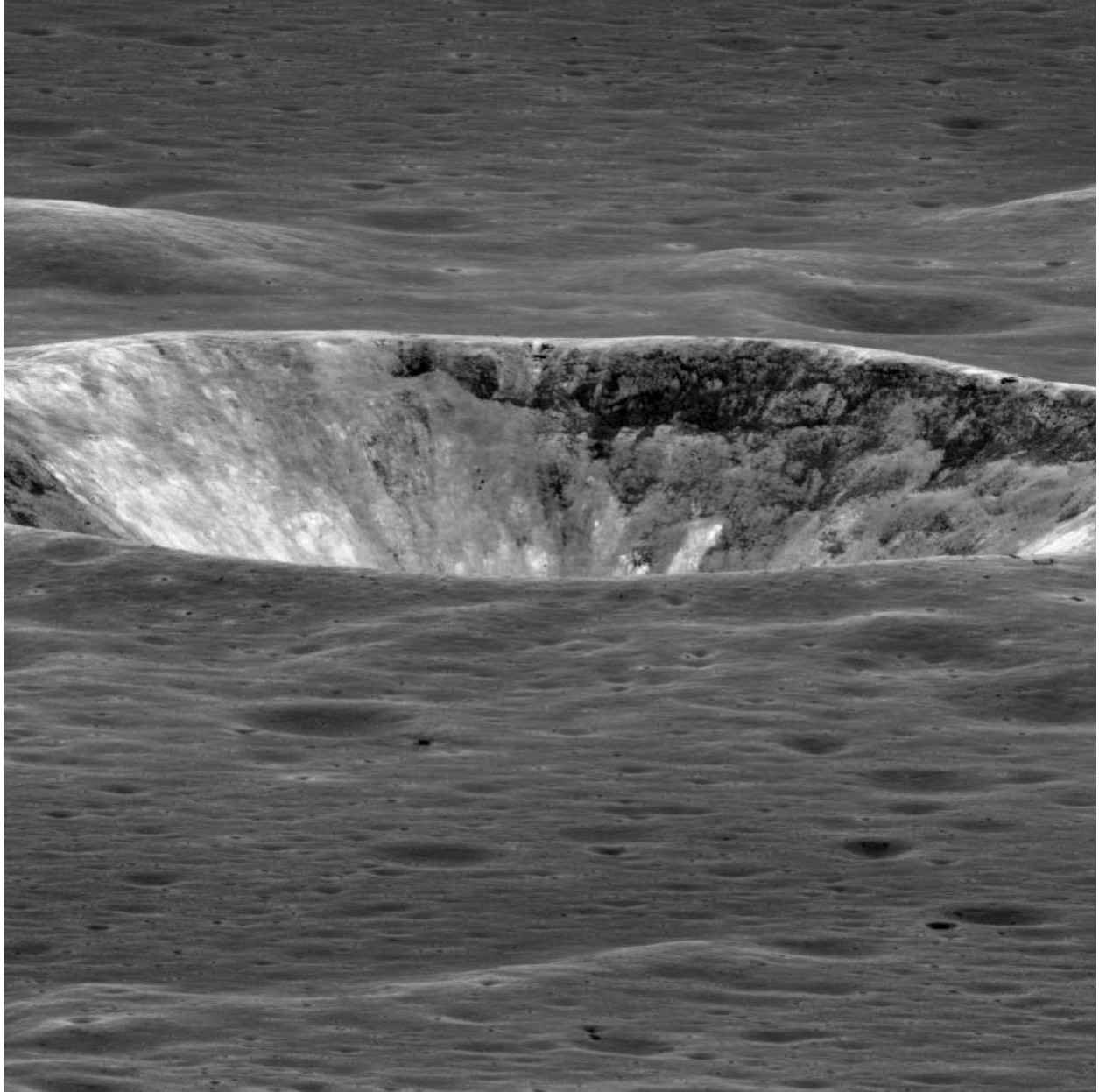


Figure 11.7: This spectacular view across the rim of the Moon's Wallach crater, 3.5 miles (5700 meters) across, comes from NASA's Lunar Reconnaissance Orbiter. It was taken when the spacecraft was just 58 miles (93 kilometers) above the surface (NASA/GSFC/Arizona State University, September 17, 2018).

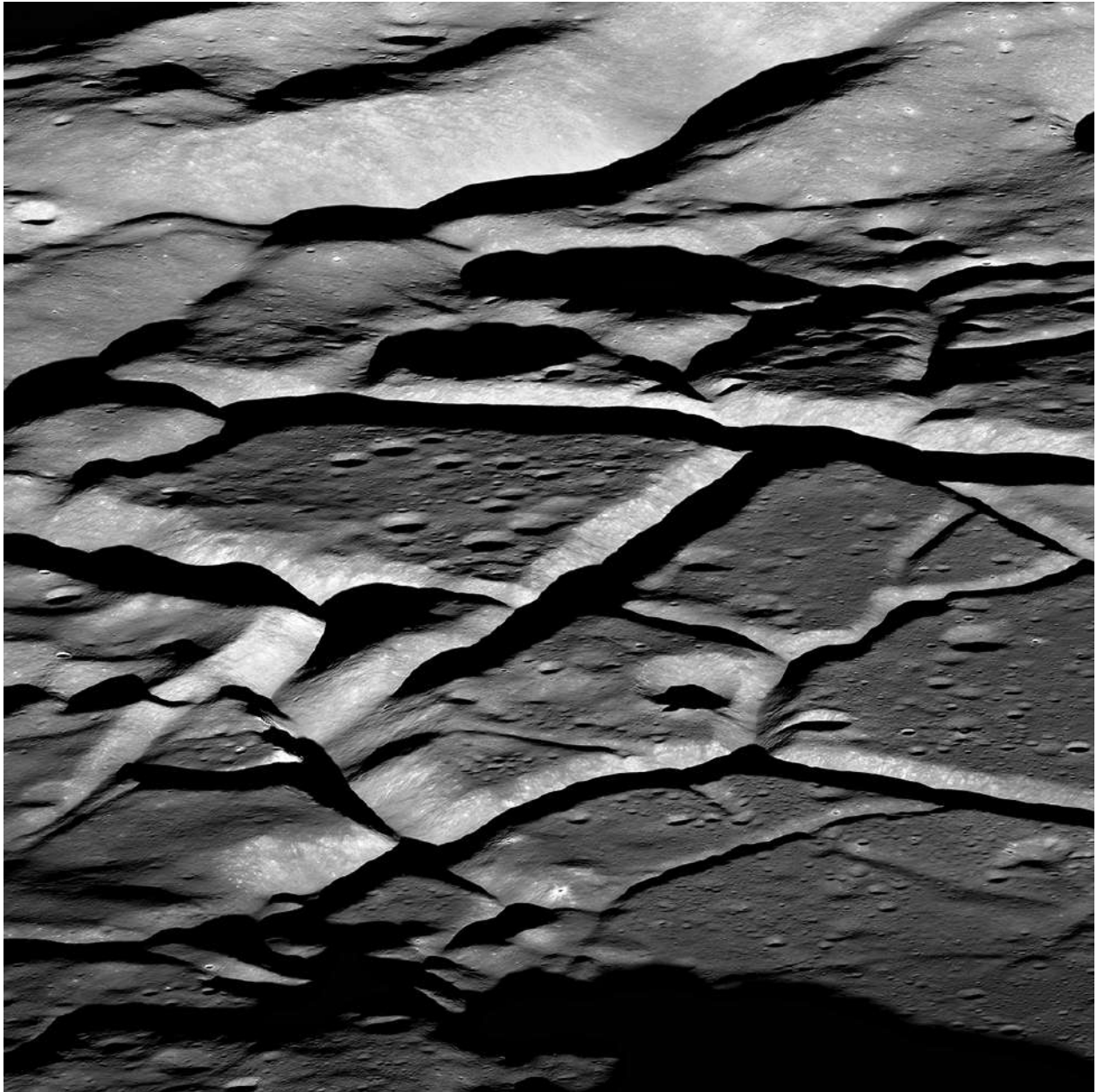


Figure 11.8: NASA's Lunar Reconnaissance Orbiter captured this detailed look at the floor of Komarov crater on the far side of the Moon. The spectacular fractures that cut across the floor of Komarov, which is about 53 miles (85 kilometers) in diameter, were formed when magma rose from the mantle, uplifting and fracturing the crater in the process. In this case, the magma did not erupt to the surface, so the fractures remain visible. This image shows an area just over 9 miles (15 kilometers) wide (NASA/GSFC/Arizona State University, November 17, 2018).

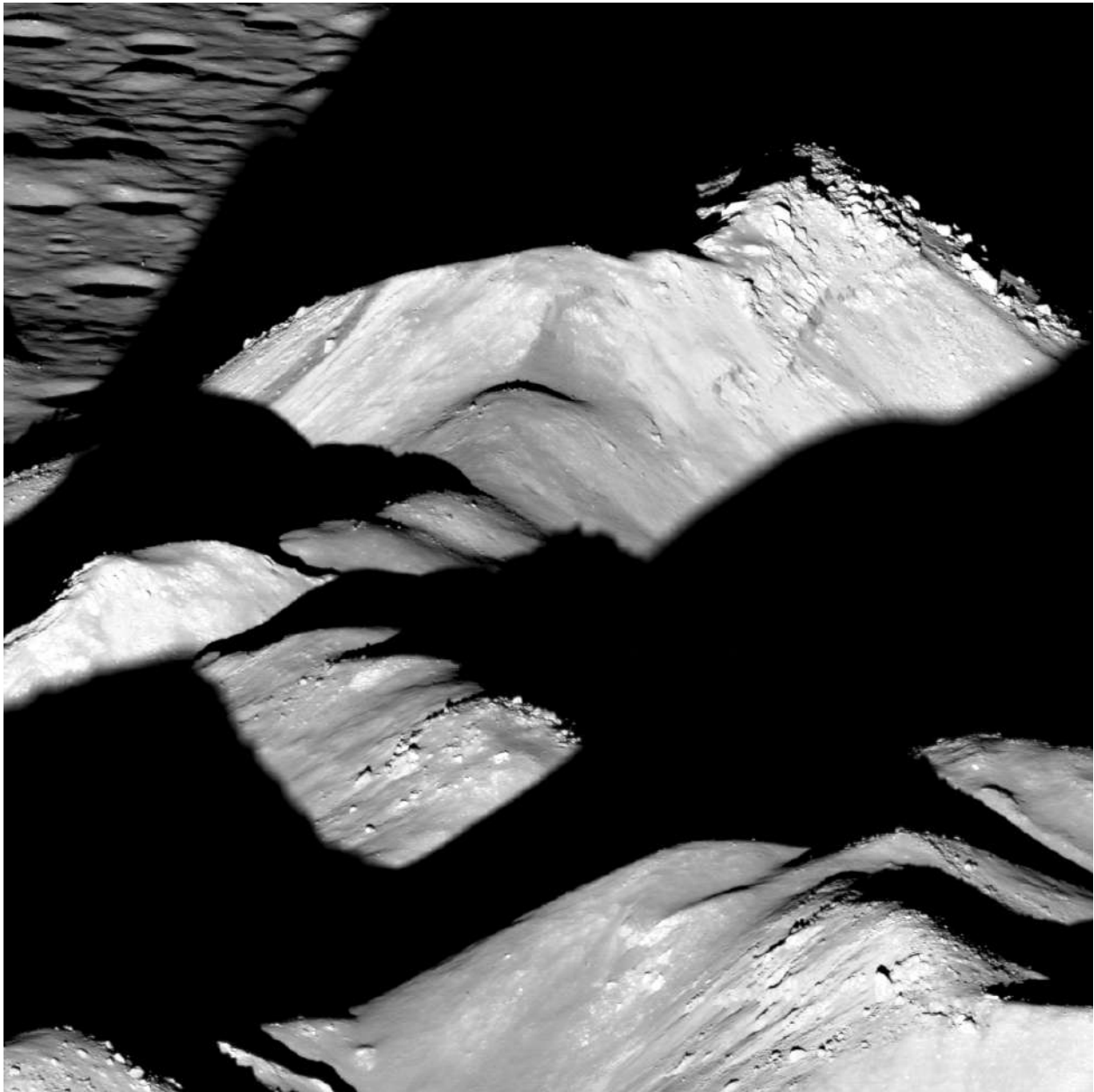


Figure 11.9: The central peak in the Moon's Copernicus crater reveals the complexity of the lunar crust through distinct layering and patchy surface brightness. The area shown here is about 1.8 miles (3 kilometers) wide. Copernicus, which is easily seen with a moderately powerful backyard telescope, is one of the best-known craters on the Moon. Despite its age (around 860 million years), it is well preserved, with over 2.5 miles (4000 meters) of relief from floor to rim, and the tallest of its central peaks rises nearly a mile (approximately 1300 meters) above the crater floor. This image, centered on the central peaks, was captured just after dawn by NASA's Lunar Reconnaissance Orbiter (NASA/GSFC/Arizona State University, October 8, 2018).

11.3 Missions to Mars

Below we list a few of the many missions to Mars:

- Mars 4NM and Mars 5NM - projects intended by the Soviet Union for heavy Marsokhod (in 1973 according to initial plan of 1970) and Mars sample return (planned for 1975). The missions were to be launched on the failed N1 rocket.
- Mars 5M (Mars-79) - double-launching Soviet sample return mission planned to 1979 but cancelled due to complexity and technical problems
- Voyager-Mars - USA, 1970s - Two orbiters and two landers, launched by a single Saturn V rocket.
- Vesta - the multiarmed Soviet mission, developed in cooperation with European countries for realisation in 1991-1994 but canceled due to the Soviet Union disbanding, included the flyby of Mars with delivering the aerostat and small landers or penetrators followed by flybys of 1 Ceres or 4 Vesta and some other asteroids with impact of penetrator on the one of them.
- Mars Aerostat - Russian/French balloon part for cancelled Vesta mission and then for failed Mars 96 mission,[71] originally planned for the 1992 launch window, postponed to 1994 and then to 1996 before being cancelled.
- Mars Together, combined U.S. and Russian mission study in the 1990s. To be launched by a Molinya with possible U.S. orbiter or lander.
- Mars Environmental Survey - set of 16 landers planned for 1999-2009
- Mars-98 - Russian mission including an orbiter, lander, and rover, planned for 1998 launch opportunity as repeat of failed Mars 96 mission and cancelled due to lack of funding.
- Mars Surveyor 2001 Lander - October 2001 - Mars lander (refurbished, became Phoenix lander)
- Kitty Hawk - Mars airplane micromission, proposed for December 17, 2003, the centennial of the Wright brothers' first flight. Its funding was eventually given to the 2003 Mars Network project.[76]
- NetLander - 2007 or 2009 - Mars netlanders
- Beagle 3 - 2009 British lander mission meant to search for life, past or present.
- Mars Telecommunications Orbiter - September 2009 - Mars orbiter for telecommunications
- Sky-Sailor - 2014 - Plane developed by Switzerland to take detailed pictures of Mars surface
- Mars Astrobiology Explorer-Cacher - 2018 rover concept, cancelled due to budget cuts in 2011. Sample cache goal later moved to Mars 2020 rover.

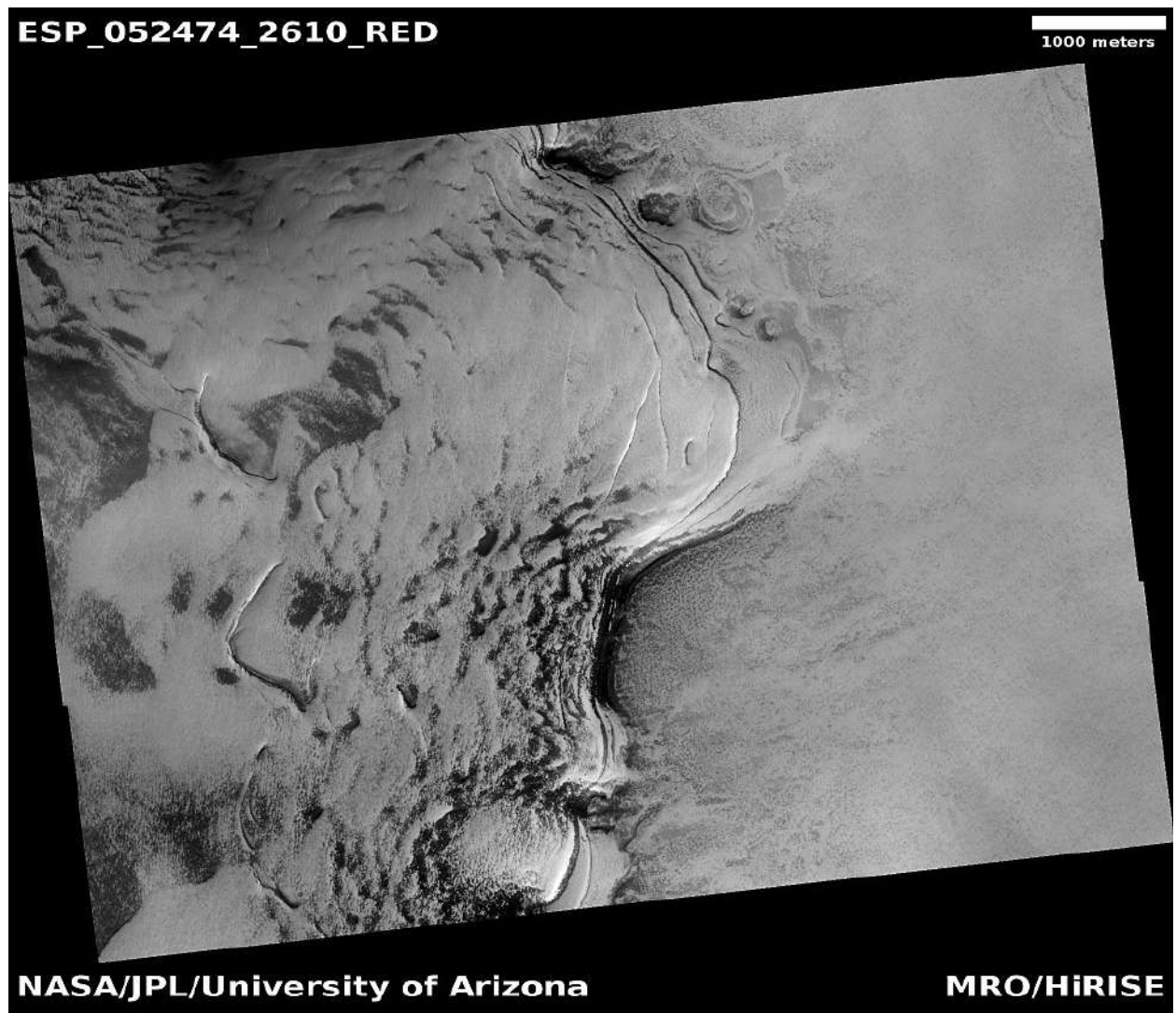


Figure 11.10: Ridges in Mare Boreum quadrangle, as seen by HiRISE under HiWish program.

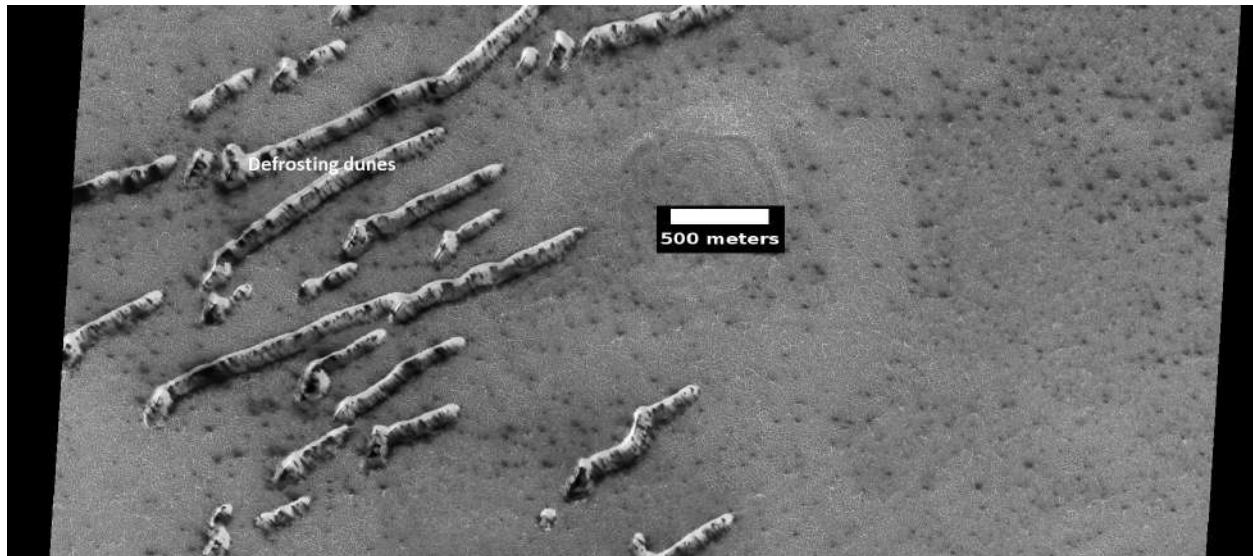


Figure 11.11: Defrosting dunes and ice in troughs of polygons, as seen by hirise under HiWish program (Mare Borium).



Figure 11.12: Defrosting dunes and ice in troughs of polygons, as seen by hirise under HiWish program, in color.

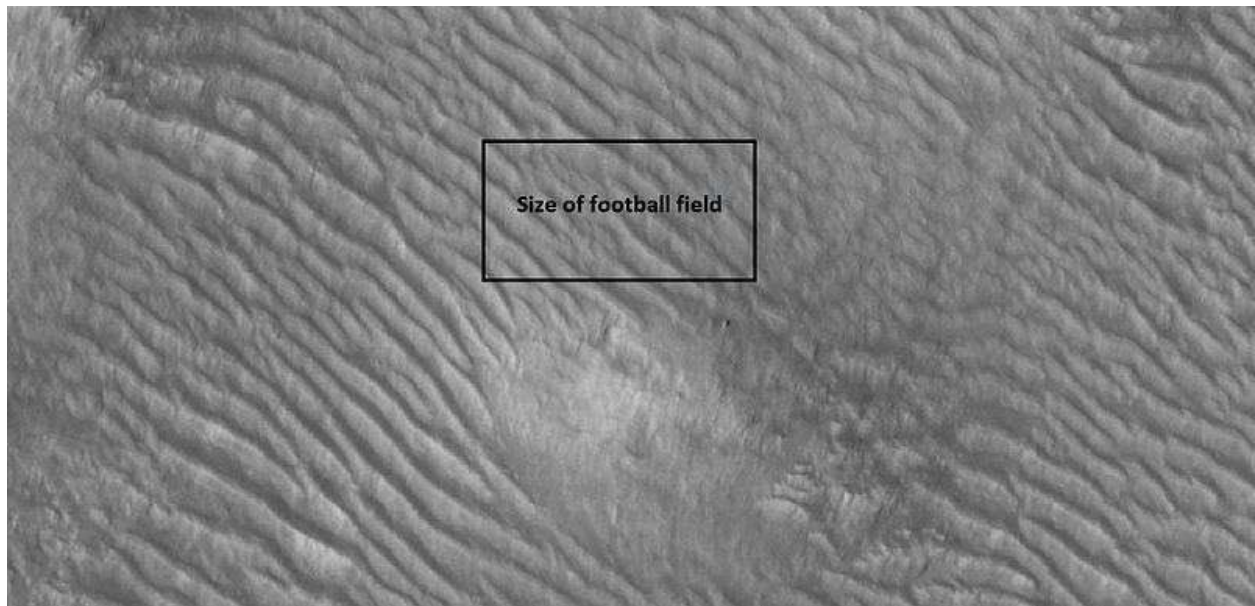


Figure 11.13: Close-up of ridges on crater floor, as seen by hirise under HiWish program. Location is 33.592 N and 219.564 E (Diacria quadangle).

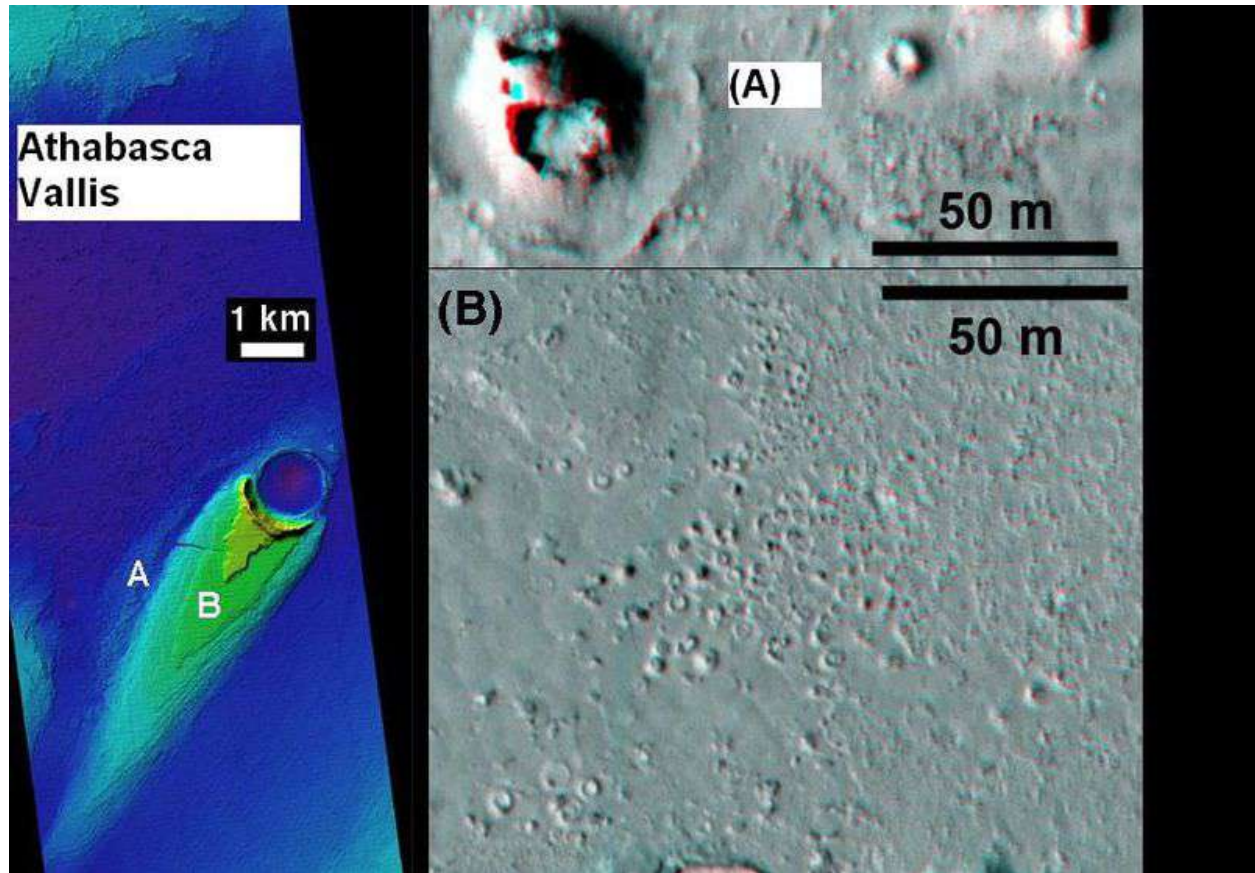


Figure 11.14: Cones in Athabasca Vallis, Elysium quadrangle, as seen by HiRISE. Cones were formed from lava interacting with ice. Larger cones in upper image were produced when water/steam forced its way through thicker layer of lava. Difference between highest elevation (red) to lowest (dark blue) is 170 m (560 ft).

11.4 The Cassini-Huygens space probe

The Wikipedia article on Cassini-Huygens gives the following description of the probe:

The Cassini-Huygens space-research mission, commonly called Cassini, involved a collaboration between NASA, the European Space Agency (ESA), and the Italian Space Agency (ASI) to send a probe to study the planet Saturn and its system, including its rings and natural satellites. The Flagship-class robotic spacecraft comprised both NASA's Cassini probe and ESA's Huygens lander, which landed on Saturn's largest moon, Titan. Cassini was the fourth space probe to visit Saturn and the first to enter its orbit. The two craft took their names from the astronomers Giovanni Cassini and Christiaan Huygens.

Launched aboard a Titan IVB/Centaur on October 15, 1997, Cassini was active in space for nearly 20 years, with 13 years spent orbiting Saturn and studying the planet and its system after entering orbit on July 1, 2004. The voyage to Saturn included flybys of Venus (April 1998 and July 1999), Earth (August 1999), the asteroid 2685 Masursky, and Jupiter (December 2000). The mission ended on September 15, 2017, when Cassini's trajectory took it into Saturn's upper atmosphere and it burned up in order to prevent any risk of contaminating Saturn's moons, which might have offered habitable environments to stowaway terrestrial microbes on the spacecraft. The mission is widely perceived to have been successful beyond expectations. NASA's Planetary Science Division Director, Jim Green, described Cassini-Huygens as a "mission of firsts", that has revolutionized human understanding of the Saturn system, including its moons and rings, and our understanding of where life might be found in the Solar System.

Cassini's planners originally scheduled a mission of four years, from June 2004 to May 2008. The mission was extended for another two years until September 2010, branded the Cassini Equinox Mission. The mission was extended a second and final time with the Cassini Solstice Mission, lasting another seven years until September 15, 2017, on which date Cassini was de-orbited to burn up in Saturn's upper atmosphere.

The Huygens module traveled with Cassini until its separation from the probe on December 25, 2004; it landed by parachute on Titan on January 14, 2005. It returned data to Earth for around 90 minutes, using the orbiter as a relay. This was the first landing ever accomplished in the outer Solar System and the first landing on a moon other than Earth's Moon.

At the end of its mission, the Cassini spacecraft executed its "Grand Finale": a number of risky passes through the gaps between Saturn and Saturn's inner rings. This phase aimed to maximize Cassini's scientific outcome before the spacecraft was disposed. The atmospheric entry of Cassini ended the mission, but analyses of the returned data will continue for many years.

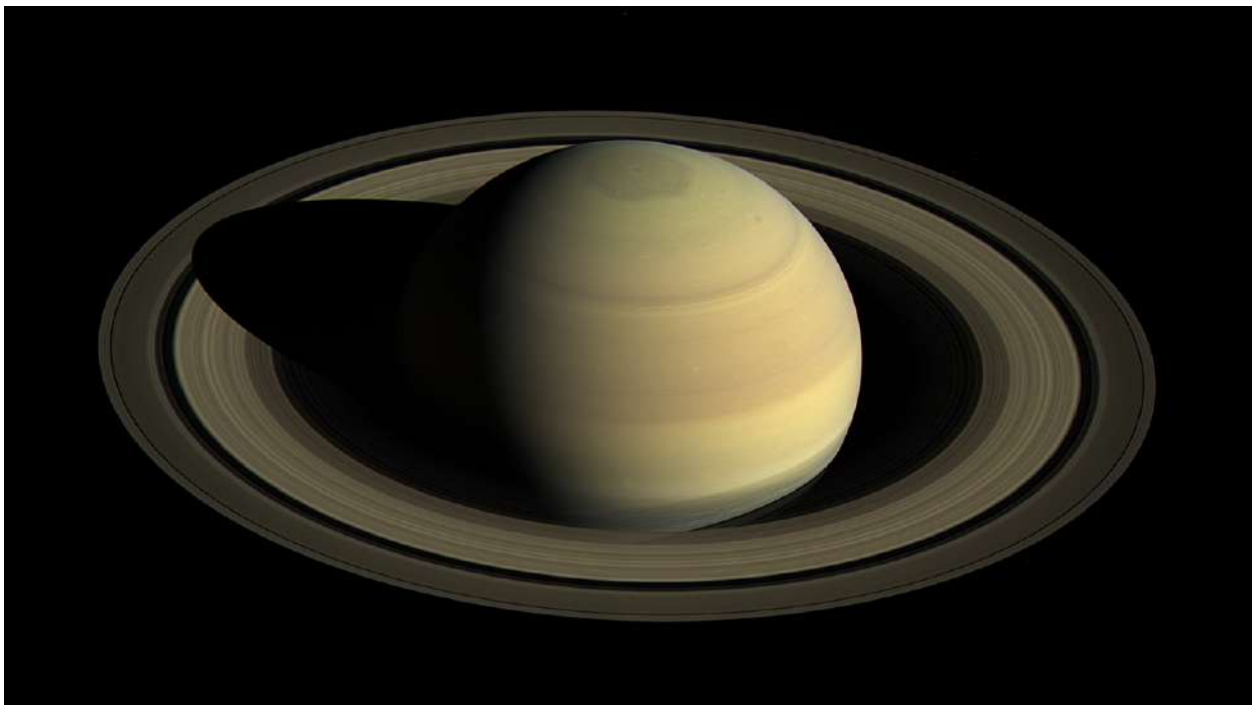


Figure 11.15: This view shows Saturn's northern hemisphere in 2016, as that part of the planet nears its northern hemisphere summer solstice in May 2017.

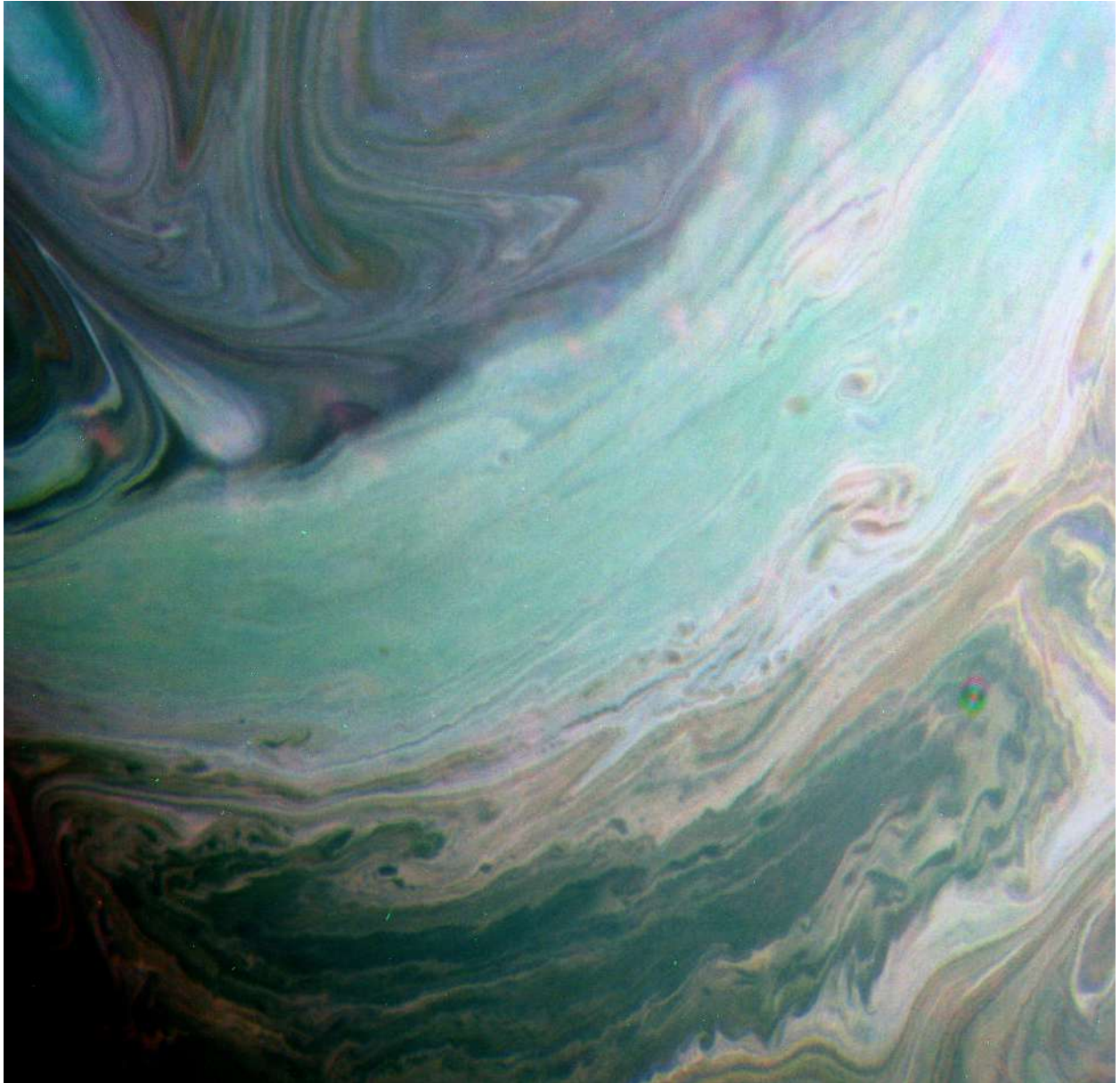


Figure 11.16: Amateur Image: Saturn in the Infrared: A false-color view of Saturn's clouds from Kevin M. Gill, a frequent amateur processor of space images.

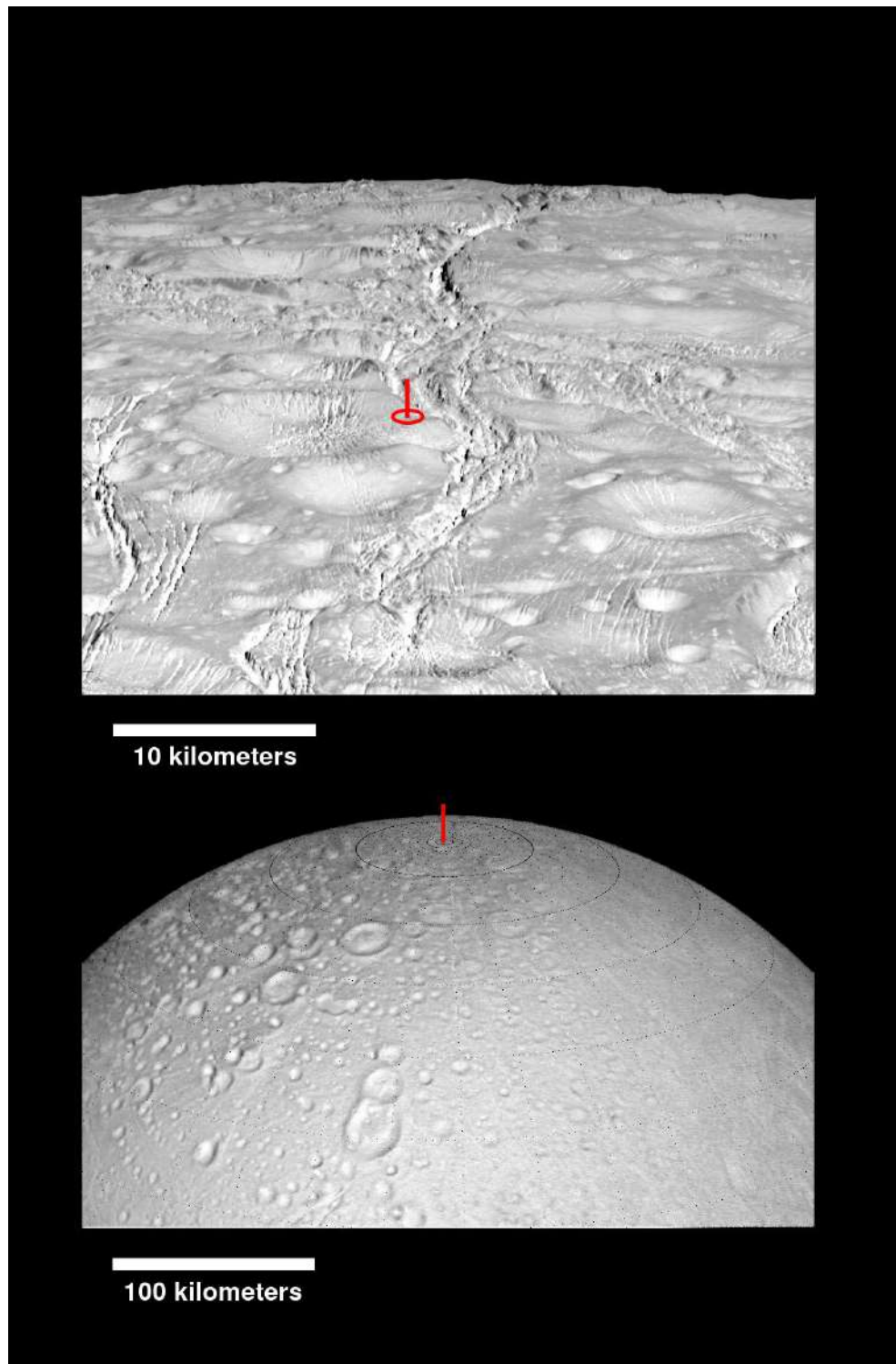


Figure 11.17: This montage of images shows the precise location of the north pole on Saturn's icy moon Enceladus. The snow-white surface is kept bright by material sprayed from the active plume of ice and vapor in the moon's south polar region.

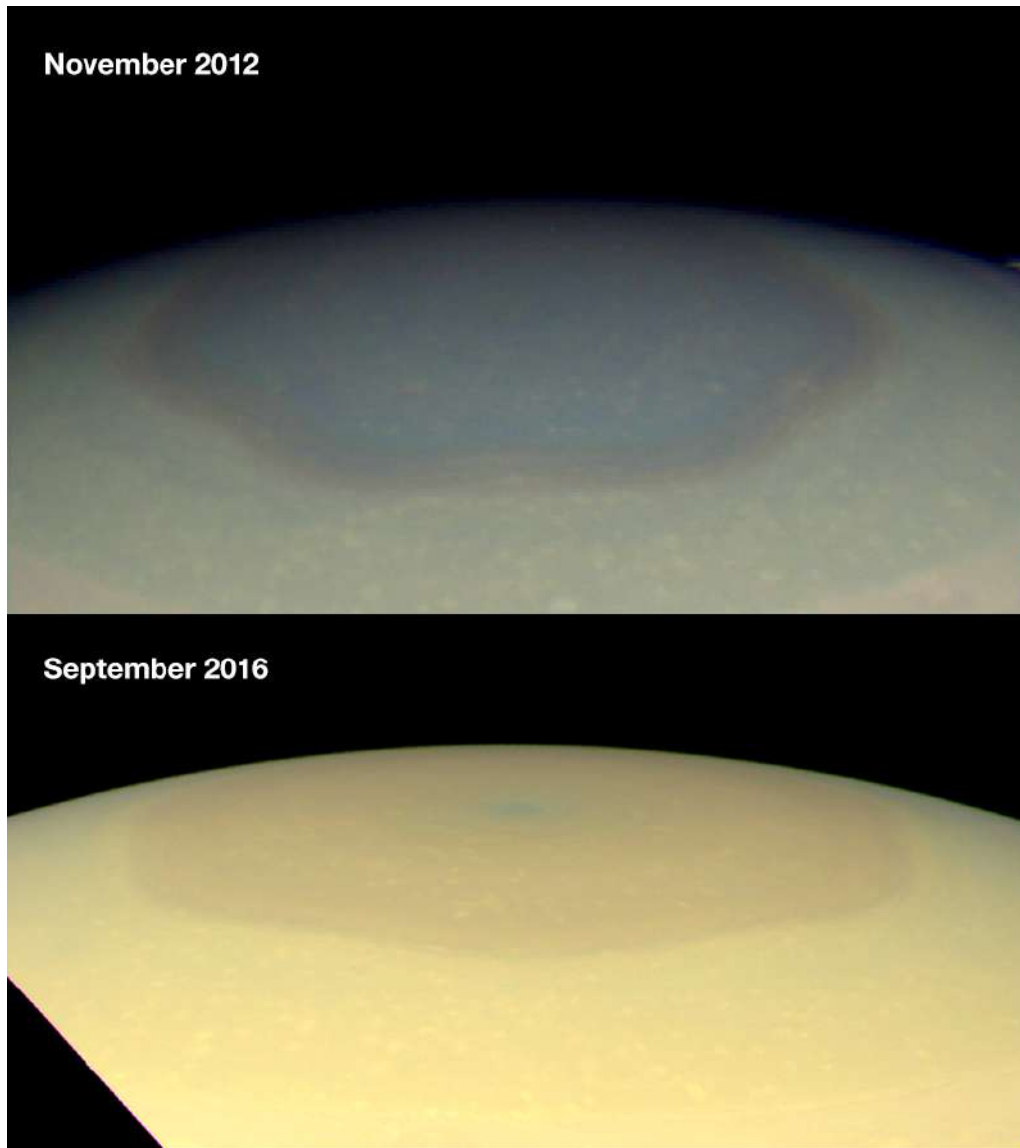


Figure 11.18: **Changing Colors in Saturn's North:** These two natural color images from Cassini show the changing appearance of Saturn's north polar region between 2012 and 2016.

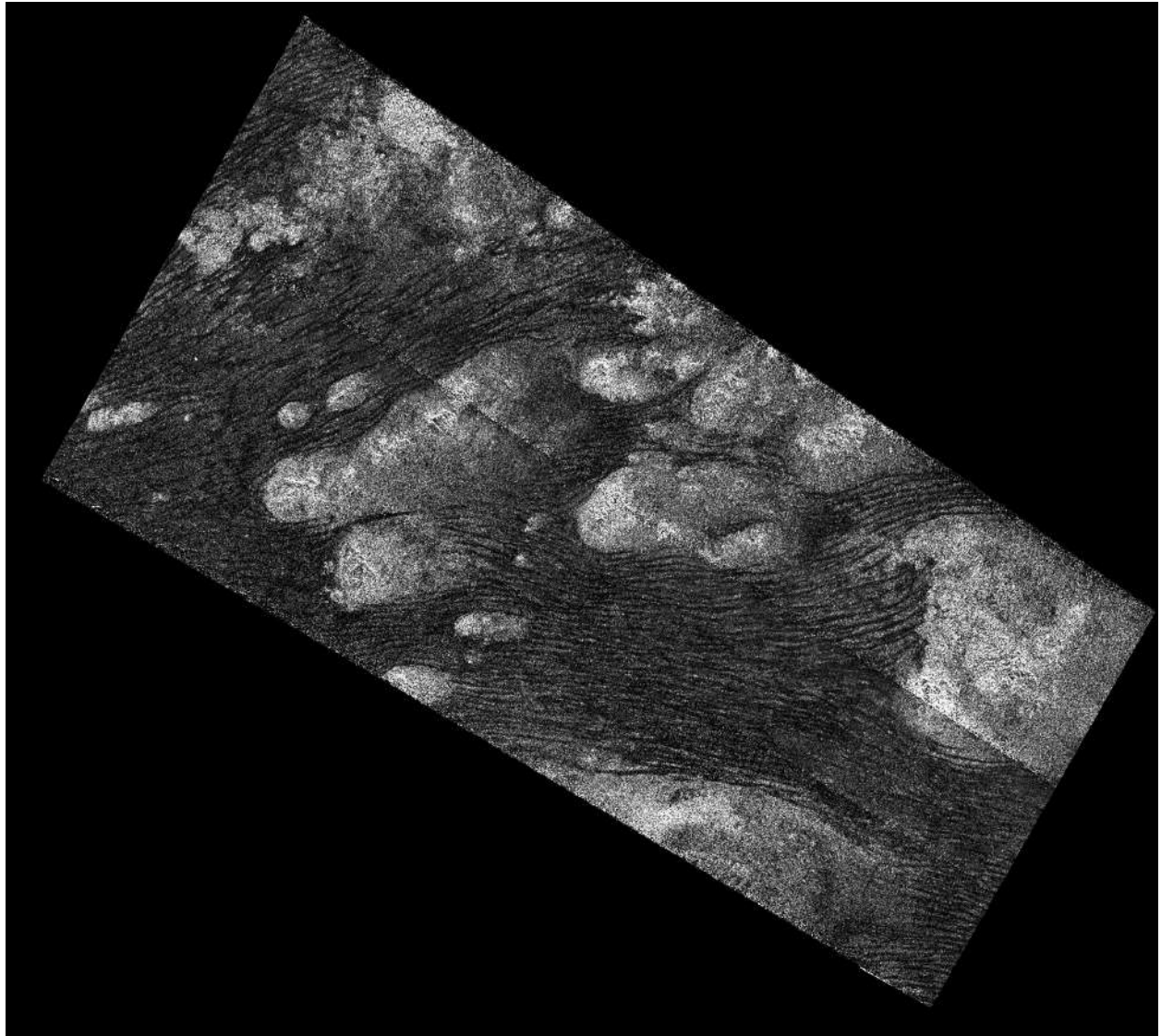


Figure 11.19: **Flowing Dunes of Shangri-La:** The Shangri-La Sand Sea on Titan is shown in this image from the Synthetic Aperture radar (SAR) on Cassini. Hundreds of sand dunes are visible as dark lines snaking across the surface. These dunes display patterns of undulation and divergence around elevated mountains (which appear bright to the radar), thereby showing the direction of wind and sand transport on the surface.

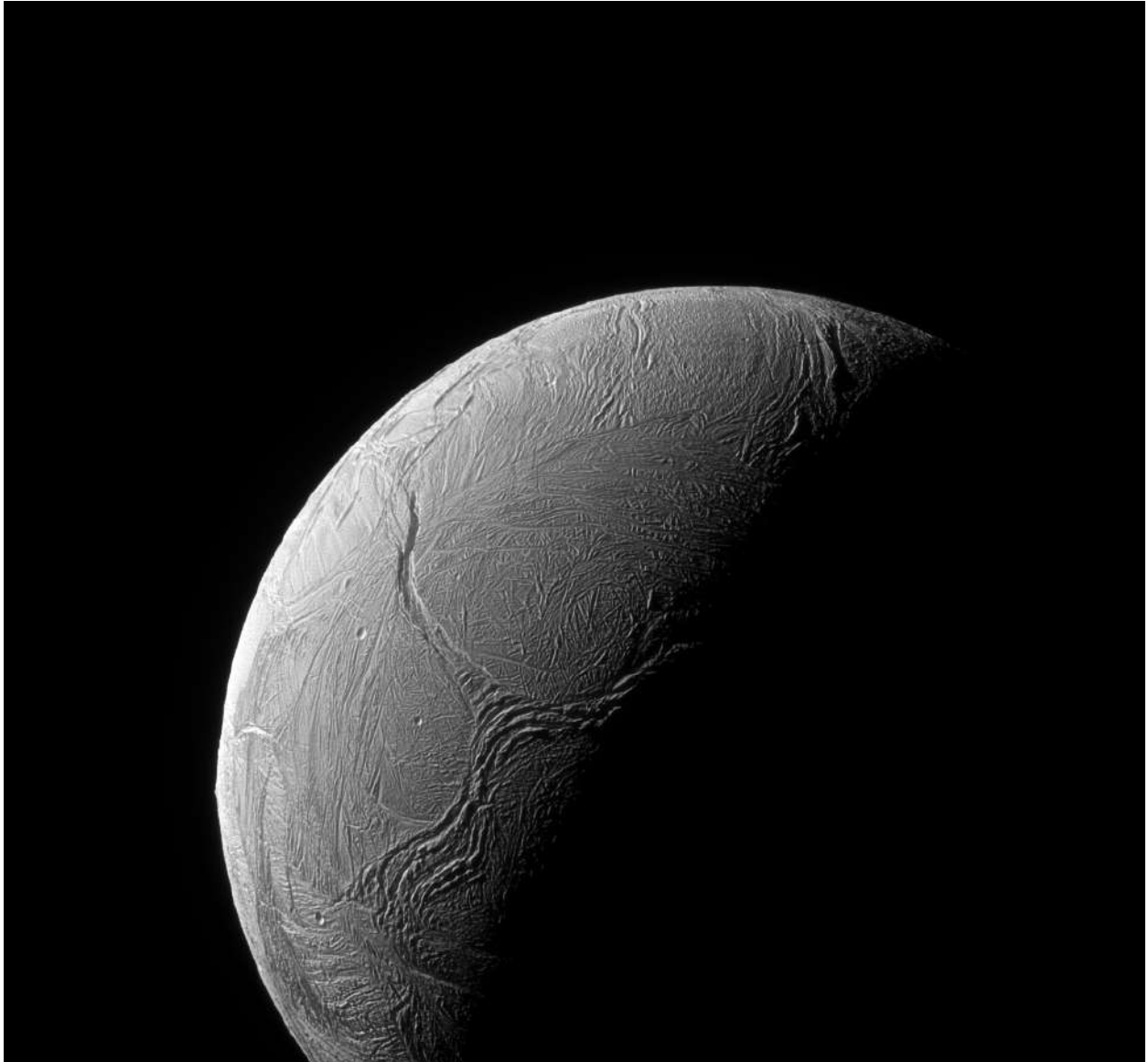


Figure 11.20: Y Marks the Spot: A sinuous feature snakes northward from Enceladus' south pole like a giant tentacle. This feature, which stretches from the terminator near center, toward upper left, is actually tectonic in nature, created by stresses in Enceladus' icy shell.

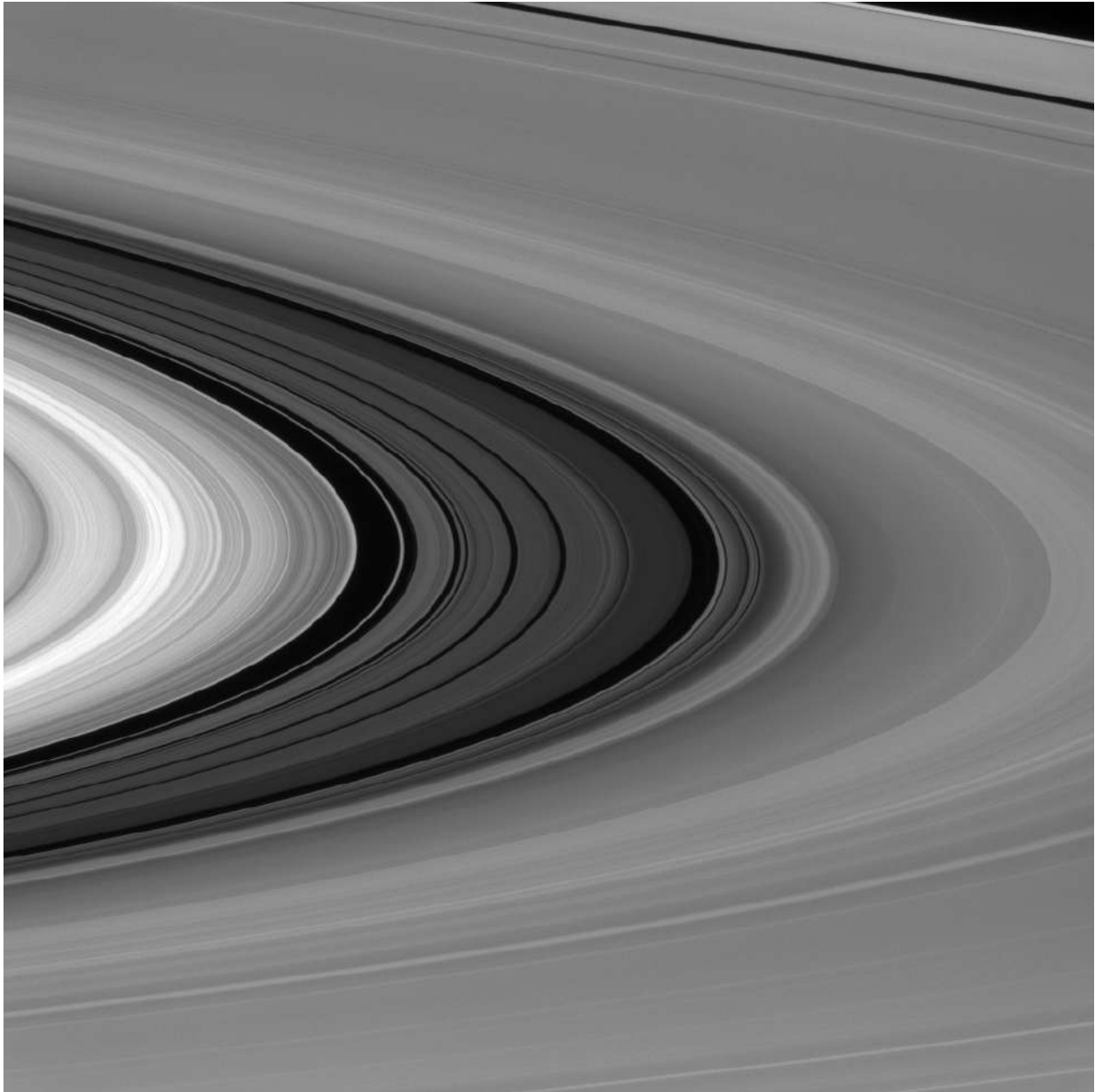


Figure 11.21: The Great Divide: It's difficult to get a sense of scale when viewing Saturn's rings, but the Cassini Division (seen here between the bright B ring and dimmer A ring) is almost as wide as the planet Mercury. The 2,980-mile-wide (4,800-kilometer-wide) division in Saturn's rings is thought to be caused by the moon Mimas. Particles within the division orbit Saturn almost exactly twice for every time that Mimas orbits, leading to a build-up of gravitational nudges from the moon. These repeated gravitational interactions sculpt the outer edge of the B ring and keep its particles from drifting into the Cassini Division.

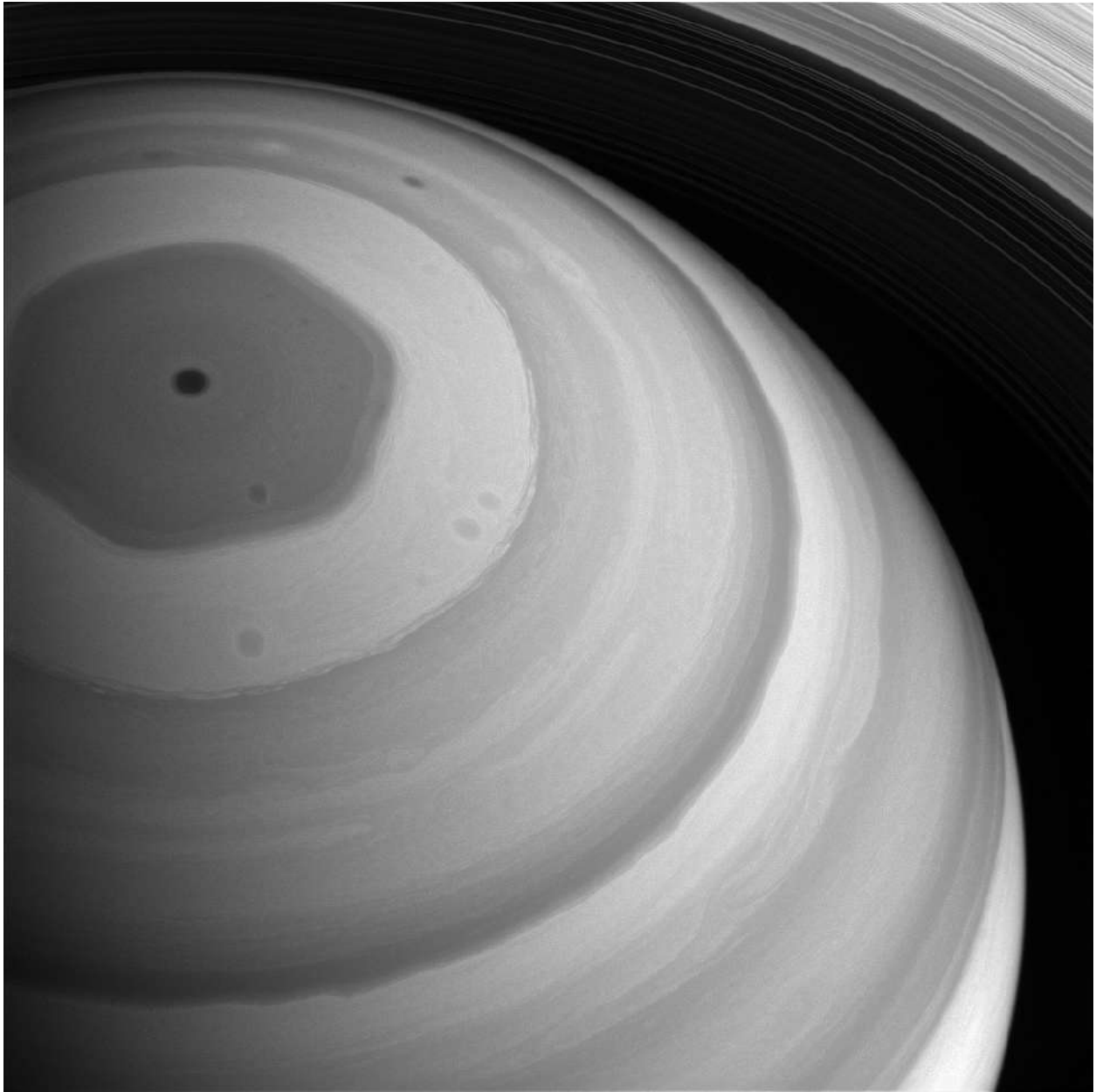


Figure 11.22: **Basking in Light:** Sunlight truly has come to Saturn's north pole. The whole northern region is bathed in sunlight in this view from late 2016, feeble though the light may be at Saturn's distant domain in the solar system. The hexagon-shaped jet-stream is fully illuminated here. In this image, the planet appears darker in regions where the cloud deck is lower, such the region interior to the hexagon.

11.5 Life elsewhere in the universe

Formation of the Sun and the Earth

Our local star, the Sun, was formed from molecular clouds in interstellar space, which had been produced by the explosion of earlier stars. Our Sun contains mainly hydrogen and a little helium, with very small amounts of heavier elements. The vast amounts of energy produced by the sun come mainly from a nuclear reaction in which hydrogen is converted into helium.

There were clouds of containing not only hydrogen and helium, but also heavier elements left swirling around the infant Sun. Gradually, over many millions of years, these condensed through a process of collision and accretion, to form the planets. In the four relatively small inner planets, Mercury, Venus, Earth and Mars, heavy elements predominate, while in the giants, Jupiter, Saturn, Uranus and Neptune, we find lighter elements.

The Sun accounts for 99.86% of the solar system's mass, while the four giant planets contain 99% of the remaining mass.

One *astronomical unit* (1 AU) is, by definition, the average distance of the earth from the sun, i.e. approximately 93 million miles or 150 million kilometers. In terms of this unit, the average distances of the planets from the sun are as follows: Mercury, 0.387 AU; Venus, 0.722 AU; Earth, 1.000 AU; Mars, 1.52 AU; Jupiter, 5.20 AU; Saturn, 9.58 AU; Uranus, 19.2 AU; Neptune, 30.1 AU.

The Solar System also includes the asteroid belt, which lies between the orbits of Mars and Jupiter; the Kuiper belt and scattered disc, which are populations of trans-Neptunian objects; the dwarf planets, Ceres, Pluto and Eris; and the comets. Many of the bodies in the solar system, including six of the planets, have natural satellites or moons. The Earth's moon was produced by collision with a Mars-sized body, soon after the formation of the Earth.

Of the four inner planets, the Earth is the only one that has large amounts of liquid water on its surface. When the Earth cooled sufficiently after the violent collision that gave us our Moon, oceans began to form, and life is believed to have originated in the oceans, approximately 3.8 billion years before the present.

Extremely early life on earth

On December 18, 2017, scientists from the University of California published an article in *Science News* entitled *Ancient fossil microorganisms indicate that life in the universe is common*. According to the article:

“A new analysis of the oldest known fossil microorganisms provides strong evidence to support an increasingly widespread understanding that life in the universe is common.

“The microorganisms, from Western Australia, are 3.465 billion years old. Scientists from UCLA and the University of Wisconsin-Madison report today in the journal *Proceedings of the National Academy of Sciences* that two of the species they studied appear to



Figure 11.23: Much experimental evidence supports the Standard Model of cosmology, according to which our Universe began in an enormously hot and dense state 15.72 billion years ago, from which it is exploding outward. By 10 billion years before the present it had cooled enough for the first stars to form. Our own local star, the Sun, was formed 4.54 billion years ago from dust clouds left when earlier stars exploded.

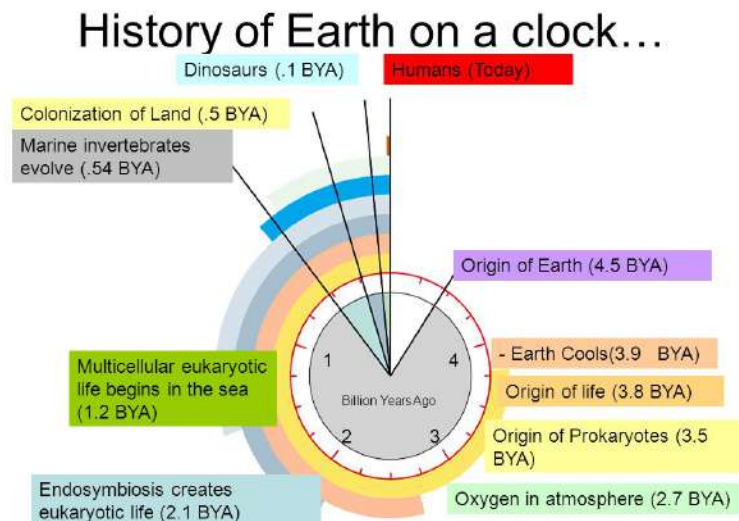


Figure 11.24: The Earth was formed 4.54 billion years ago. Life on earth originated approximately 3.8 billion years ago (3.8 BYA).



Figure 11.25: This figure shows the relative sizes of the planets. Closest to the Sun are the relatively small terrestrial planets, Mercury, Venus, Earth and Mars, composed of metals and rock. Farther out are two gas giants, Jupiter and Saturn, which are composed mainly of hydrogen and helium. Still farther out are two ice giants, Uranus and Neptune, which are composed mainly of frozen water, frozen ammonia and frozen methane. The distances of the planets from the Sun shown in this figure are not realistic. The planetary orbits lie in roughly in the same plane, which is called the ecliptic, and all the planets circle the Sun in the same direction.

have performed a primitive form of photosynthesis, another apparently produced methane gas, and two others appear to have consumed methane and used it to build their cell walls.

“The evidence that a diverse group of organisms had already evolved extremely early in the Earth’s history, combined with scientists’ knowledge of the vast number of stars in the universe and the growing understanding that planets orbit so many of them, strengthens the case for life existing elsewhere in the universe because it would be extremely unlikely that life formed quickly on Earth but did not arise anywhere else.”

Suggestions for further reading

1. James Gleick, *Moon Fever* [review of Oliver Morton, *The Moon: A History of the Future*; Apollo’s Muse: *The Moon in the Age of Photography*, an exhibition at the Metropolitan Museum of Art, New York City, 3 July - 22 September 2019]
2. Douglas Brinkley, *American Moonshot: John F. Kennedy and the Great Space Race*.
3. Brandon R. Brown, *The Apollo Chronicles: Engineering America’s First Moon Missions*.
4. Roger D. Launius, *Reaching for the Moon: A Short History of the Space Race*
5. *Apollo 11*, a documentary film directed by Todd Douglas Miller.
6. Michael Collins, *Carrying the Fire: An Astronaut’s Journeys (50th Anniversary Edition)*, *The New York Review of Books*, vol. LXVI, no. 13 (15 August 2019), pp. 54-58. “If we can put a man on the moon, why can’t we...?” became a cliché even before Apollo succeeded.... Now... the missing predicate is the urgent one: why can’t we stop destroying the climate of our own planet?... I say leave it [the moon] alone for a while.” (pp. 57-58.)
7. Terzian, Yervant; Bilson, Elizabeth, eds. (1997). *Carl Sagan’s Universe*. Cambridge; New York: Cambridge University Press.
8. Achenbach, Joel (1999). *Captured by Aliens: The Search for Life and Truth in a Very Large Universe*. New York: Simon & Schuster.
9. Davidson, Keay (1999). *Carl Sagan: A Life*. New York: John Wiley & Sons.
10. Poundstone, William (1999). *Carl Sagan: A Life in the Cosmos*. New York: Henry Holt and Company.
11. Spangenburg, Ray; Moser, Kit (2004). *Carl Sagan: A Biography*. Westport, CT: Greenwood Publishing Group.
12. Head, Tom, ed. (2006). *Conversations with Carl Sagan (1st ed.)*. Jackson, MS: University Press of Mississippi.
13. Morrison, David (2006). *Carl Sagan: The People’s Astronomer*. *AmeriQuests*. 3 (2).

Index

- Abbevillian, 12
- Abel Tasman, 121
- Agassiz, Louis, 163
- Age of the earth, 151
- Alexandria, 49
- Alpha-proteobacteria, 17
- Amerigo Vespucci, 115
- Amundsen, Roald, 178
- Anaerobic ecological niches, 17
- Ancestral adaptations, 161
- Ancient fossil microorganisms, 219
- Andes mountains, 153
- Anexagoras, 199
- Anthropoid apes, 11
- Apollo 11 lands on the Moon, 200
- Ardipithicus ramidus, 12
- Aristarchus, 199
- Aristotle, 49, 159
- Armstrong, Niel, 200
- Asteroid belt, 219
- Astronautics, 193
- Astronomical unit, 219
- Astronomy, 50
- Aud the Deep-Minded, 63
- Aurignacean, 12
- Australia, 154
- Australopithicus, 12
- Baer, Karl Ernst von, 160
- Barentsz, William, 169
- Barnacles, 158
- Beagle, 150
- Beetle collecting, 149
- Bering Strait land bridge, 34
- Bering, Vitus, 133
- Bishop of Oxford, 162
- Bonet, Charles, 150
- Books, 50
- Botany, 149
- Brain size, 14
- Brian, William Jennings, 163
- Broca's area, 12
- Broom, Robert, 12
- Buddhism, 93
- Cabot, John, 112
- Cambridge University, 149
- Cape Horn, 152
- Cassini, Giovanni, 210
- Cassini-Huygens space probe, 210
- Catastrophist school, 150
- Cell-surface antigens, 16
- Ceres, 219
- Chagas disease, 157
- Champlain, Samuel de, 131
- Changing colors in Saturn's north, 210
- Chartist movement, 158
- Checks on population growth, 159
- Chilian coast, 153
- Chimpanzees, 11
- Chomsky, Noam, 23
- Choukoutian, 12
- Christopher Columbus, 110
- Chronology, 50
- Clark, William, 134
- Classification of species, 160
- Columbus, Christopher, 110
- Comb-making instinct, 165
- Combustion of glucose, 17
- Comets, 219
- Compass, 94
- Concepcion, 153

- Congreve rockets bombard Copenhagen, 193
- Cook, James, 123
- Coral atolls, 156
- Cosmonaut Yuri Gagarin, 198
- Cultivation of potatoes, 35
- Cultural evolution, 11
- Cultural skills, 14

- Da Gama, Vasco, 115
- Darrow, Clarence, 163
- Dart, Raymond, 12
- Darwin, Charles, 15, 147
- Darwin, Erasmus, 147, 159
- Denmark, 63
- Descent of Man, 15, 162, 163
- Dillehay, Tom, 34
- Dispersal of modern humans, 18
- Diversity, 16
- DNA, mitochondrial, 16
- DNA, Y-chromosomal, 16
- Down, 157
- Drake, Sir Francis, 119
- Dubois, Eugene, 11
- Dwarf planets, 219

- Earliest people in the Americas, 34
- Earth, 219
- Eastern Eurasia, 17
- Eclipses, 50
- Ecology, 160
- Edinburgh University, 147
- Egypt, 50
- Embryos, 160, 161
- Enceladus, 210
- Endosymbionts, 17
- Eris, 219
- Ernest Shackleton, 180
- Ethology, 163
- European Space Agency, 210
- Evolution of human language, 11
- Evolution of language, 14
- Exodus from Africa, 16, 20
- Exploration of the Earth's Moon, 199
- Expression of emotions, 163
- Extinct animals, 152

- Falkland Islands, 152
- Family structure, 14
- Family tree, 160
- Female lines, 17
- Ferdinand Magellan, 117
- Finches, 154
- Finland, 63
- Fire, use of, 12
- FitzRoy, Robert, 149, 152, 162
- Flightless birds, 152
- Formation of the earth, 219
- Formation of the oceans, 219
- Formation of the Sun, 219
- Fossil animals, 154, 157
- Fossils, 11, 150
- FOXP2 gene, 15
- Frequency of mutations, 17
- Fridtjof Nansen, 175

- Galapagos Archipelago, 154, 157
- Gas giants, 219
- Gate of Grief, 20
- Genealogical classification, 160
- Genetic drift, 17
- Genetic lottery, 16
- Genetic predisposition, 165, 166
- Geography, 50
- Geology, 149, 150
- Giant armadillo, 152
- Giant sloth, 152
- Gibbons, Ann, 20
- Gills, 161
- Gorillas, 11
- Gracile skeletons, 14
- Grant, R.E., 147
- Greeks, 49
- Greenberg, Joseph, 22
- Guinea pig domestication, 35
- Gunpowder, 94

- Haekel, Ernst, 163

- Harold Finehair, 63
Helpless human babies, 15
Henry Hudson, 129
Henslow, John Stephens, 149, 156
Hero of Alexandria, 193
Herring gulls, 165
Hominids, 12
Homo erectus, 12
Homo habilis, 12
Homo sapiens, 12
Homologies, 161
Hooker, Sir Joseph, 158
Huaca Prieta, 34
Hudson, Henry, 129
Human language, 11
Human migration scenarios, 22
Human prehistory, 11, 16, 17
Humboldt, Alexander von, 149, 151
Hunter-gatherers, 14
Hutton, James, 150
Huxley, Thomas Henry, 11, 162, 163
Huygens module lands on Titan, 210
Huygens, Christian, 210

Iceland, 63
Immune systems, 16
Implicational universals, 23
Incas built terraces, 35
Inherited behavior patterns, 163
Ink, 93
Inner planets, 219
Insect-eating birds, 160
Instinctive behavior, 163
Instincts, 15, 160
Invertebrate zoology, 147
Ireland, 63
Italian Space Agency, 210

James Cook, 123
John Cabot, 112
Jupiter, 219

Kansas State School Board, 163
Kennedy, John F., 199

Kew Botanical Gardens, 158
Knud Rasmussen, 182
Kuiper belt, 219

L3 lineage, 17
Laetoli footprints, 12
Lake Rudolph, 12
Lamarck, Chevalier de, 147, 159
Land bridge, 154
Land of the Spotted Eagle, 38
Leaky, Louis and Mary, 12
Learning languages, 166
Lepidoptera, 151
Lewis and Clark expedition, 134
Lewis Meriwether, 134
Library at Alexandria, 49
Life elsewhere in the universe, 222
Life in the Solar System, 210
Linguistic ability, 20
Linguistic skills, 15
Linguistically-based prehistory, 22
Linnaeus, Carolus, 11
Linnean Society, 158
Liquid water, 219
Llama domestication, 35
Lorenz, Konrad, 165
Luther Standing Bear, 38
Lyceum, 49
Lyell's hypothesis, 150, 152
Lyell, Sir Charles, 150, 156–158

M and N lineages, 17
M168 mutation, 16
M242 mutation, 16
Magdalenian, 12
Magellan, Ferdinand, 117
Maize, squash and beans, 35
Male lines, 17
Malthus, T. Robert, 158
Man's Place in Nature, 163
Mars, 219
Marsupials, 154
Mellars, Sir Paul, 18, 20

- Mercury, 219
- Meriwether Lewis, 134
- Metallurgy, 94
- Mitochondrial DNA, 16, 17
- Mitochondrial Eve, 17
- Modification of species, 154
- Monkey Trial, 163
- Moons, 219
- Moustrian, 12
- Museum, 49
- Mussel shells, 153
- Mutations, 16
- My Indian Boyhood, 38
- My People, the Soux, 38

- Nansen, Fridtjof, 175
- NASA, 210
- NASA photographs of the Moon, 200
- Natural satellites, 219
- Natural selection, 158–160
- Nazi V2 rocket, 193
- Neanderthal man, 11, 12
- Neanderthals, 20
- Neptune, 219
- Neptunists, 150
- Norway, 63
- Nuclear reactions, 219

- Oldowan, 12
- Olduvai gorge, 12
- Omnivorous diet, 14
- Origin of Species, 157, 159, 162, 164
- Otters, 160
- Oxford University, 162
- Oxidative phosphorylation, 17
- Oxygen crisis, 17

- Pacific Islands, 154
- Pack leader, 166
- Papyrus, 50
- Parasites, 16
- Parasitic insects, 160
- Parchment, 50
- Peacock, George, 149

- Peary, Robert, 171
- Peking man, 12
- People walked from Siberia, 35
- Photographs returned by Cassini-Huygens, 210
- Photosynthesis, 17
- Piki Mach'ay, 35
- Pithecanthropus erectus, 11
- Pluto, 219
- Plutonists, 150
- Potato cultivation, 35
- Pre-Colombian Argentina, 35
- Predisposition to learn, 15
- Prehistoric family trees, 16
- Primate hand, 14
- Primes, 50
- Prince Henry the Navigator, 107
- Principles of Geology, 150
- Ptolemy I, 49

- Queen Elizabeth I, 35

- Radiocarbon dates, 34
- Radius of the earth, 50
- Raleigh, Sir Walter, 35
- Rampino, Michael R., 20
- Random variation, 160
- Rasmussen, Knud, 182
- Red Sea, 20
- Reef-building organisms, 156
- Roald Amundsen, 178
- Robert Falcon Scott, 176
- Robert Peary, 171
- Rocket timeline, 193
- Rockets used in warfare in China, 193
- Route down the Pacific coast, 35

- Saint-Hillaire, Etienne Geoffrey de, 159
- Salamander, 161
- Salamandra atra, 161
- Samuel de Champlain, 131
- Sand sea on Titan, 210
- Saturn, 219
- Saturn in the infrared, 210
- Saturn's northern hemisphere, 210

- Saturn's rings, 210
Scandinavia, 63
Scandinavian women, 63
Scattered disc, 219
Scopes Trial, 163
Scotland, 63
Scott, Robert Falcon, 176
Seals, 160
Sedgwick, Adam, 149, 156
Selection, 157
Self, Steven, 20
Serial homologies, 161
Sexual reproduction, 16
Shakleton, Ernest, 180
Sheep dogs, 166
Siberia-Alaska land bridge, 20
Sign stimulus, 165
Sinanthropus pekinensis, 12
Sir Francis Drake, 119
Skhul and Qafzeh, 20
Solar System's mass, 219
Solutrian, 12
South American species, 154
Soviet un-manned rocket Luna 2, 199
Space exploration, 193
Space race, 199
Species, modification of, 154
St. Jago, 151
Stone tools, 34
Struggle for existence, 159
Sub-Saharan Africa, 16
Subsiding regions, 156
Super-normal stimulus, 165
Sweden, 63
Systema Naturae, 11

Tasman, Abel, 121
Teaching of evolution, 163
Tendency to babble, 15
Three sisters, 35
Tierra del Fuego, 149, 152
Tinbergen, Nickolas, 165
Toba Catastrophe Theory, 20

Transmutation of species, 157

Underhill, Peter, 18
Uniformitarianism, 150
Upper Paleolithic technology, 20
Upright locomotion, 12
Uranus, 219

Vanderbilt University, 34
Variation under domestication, 159
Vasco da Gama, 115
Venus, 219
Vespucci, Amerigo, 115
Vestigial organs, 160
Virchow, Rudolf, 11
Vitus Bering, 133
Volcanic eruptions, 153
Volcanic islands, 154, 159
Voyage of the Beagle, 156

Wade, Lizzie, 34
Wade, Nicholas, 22
Wallace, Alfred Russell, 158, 159
Wedgwood estate at Maer, 156
Wedgwood, Emma, 157
Wedgwood, Josiah, 149
Western Eurasia, 16, 17
Whales, 160
Wilberforce, Samuel, 162
Wild horses, 152
William Barentsz, 169
William Clark, 134
Wolves, instincts of, 166
Writing, 94

X-chromosomes, 16

Y-Chromosomal Adam, 17
Y-chromosomal DNA, 16
Y-chromosomes, 16

Zoology, 149
Zoonomia, 147