PART 1

MATHEMATICS IN AFRICA AND THE MEDITERRANEAN REGION

CHAPTER 1

ANCIENT CIVILIZATION MATHEMATICS: AFRICA AS OUR BIRTHPLACE

Humanity likely originated in Africa several million years ago as it separated from the common ancestor that we share with chimpanzees. *Homo erectus* migrated to Asia, while *Homo neanderthalensis*, or the Neanderthals, migrated to Europe. However, those whom are considered to be humans today, *Homo sapiens*, actually originated in Africa 200,000 years ago and eventually replaced *H. erectus* and *H. neanderthalensis* in Asia and Europe. Our ideas of what we consider to be typically recognizable human characteristics, such as reliance on speech and abstract thought, places humans around 50,000 years ago.

It is commonly believed that humanity first evolved in the eastern regions of Africa in today's nations of Ethiopia and Kenya. Researchers have followed humanity's migration and settlements into Asia and Europe, across the Indonesian archipelago into Australia and over the Bering Straight into the Americas. Not surprisingly, mathematics developed in a similar manner. The earliest known mathematical object is the Lebombo bone found in the 1970s, which is estimated to have originated around 37,000 years ago in Swaziland in southern Africa and is named after the Lebombo Mountains. Found in the Border Cave, the Lebombo bone is a tally stick with 29 notches that

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may have marked the lunar calendar. The Ishango bone was found in the Ishango area of the Congo in 1960 and indicates prime numbers, positive integers that have only two unique factors, between 10 and 20, and a lunar calendar like the Lebombo bone. There has been speculation that the first tally sticks indicate a lunar calendar for the purpose of predicting female menstruation cycles, which means African females may have been the first to create mathematical instruments and history recognizes them as the earliest mathematicians. The Ishango bone was found by Belgian geologist Jean de Heinzelin de Braucourt and may be about 20,000 years old. Both the Lebombo and Ishango Bones are made from the fibula, or calf bone, of a baboon. Today, the Ishango bone is on display at the Royal Belgian Institute of Natural Sciences in Brussels, Belgium.

There is also evidence of the early use of tally sticks in Europe. In 1937, the Wolf bone was found in Czechoslovakia by Karl Absolon, which may be up to 30,000 years old. It had 55 notches set in groups of five. The first 25 notches are separated from the other 30 notches by having one notch double in size from the others. Also found in Europe, the famous Lascaux Cave paintings are a collection of cave images found in southwestern France in 1940. The paintings mainly depict humans and animals, but may also have indicated a lunar calendar with 29 markings. In 1950, Willard Libby, who discovered carbon-14 dating and received the Nobel Prize for it in 1960, famously dated the Lascaux Cave paintings. Libby found that there was only 15% of carbon-14 present, as would be found in plant-based paint in 1950. The formula for exponential decay is $A = Pe^{kt}$, where A is the new amount, in this case the amount of carbon-14, P is the original amount, k is the decay constant, t is the time elapsed, and e is Euler's number, which is approximately 2.7182818285. By knowing the half-life of carbon-14 to be roughly 5700 years, one could reason that since in 5700 years, we would have half of the carbon-14 present left from when an organic life-form died, in this case the planets that made up the plant-based paint, we can find the decay constant because $0.5P = Pe^{k(5700)}$. Solving for k gives us $0.5 = e^{5700k}$. Taking the natural logarithm of both sides of the equation gives us $\ln(0.5) = 5700k$, and

k is approximately equal to –0.0001216. Since Libby had found that only 15% of the original carbon-14 was present, we have $0.15P = Pe^{-0.0001216t}$. Solving for t gives us $0.15 = e^{-0.0001216t}$. Taking the natural logarithm of both sides of the equations gives us $\ln(0.15) = -0.0001216t$, and t is approximately equal to 15,600. This means the paint originated 15,600 years before 1950, which was 13,650 BCE.

The people who used the tally sticks were likely nomadic hunter–gatherers because they did not transition into an agricultural lifestyle, domesticating animals and plants, until about 10,000 years ago. It is argued that the shift from nomadic hunting–gathering to an agriculturally based system allowed for great social change for early humans. Since people became more sedentary, they gained the opportunity to begin the development of permanent settlements and stable civilizations. In fact, it is the environmental factors of good agricultural land, along with animals that are easy to domesticate, that has led noted physiologist and geographer Jared Diamond to conclude that history's most successful societies can be explained by access to these benefits.

As we shall see in later chapters, not all societies utilized the base 10 system, a system in which there are nine digits representing 1–9, a symbol for zero, and the number 10 being represented through the positioning of 1 and zero. Additionally, as we shall see, the zero took a very long time in development in human history. However, it should not be surprising that many societies, including our own modern societies throughout most of the world today, use base 10. Early humans had noticed that there was great convenience in using their fingers for counting and basic arithmetic, as many children and adults do today. Therefore, it made sense to consider the first 10 numbers as the foundation for a number system.

When numbers exceeded the number of fingers on human hands, people could turn to counting on their toes, which certainly becomes more cumbersome, but has been done in some civilizations. Another level of sophistication would be the use of the tally sticks, such as the use of the Lebombo, Ishango, and Wolf tally sticks.

For the ancient people, the next important use of mathematics was in their astronomical observations for religious purposes and tracking calendars, which would have often been connected in the celebration of holy days. Early humans, like humans of today, were fascinated by the night sky. There is mathematical regularity in the patterns found in observing the heavens. Calendar records have naturally arisen indicating each day that is designated by the rotation of the Earth, the monthly cycles of the Moon, and the yearly revolution around the Sun. We see evidence in the way the night sky influenced early mathematics in ancient Egypt, Babylon, China, India, and Greece. As humans developed stable agricultural societies, ruling and priestly classes began to develop due to societal surplus of goods. These classes would find the time to develop the mathematics of calendars for religious observances. Mathematics evolved for practical purposes such as civil affairs, including taxation, and better agricultural techniques. However, the night sky and its regularity could be considered an early birthplace of mathematics.

There is a connection between the night sky and religion. Early humans looked to the stars to find the divine. Today, this is manifested in the childhood belief in and our poetic fascination with Heaven residing in the clouds. For many cultures, the gods were found in constellations and planets. In school today, many students study the Greek names of constellations, and, even today, the planets in our solar system are named after the Greek and Roman gods. Jupiter is a Roman god, who is the greatest of gods, and equivalent to the Greek's Zeus. Saturn is the Roman equivalent to the Greek's Kronos, Neptune is the Greek's Poseidon, and Uranus is the name of a Greek god who is the father of Kronos and grandfather of Zeus. Pluto, no longer considered a planet, is the Roman name for the Greek's Hades. For the inner planets, Mercury is the Greek's Hermes, Venus is the Greek's Aphrodite, and Mars is the Greek's Ares.

The author of this book has always been fascinated by the constellations and night sky, and finds it appropriate that we can find such a connection between mathematics and the early civilizations. In a world that is ever changing as humans shape the landscape and environment around them, we can take comfort in the knowledge that when we gaze on the night sky, we are essentially viewing what ancient civilizations before us had viewed.