

# Ancient Alexandria

A collection of essays on a variety of themes



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## How did Hypatia's work contribute to the mathematics at the time?

Hypatia was a renowned mathematician and astrologer in ancient Alexandria. Known as a great advocate for female equality, she was one of the first known feminists in the world and changed the perception of women in these times. She worked in fields like geometry, algebra, number series, and arithmetic. Many of her theories in mathematics aided the understanding of space and set the ground for space travel and exploration. She was one of the first female mathematicians to be recorded and what is left tells us a very interesting story about her contributions to society and mathematics at the time.

Hypatia's contribution to mathematics was undeniable. Her work on ellipses in a cone helped astronomers at the time to gain an understanding of planetary and comet orbits. The intersections of a cone at different angles depicted the exact trajectory at which planets and asteroids orbit. These were ellipses, hyperbolas and parabolas, and they greatly helped other mathematicians to build on her work and push the boundary of human knowledge. In 1602, Kepler believed that the orbit of Mars was an oval. He later discovered, with the help of Hypatia's ellipses, that it was an ellipse with the Sun at its focus. With this having been discovered, great leaps were made in understanding the cosmos. Astronomers like Galileo and Newton were able to discover important things about the universe. Newton thought that if the Earth rotates around the Sun, something must draw it in – a constant fall. From this he created the famous Newton's cannon, the idea that at a certain height, with a certain power relative to weight, an object will rotate around the planet by constantly falling towards the centre of gravity.

At a young age, Hypatia was encouraged to pursue mathematics by her father, who was also a renowned mathematician. Her line of thinking was encouraged by her father, and ancient sources believe that she passed him intellectually at a very early age, not only in her work and in the legacy she set out, but by how she inspired women across the ancient world to go against the common sexist bias in society and work in complicated fields of understanding. Over the past hundred years, many female scientists and mathematicians have done so, inspired by Hypatia. This contribution meant that the field of scientific research and philosophical thinking is open to both men and women, in what was a previously male-only field.

Today, especially in the space programme, we see ellipses, hyperbolas and parabolas used to calculate the distance for a launch and how much fuel a shuttle will need to complete its journey. The work that Hypatia did was and still is the focal point of space travel, and it may prove to remain useful in reaching distant celestial bodies. Mathematicians have been able to build on this groundwork and further our understanding. Another very interesting use for ellipses is in manufacturing. Machines that build products in factories use these equations to make a perfect curve on things such as a football or a car windshield. Even medical devices such as the lithotripter, used to break up kidney stones, use manufactured, elliptical reflectors. Other famous examples of the application of ellipses are the statuary hall in the US Capitol building, the whispering galleries in Salt Lake City and the ellipse garden in front of the White House.

One of Hypatia's greatest achievements was her development of the astrolabe, a device that is a model of the universe. It helps mathematicians to solve complex equations about cosmology and space. The astrolabe was in common use for almost 1,600 years, until the invention of the advanced computers made it easier to solve these equations. In around the 10th century, an astronomer deduced that there were over 1,000 uses for this intricate device, and this was the reason it was commonly used in the Islamic, Roman, French and British empires. According to some mathematicians and historians, the astrolabe was the most sophisticated device used during the Medieval and Renaissance periods, even though it had been invented by Hypatia over a thousand years before. This device was used to locate the direction of Mecca from certain mosques around the world and dictates where people from many religions believe Jerusalem is located in relation their place of worship.

Ellipses have been used to create radars with a perfect curve; this means that we gain accurate signals from afar, and we are also able to locate nearby moving objects. Radars have allowed our military to advance in their technological prowess and to ensure our safety. As well as being used by scientists to further our knowledge of the space around us, our global communication network is in debt to Hypatia's work. This is due to the orbits of the satellites and the curve of the radar on them.

Hypatia's contribution to mathematics at the time was immense; her work on ellipses and astrolabes furthered the understanding of the universe and helped women across the world to believe that they could become an intellectual part of society. Without her work we would have missed the work of thousands of women since her time, due to the sexist bias in Alexandria. The effect that she has had on space travel and contemporary mass manufacturing has left a

great legacy. Computers use her equations to manufacture basic products such as balls and windshields, and technology like satellites and radars has been immense. The communications network that we have in place can trace back their origin to the work that Hypatia did on conic section, and the world would not have progressed so far by now, if Hypatia never completed this work. Hypatia contributed to mathematics in a multitude of ways, moving technology forward at the time with the astrolabe, and also today with orbits, space travel, manufacturing and communications. Society today is greatly in debt to her work, and she deserves far more recognition than she gets.

**Sarah-Jane Davidson and Felix Boegh-Nielsen**

**Is the geography of Alexandria a blessing or a curse  
and how did it come to be the most prosperous city  
in the world at one time?**

At the fingertips of Africa's longest river and perched on the glistening Mediterranean Sea, you will find the once most prosperous city of Egypt. Just by looking at its size, one begins to wonder how Alexandria became so powerful, a hub for tourism and business. However, today's high-rise glass buildings and the hubbub of the traffic below give no clue to the chequered history of the city. The most significant monument to Alexandria's days of glory, once an ancient wonder of the world, is now buried under the sea.

Founded by Alexander the Great, by 365CE it was the most prominent commercial and cultural center of the Graeco-Roman world. A flourishing city, it was a place of rest for every sailor, merchant and traveller. Located on the northern coast of Egypt, the city is a short sail away from Greece and Italy. From here, the surplus of wheat from the Nile Valley was shipped to Rome. Africa's largest river connects Alexandria to the farming regions of Egypt, Sudan, and Ethiopia, flowing 6,650km from Lake Victoria. These geographical advantages placed Alexandria as the most powerful city in Africa. However, the location was both a blessing and a curse, which led to the expansion and destruction of the economic powerhouse.

**Benefits**



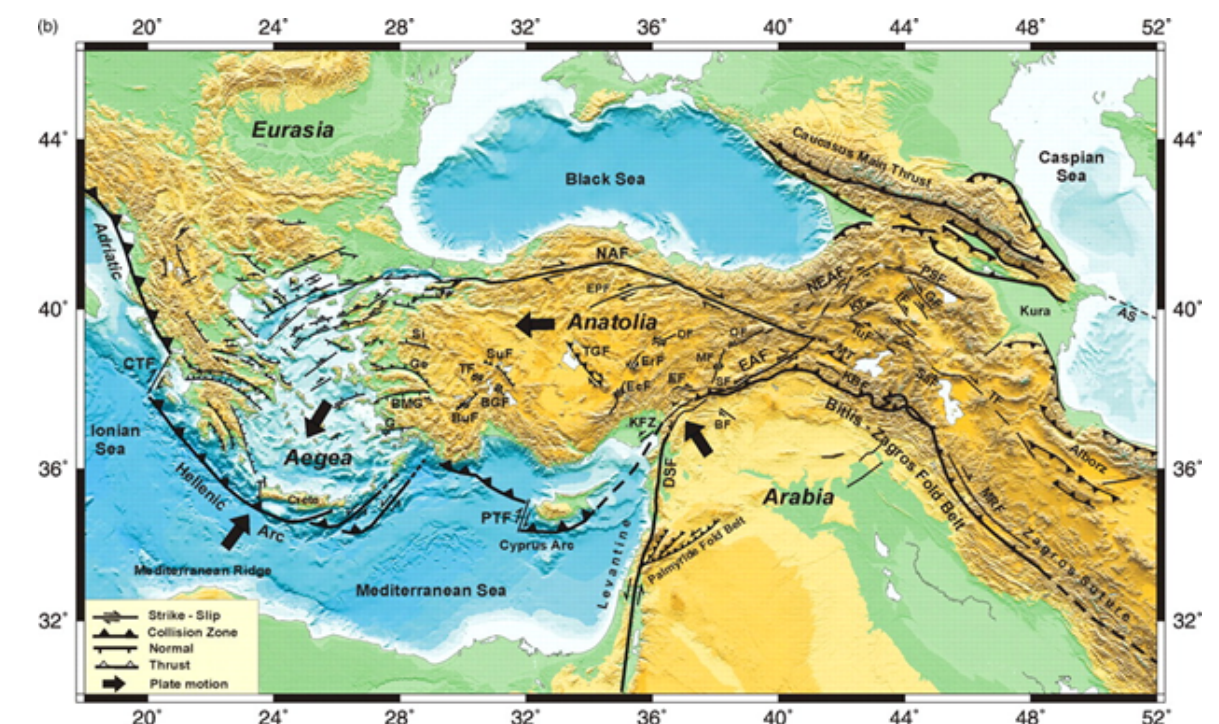
Alexandria's location 20 miles west of the Nile's mouth promoted the city's growth as a trading hub. The proximity to Rome and placement in the Nile Delta defined the trading and economic success of the city. The delta contains mineral-rich super-fertile soil ideal for crop cultivation, especially papyrus and grains. Furthermore, the Egyptians already cultivated the delta with highly sophisticated infrastructure, such as canals and irrigation. A good season could feed the Egyptian population for a year and profit on trade. The grain supply later supported one third of Rome's total annual grain consumption. Alexandria, as the nearest and largest port city close to farms and a short distance away from Rome, became the hot depot for food. Canals connected from the Nile to Lake Mariotis, linking agriculture from Upper Egypt and the Red Sea trade to the Mediterranean, creating even more trade routes passing through. In Alexandria, intermediaries bartered for profit and spent money in the city; merchants from the east sold exotic products to a curious collection of Romans, Greeks and native Egyptians. Merchants invested in gigantic ships to jump in the profitable grain trade. Therefore, more coins circulated in the city and made it rich. With this money, the Ptolemies created the most significant hub of knowledge in ancient times. The geography of the entire Mediterranean and the Nile was an economic blessing to Alexandria.



Alexander created Alexandria on a spit of land not only because he saw Homer in a dream telling him to go to Pharos, but because he recognised the strategic importance of the location. The hinterland is almost an island, facing the rocky Mediterranean to the north and Lake Mariotis to the south, connected by a canal to the Nile. Two masses of water separate the

city from interior Egypt and Rome. The situation is very similar to many modern-day trading hubs: the Hudson River and the misleadingly named East River (it is not a river) divide Manhattan, while Hong Kong is an island. The delocalised location separates people from their own culture allowing them to mingle in neutrality – precisely what is needed for a trading hub to develop. This ambivalence allowed Alexandria to accept many different customs without significant controversies, necessary when Egyptians might grow angry at the Greek conquerors. Furthermore, the presence of water allowed the development of the ancient world's largest natural port, a link between the Nile and the Mediterranean to promote international trade, and a freshwater supply in a coastal city to maintain a settled population. Therefore, the local geography of Alexandria created ideal conditions for a trading port.

### Curses



Alexandria lies on the north-eastern tip of the African tectonic plate, lying relatively near the Dead Sea fault; the western coast directly faces the Hellenic Arc and Crete. The 365CE Cretan earthquake (magnitude 8.5+, seafloor earthquake, epicentre north-west of Crete) sent shockwaves around the region and caused a massive tsunami. The wall of water travelled at almost 500 miles per hour across the Mediterranean and struck Alexandria, killing as many as 50,000 people. The catastrophe devastated the economy, destroying many important infrastructures (e.g. the royal palaces), Cleopatra's Needles, and hundreds of ships crucial to a trading city. After the tsunami, a constant underlying fear loomed over Alexandria. With no one



fully understanding what caused it, and earthquakes continuing to occur, the city lost its confidence as a seaport. Eventually, the center of power moved deeper inland, as before Greek times, to Cairo. The grand canals connecting Lake Mariotis to the Nile fell into disrepair and caved in, severing Alexandria's connection to internal Egypt. With no access inland, where many migrated to in fear of tsunamis, the city lost much of its economic prominence. But this single and sudden act of nature, while destructive, was perhaps not as damaging as the internal religious conflict that plagued the city for centuries afterwards.



(Cyril I, Patriarch of Alexandria)

Alexandria, although seen as a city of prosperity and wealth, also became home to much religious conflict between Christianity and Paganism. The thriving economy attracted thousands from all over the world, creating a diverse, multicultural city. Despite the implied benefits, diversity also brought disadvantages. Alexandria became a constant religious battlefield, while different rulers tried to eradicate Paganism. Theodosius I was the first to try, just 15 years after the tsunami, as the city was rebuilding. He outlawed Paganism and encouraged the adoption of Nicene Christianity. Following in his footsteps, his successor Theophilus destroyed all the Pagan temples in Alexandria or converted them into churches. By 400CE, Alexandria churned in perpetual religious strife; an angry Christian mob murdered the Neoplatonic philosopher Hypatia and set aflame multiple buildings. Cyril of Alexandria was enthroned in 412CE and titled himself Pillar of the Faith and Seal of all the Fathers. He expelled people of the Novation Christian sect and the Jewish community, and it was under his influence that an angry Christian mob murdered Hypatia. After this date, the city rapidly declined; philosophers, scholars and scientists all left in search of safer communities.

Alexandria became a frequent 'no man's land' where different religions fought for power. In 619CE, the Sassanid Persians dominated; in 628CE, it was the Christian Byzantines, and in 641CE, the Arab Muslims. After years of conflict, Alexandria became dominated for several centuries by the Islamic faith and its power lasted until 1250CE. Then, throughout the Middle Ages (periods of Mamluk and Ottoman rule), wars, strife and nature destroyed the academic legacy of the city and the few scores of philosophers remaining finally left. The central and channelling geography of Alexandria funnelled conflicting religions, leading to a perpetual destabilisation of the city.

Charlotte Farrell and June Hyun

## Why was Alexandria home to so many different religions, and to what extent did this affect the culture of the city?

Alexandria was home to a plethora of religions over the course of the classical period. Indeed, it was this mass number of religions that resulted in Alexandria becoming the cultural hub of the classical era, where scholars, politicians, artists and rulers chose to spend their time. But after the annexation of Egypt by Alexander the Great, how did Egypt grow from a Greek colony to the height of cultural diversity during the Ptolemaic years and, specifically, why did Alexandria house so many religions and to what extent did this affect the city?

Within classical Alexandria there were five notable religious movements: Judaism, Greek and Roman deities, Oriental religions, Christianity and, of course, Egyptian culture. The appeal of Alexandria was its literature. The Library of Alexandria is estimated to have held roughly 100,000 scrolls, on all manner of topics, chronicling history, science, design and stories. For many global scholars, the appeal of this city and its rich fountain of knowledge was too strong to quell and thus they journeyed there, with immigrants arriving from the Greek and (later) Roman empires. They brought with them their own cultures and religions. A statue shows Trojan priest Laocoon and his two sons being devoured by snakes. The depiction of this story, derived from a Greek myth, displays the scope to which Alexandria contained Hellenistic religious influences. This is partially due to the Ptolemaic rulers' Greek roots and partly due to scholarly influence on the city.

Ancient Alexandria was also home to the world's largest population of Jewish people, with the first records of Jews practising their faith in the city dating back to 331BCE. The Jewish community greatly impacted both the culture of the city and the culture of the classical world. It was Jewish scholars in Alexandria who translated the Torah into classical Greek. This book was called the *Septuagint*. Greek at the time was an almost universally spoken language in the stretch of territory conquered by Alexander of Macedon (commonly known as Alexander the Great), and thus allowed for the spreading of Jewish culture across Europe and the Eastern Territories. The Torah radically reformed thought throughout the Near East, because of its message of egalitarian values and the rule of law rather than the law of rule. It was thought processes like those which, although they did not convert people to Judaism, helped the intellectual elite of the world gain a perspective on the style of leadership the Roman Republic would later adopt.

As well as the development of current religions, Ancient Alexandria also saw the merging of religious cultures, as for the citizens these different theistic beliefs had all become valid. In depictions of Christian culture, and specifically the Christmas story, we see a depiction of the Virgin Mary (mother to Jesus) portrayed as the Egyptian goddess Isis (who had subsequently been deified by Greco-Roman culture). This fluid use of figures in an interwoven web of religions displays how Alexandrians adopted all the religions that entered the city, as well as the fluidity in their art and portrayals of the deities and holy figures.

Moreover, religion had a huge impact on the artistic culture of Ancient Alexandria. Aside from the aforementioned artistic portrayals, art was everywhere in Ancient Alexandria, especially in the form of sculptures or tapestries depicting various deities. Even its famous library was dedicated to the Muses – the nine Greek Goddesses of the Arts whose statues decorate the ruins of the library. Music was a well-established part of Egyptian culture at that time and was very much influenced by religion. Along with dance, music was often associated with the divine, and was incorporated into spiritual rituals and events such as funerals. Additionally, when used in religious ceremonies, music was thought to elevate participants towards a closer relationship with the deity.

To conclude, the liberal and intellectual culture of Ancient Alexandria led to a rise in a multitude of popular religions that dominated mainstream thought. By passing through the world's intellectual hub, they forever rooted themselves in the city and ensured that they would be spread by scholars across the Near Eastern and Western worlds.

**Shreya Grover and Alexander Newman**

## What evidence is there for the languages one would have heard spoken in Alexandria from its foundation to the death of Hypatia?

There were many different languages that were spoken during different periods, from 331BCE (when Alexandria was founded), up to the death of Hypatia in 415CE, and some proved to be more influential than others.

Ancient Alexandria was founded in 331BCE by Alexander the Great, who served as the King of Macedonia from 336BCE to 323BCE, and who was ruler of the Persian Empire. Alexandria was the capital of his new Egyptian dominion and became known for 'housing the knowledge of the world'. Many philosophers, mathematicians, historians, and scientists flooded into the prestigious city to continue their studies, making Alexandria one of the most powerful cities in the world at the time. It was said that Alexander named 70 settlements 'Alexandria', however the most famous city was the 'Alexandria' in Egypt.

Greek was the 'official' language spoken by the Egyptians in 331BCE and was probably the most common. However, Alexander the Great respected the culture of the places he conquered, and allowed their customs to continue, and is also considered as being 'responsible' for the blending of cultures, with the Greeks in Egypt coming into contact with cultures from Asia and Africa. Significantly, Alexander's conquests spread Greek culture, also known as 'Hellenism', and his reign marked the beginning of the 'Hellenistic Age' due to the powerful influence Greek culture had on many people. Hence, Alexandria's most dominant socio-economic group spoke Greek and many legal documents were written in Greek. This policy of fusing cultures adopted by Alexander led to a diversity of language in Alexandria.

Symbolically, the Library of Alexandria was almost like the 'hub' for literature and other studies, where scholars and rulers contributed their books to make up the immense library containing up to 70,000 papyrus scrolls. Books in the library were mainly written in Greek and Egyptian, and an example of a Greek book written in the early 3rd century was the *History of Babylonia*, written by a priest named Berosus, which quickly became known throughout Egypt. Building on the library started in 305BCE and was completed in 246BCE. It was of linguistic importance because it was a collation of texts in a variety of languages and contained some translations, which made knowledge more accessible. Then, during Julius Caesar's short one-year Roman rule over Egypt, the library was burned and destroyed, when Caesar laid siege to Egypt in 47BCE.

What signified the end of the Hellenistic Ptolemaic period, and the beginning of the Roman rule over Ancient Egypt, was the battle of Actium in 31BCE between the fleet of Octavian and the combined forces of Mark Antony and the queen Cleopatra of Egypt. It was during this time that the descendant of Ancient Egyptian, the Coptic language, was developed. Coptic was a northern Afro-Asiatic language that was widely spoken and read.

With Alexandria situated on the coast of the most travelled sea in the ancient world and on the banks of the Nile Delta, it can be inferred that it would have been an easy access route for foreigners to come into the city, bringing different native tongues along with them, widening the spectrum of languages spoken. Coptic was a commonly spoken language, with several dialects identified, and was the latest stage of the Egyptian language. Two of the most prominent dialects were Sahidic and Bohairic, both of which originated from Arabic. Sahidic was considered the standard Coptic spoken in Upper Egypt, whereas as Bohairic was originally spoken in the Western part of Lower Egypt, including Alexandria.

Moreover, the Demotic language was an Ancient Egyptian script, deriving from forms of Hieratic used in the Nile Delta. Hieratic is the name of the cursive writing seen in the Egyptian language, and Demotic was used as a significant language in everyday business of Egypt. During the years after the end of the Ptolemaic kingdom, after the death of Cleopatra in 30BCE, Demotic continued to grow, being found in letters, contracts, wills and legal documents. Many prestigious works of literature are written from Roman-period Demotic texts.

The Greek language proved its dominance through the translation of the Greek Bible, which was completed in 132CE in Alexandria. With the Christian Bible now placed as an important book in Alexandria, one could argue that this was a turning point in the rise in popularity of the Christian religion throughout the city because it became more widely available. This led to underlying tension between the Jews, Pagans and Christians. Whereas Paganism had been valued and respected in the early years of Alexandria's creation, the Pagans who had once thrived with their studies of philosophy, astronomy and many more, were now becoming dominated by the Christian zealots who believed Christianity should be the focal point of all religions.

This dispute between the religions then led to the death of one of the greatest mathematicians and astronomers at the time: Hypatia. She was the leader of the last Greek school of philosophy and Neoplatonism in Alexandria. Hypatia was also known for defying the profound sexism in society during the Roman rule. This significant event provoked many philosophers, scholars and



scientists with different beliefs and ideas of the world to leave the city to retreat to safer places, marking the end of Paganism and the triumph of Christianity in the ancient city of Alexandria.

So, from this, we can see the different language links there were to Arabic and the Ancient Egyptian language (including Coptic and Demotic, and their input into Egyptian literature) as well as the significance of Greek, which was a compelling language during Alexander the Great's reign and also during the time up to Hypatia's death.

**Maddie Halliday and Michel Quist**

### **How did Eratosthenes calculate the circumference of the Earth, and what were the implications of his discovery?**

Eratosthenes was a librarian, geographer, mathematician, astronomer, historian and poet. He was born in 276BCE in Cyrene, Libya, and died in 194BCE in Alexandria in Egypt. After studying in Alexandria and Athens, Eratosthenes lived in Alexandria in 255BCE and became the director of the great library there. He started writing and some of his famous works included a poem inspired by astronomy, as well as works on theatre and ethics. Eratosthenes was affected by blindness later in his life, and many people assumed that he had committed suicide by voluntary starvation. He is currently known for being the first astronomer and mathematician to calculate the circumference of the Earth.

When Eratosthenes was living in Alexandria, he heard from travellers about a famous well in Syene. At noon one day each year (the summer solstice between 20 June and 22 June) the Sun's rays shone straight down into the pit. The rays only lit up the water at the bottom and not the sides of the well like on other days, showing that the sun was directly overhead, and no shadows were cast. Syene was south of Alexandria and he wanted to know if this would also happen in Alexandria; so, on 21 June he placed a stick in the ground and waited to see if a shadow would be cast on it by noon. His discoveries showed that a shadow was made, and it measured  $7.2^\circ$ . Eratosthenes subsequently came to the conclusion that if the sun's rays were coming in at the same angle, at the same time of day, then it must have meant that the Earth's surface is curved – due to the well in Syene not making a shadow, whilst the stick in Alexandria did. The idea of a spherical Earth came from Pythagoras in around roughly 500BCE and was confirmed by Aristotle a few centuries later.

Assuming the Earth was a sphere, Eratosthenes decided that he could use his observations to estimate the circumference of the planet. Since the difference in shadow length between Syene and Alexandria was  $7.2^\circ$ , this meant that the two cities were  $7.2^\circ$  apart on the Earth's  $360^\circ$  surface. Eratosthenes hired a man to walk the distance between the two cities and found out that they were 5000 stadia apart (approximately 800km). He then used simple ratios to find the Earth's circumference:  $7.2^\circ$  is one fiftieth of  $360^\circ$ , so roughly 800km multiplied by 50 which is around 40,000 kilometres, therefore this was what he believed the circumference of the Earth to be. The circumference has been recently measured by an orbiting spacecraft to be 40,075 km which shows how accurate Eratosthenes' calculations were.

This discovery played a huge role in advancing our understanding of astronomy. An example of this would be during the 18th and 19th centuries when astronomers used the diameter of the Earth to determine the size of the solar system and from the circumference found the diameter by dividing it by pi. Eratosthenes is often known as the "father of geography" since his assessments led to the creation of longitudes and latitudes. This is how we developed time maps and location digits.

In conclusion, Eratosthenes' calculation of the circumference of the Earth was a great milestone in our growing understanding of the Earth. It led to the advancements in astronomy and our appreciation of the world today.

**Nur Mohiuddin and Aryan Rudraraju**

### **To what extent was Alexandria's reputation as a centre for scientific discovery justified?**

Source

*Moreover, as pains, and various kinds of diseases, arise in the more internal parts, they hold that no one can apply remedies for these who is ignorant about the parts themselves; hence it becomes necessary to lay open the bodies of the dead and to scrutinize their viscera and intestines. They hold that Herophilus and Erasistratus did this in the best way by far, when they laid open men whilst alive – criminals received out of prison from the kings – and whilst these were still breathing, observed parts which beforehand nature had concealed, their position, colour, shape, size, arrangement, hardness, softness, smoothness, relation, processes and depressions of each, and whether any part is inserted into or is received into another. For when pain occurs internally, neither is it possible for one to learn what hurts the patient, unless he has acquainted himself with the position of each organ or intestine; nor can a diseased portion of the body be treated by one who does not know what that portion is. When a man's viscera are exposed in a wound, he who is ignorant of the colour of a part in health may be unable to recognize which part is intact, and which part damaged; thus he cannot even relieve the damaged part. External remedies too can be applied more aptly by one acquainted with the position, shape and size of the internal organs, and like reasonings hold good in all the instances mentioned above. Nor is it, as most people say, cruel that in the execution of criminals, and but a few of them, we should seek remedies for innocent people of all future ages.*

*Celsus, On Medicine 1.23-26*

*Trans. W G Spencer*

With ancient Alexandria lying at the crossing points of both Greek and Egyptian culture, it should come as no surprise that it was a glorious centre of scientific discovery. Most notably, perhaps, was its ancient Library – the summit of knowledge in the Ancient European world. It was there that Aristarchus first stated that Earth revolves around the Sun; that Eratosthenes proved the roundness of the Earth and estimated its circumference; that Euclid wrote his book of elements, one of the foundational pillars of all mathematical studies. In our essay, through the exploration of Ancient Alexandria's medical advances and through our responses to a first-hand source, we will be further justifying its status as the heart of scientific experimentation and findings.



Alexandria was a city of curious people. It was a civilisation built on the desire for something more. It is defined now by what it became, but it was just the prospect of becoming that prompted its founding and eventual graduation into a centre for scientific discovery. To be honest, I think we're all aware that 300BCE wasn't necessarily the most liberal or free-thinking time in history. The hierarchical way society was structured meant that academics could only work if they were sponsored by wealthy patrons and, more often than not, those wealthy patrons didn't want anything discovered that could suggest that their incredibly privileged lifestyles were in no way a divine right, just chance. Alexandria's creation was a fundamental rebellion against these ideas of approved discovery. Yes, it was still ridiculously caught up in the idea of predestined rights, but it also made an effort to understand women's health in an utterly unprecedented way, which in turn suggests that it had a more developed view on women's rights. It wasn't just the people located there who encouraged discovery. It was the city itself. We could use this essay to list the innumerable achievements that were made there. The discoveries that continue to define our search for the truth today, but Alexandria was a centre for scientific discovery because of the environment it fostered.

Alexandria's location as a waypoint on trade routes to Ancient Rome, Greece, the Middle East and Northern Africa allowed it to be a melting pot of innumerable philosophies and ideas. The thirst for knowledge that the city itself inherited from its Macedonian-Greek founders allowed these different ideas not to be rejected but embraced. The astronomers of the Middle East were able to share ideas and theories with the mathematical pioneers of the ancient Greek world, who would use this new information to rethink what they previously thought they knew about their own field of study. Its location allowed geniuses from all across the world to meet, but the city's uncanny ability to almost encourage progressive discussion is the reason it became the hub of academic progress we now know it to have been. This ability could come from many places. One could look to the founder of the city; Alexander the Great is a known scholar, so he may have left his love of learning there. Or maybe Alexandria is just one of the rare cases in history where the original intention of its first leaders gets passed down through generation after generation until it is inseparable from the city itself.

Alexandria's position as a scientific centre is more than justified. Knowledge of the human body was forever revolutionised, and Euclid discovered some of the pillars of mathematics. Discovery is not only a part of Alexandria's legacy completely integral to its position as a city. It drew upon its location and natural resources to create an environment that encouraged learning. Yes, it was always going to have voices praising its list of discoveries, but it was the effervescent,

curious, questioning nature that seems ingrained in the city's very soul that allowed these discoveries to be made that cements its place in history as one of the greatest feats of human achievement.

It is no surprise that curiosity drives discovery. Time and again in history, 'fortune favours the bold': those who dare let their yearning for knowledge drive them further and further into the mysteries of the world. In the case of medicine, the true pioneers in the third century BCE were defined by the boldness of their dissections. These were documented in Celsus' text *On Medicine*. It was written in the first century CE, about two hundred years after the first vivisection. Despite this time gap, however, Celsus' writings were accurate, and his text is now considered a medical classic, therefore giving us reasons to believe in the trustworthiness of this source. As Celsus detailed, the physicians in the third century BCE argued that, without a clear understanding of the workings of the human body, no remedy could be efficiently applied. Hence there were born people like Herophilus and Erasistratus (as mentioned in the source), who conducted hundreds of vivisections on criminals in Alexandria. People all over the classical world flocked to see their dissections, which were widely regarded as the finest of their time. Brutal as it may seem, from a purely medical perspective, this was highly fruitful and took them to the forefront of their field, justifying Ancient Alexandria's status as a centre for scientific discovery.

As an example of what they achieved, Erasistratus postulated, based on his observations, that the heart existed not as the centre of emotions but as the 'pump' of the body. This was a revolutionary discovery, taking apart millennia of culture beliefs and clashing directly with our instinctive feelings. After further studies of the nervous system, Erasistratus was also able to deduce the difference between the functions of the sensory and motor neurons. Herophilus, on the other hand, separated the veins and the arteries as two distinct families of blood vessels after watching the flow of blood around human bodies. In particular, he noticed that blood palpitated in the arteries, but not in veins. All of these discoveries wouldn't have been possible without vivisection, and as the source from Celsus concluded, the sacrifice of several hundred guilty criminals could not have been more insignificant in front of the long-term societal and individual gains from such leaps in medical understanding.

In the following paragraphs, we would like to connect our previous discussion to some more modern issues. Particularly, from a modern viewpoint, we'd like to discuss whether is it ever justified to put people through such pains as vivisection.

We do not believe that the vivisection of criminals, live criminals, is morally correct. Yes, these people are potentially guilty of committing a crime, but what gives the state a right to control their suffering, to expose the insides of their body while they are alive? These are inviolable rights 'founded on justice that even the welfare of society as a whole cannot override', and in no circumstances does the state have a right to vivisect criminals, even for the greater good of innocents. These ideas are intuitive enough, but we anticipate two counterarguments here: that of criminal retribution, and that of utilitarianism. We will address them sequentially.

Criminal punishment is fundamentally a tool to promote social justice, and while it may seem instinctive to punish people for their wrongdoing, this punishment is meaningless unless it helps encourage justice; just like unrestrained vengeance, punishment that does not further the wellbeing of a society generates only excess pain and torture and is therefore morally unjust. Therefore, all punishments should seek to maximise the promotion of justice while minimising its infringement of personal rights and liberties. To this end, general criminal punishment, such as imprisonment, serves the primary role of deterring citizens from carrying out future crimes, while not inflicting extra harm, and therefore fulfils the criterium I have laid out. However, vivisection has gone too far. It may well deter future criminals, but the same level of deterrence would be achieved with milder means of punishment, such as lifelong incarceration.

The appeal of utilitarianism clashes directly with our idea, too. However, we believe human rights and liberties stand a higher ground. After all, if you believe that the state should have the power to dictate over our rights as humans, such as in involuntary vivisection, what is the point in maximising social interests? However good and long your life is, what is the point in it if you are not respected as a person with rights, if you do not have the freedom to choose? Indeed, such a life certainly cannot be good in the first place. Benefits may be maximised in a society, but certain liberties cannot be violated, even those of criminals. A point to note here is that just because criminals have committed crimes in the past, doesn't mean they should be lowered in their status as a human. They still breathe like us, hope like us, are conscious like us, perceive pain like us, and more importantly, can correct their mistakes given appropriate guidance. Criminals should not be valued less than normal citizens.

It is the State's approach to a utilitarian form of justice that is justified only by their supposed intellectual superiority that is so eerily relevant to modern day society. In the past 70 years alone, America has performed drug trials on the supposed 'outcasts' of their society without either their knowledge or consent in the name of making progress for society as a

whole. This behaviour poses the question: were these actions ever justifiable and were the Alexandrians just lucky in that their illegal tests yielded largely positive results?

We still have so much to learn from Alexandria's approach to medicine. But we believe that it is their approach to ethics that we should be aiming to move on from. If we consider an experiment on a non-consenting human being a violation of basic human rights 2,500 years ago then how are we possibly condoning it now? Documents like the Ebers Papyrus not only make us utterly reevaluate our views on what we thought we knew about ancient approaches to medicine but also highlight just how much those approaches have developed. So surely our views on the value of human life, consent and the cruelty of unwilling sacrifice should have developed too.

In conclusion, we have justified Ancient Alexandria's status as a centre for scientific discovery in our essay through analysing their discoveries and by responding to a related source. Leading on from the source, we discussed the nature of utilitarianism and human rights within Alexandria and how the methods they used are still relevant to the world we live in today.

**Elizabeth O'Brien and Vincent Song**



**Was the Pharos of Alexandria a touristic and historic monument or a practical working lighthouse?**



The lighthouse or Pharos of Alexandria was built in the Ptolemaic Kingdom, on the island of Pharos on the western edge of the Nile. Construction began in the third century BCE, when Ptolemy I declared himself king of Alexandria after the death of Alexander the Great. It was finished during the reign of Ptolemy II Philadelphus, around 280–247BCE. It is estimated to have been at least 100m in overall height. It is one of the Seven Wonders of the Ancient World and was one of the tallest man-made structures in the world. The lighthouse was severely damaged by three earthquakes between the late 10th century and the beginning of the 11th century. The remnants of this landmark survived until 1480, when the remaining stones were used to build the Citadel of Qaitbay. Over its history, the purpose of this magnificent tower was ambiguous. Was it built to be a lighthouse to guide incoming ships to the island safely? Or was it made to magnify the glory of the nation?

Alexandria's importance in intercultural commerce during the time reached a new zenith in Egyptian history. Alexandria traded, directly or indirectly, in goods from parts of Europe, Persia, India and even China. It was the centre of the trading system at the time. Therefore, it was essential for the lighthouse to organise the incoming ships and avoid as many accidents as possible. The Mediterranean at that time was a very dangerous sea; the recorded accidents per year around the time was about 500, including shipwrecks and pirate attacks. As first century CE Roman writer Pliny the Elder wrote, 'The object of it is, by the light of its fires at night, to give warning to ships of the neighbouring shoals, and to point out to them the entrance of the

harbour.' The last sentence indicated that the Pharos was indeed used as a lighthouse and it had a significant role in leading the ships to where they should be. Furthermore, we are told that the lighthouse was lit by fire, and not by any artificial light source, and it was said that the Pharos looked odd with the fire, so we can deduce that the Pharos was more of an efficient and practical building.

Pharos in Greek meant 'lighthouse' and the French word for headlight is 'phare', derived from Greek. According to this, it seemed that the Pharos was initially designed to be a lighthouse, as its name suggests. Furthermore, many people who lived around the shores of Alexandria, in the area where the lighthouse was built, were wreckers – they picked up goods that were left by shipwrecks. Thus, Ptolemy I Soter had the lighthouse built to help guide ships into port at night, thus getting rid of the wreckers and preventing the loss of important possessions.

Julius Caesar, in his *Civil Wars* (Part III, 111–112), describes the Pharos and its strategic importance. Gaining control of the lighthouse helped him subdue Ptolemy XIII's armies (48BCE): 'Now because of the narrowness of the strait there can be no access by ship to the harbour without the consent of those who hold the Pharos. In view of this, Caesar took the precaution of landing his troops while the enemy was preoccupied with fighting, seized the Pharos and posted a garrison there. The result was that safe access was secured for his corn supplies and reinforcements'. This suggested that Caesar saw the lighthouse as a tool for him to transport across his food supplies and reinforcements. From this, we can tell that Pharos served Caesar usefully by guiding his ships and supplies to safety.

However, Alexandrian society also benefited from the Pharos' role as a monument, in terms of their tourism industry in addition to their culture regarding worship and reverence of rulers. First to consider are the important tourism opportunities it gave to the region, with its views and the potential for a market in souvenirs and alternative merchandise. An example of this is seen in the copper model of the Pharos circulated during the era, which acted not dissimilarly to a modern-day souvenir as a method to make a profit from of the landmark. Additionally, the upper tier – with a height of 300ft above sea level - was supposedly utilised as a way of gaining a profit due to the view it offered, which was not possible in other areas of the world as, in the ancient world, structures of this height were few and far between. On the other hand, ancient cultures were influenced by the religions that formed such a significant part of their society. This is reflected in the deities that were found engraved into the lower levels of the structure, offering aesthetic appeal as well as a shrine to the gods and goddesses of the region, thus conferring cultural approbation. To conclude, the Pharos of Alexandria was an icon in Ancient Egyptian

society, whose significance arose from its cultural relevance in terms of the tourism industry and the religion that was a primary influence in the lives of the ancient citizens.

To conclude, there was a reliance on the Pharos of Alexandria both as a monument and as a lighthouse. This structure allowed the city of Alexandria to experience an economic boom as a result of the tourism industry that profited from the landmark, as well providing support to the merchant ships entering the harbour – a necessity as trade had peaked in that era, with Alexandria forming a central point in the system. The Pharos was more important because of its qualities as a lighthouse in terms of the economy; however, it was socially accepted as a landmark throughout its history.

**Chloe Brennan, Genevieve Pearce and Brandon Tam**

### **Why did the Library of Alexandria gradually decline in importance up to 275CE?**

The Great Alexandria Library, arguably one of the most significant intellectual hubs of the classical era, was founded in 283BCE, probably during the reign of Ptolemy I Soter (however, there are some sources suggesting that the library was organised by Demetrius Phalerum, an exile from Athens previously taught by Aristotle). The library, also recognised as a museum, was dedicated to the Muses (a group of lesser goddesses who represent each artistic discipline). It consisted of a garden, a zoo, shrines and lecture rooms. Moreover, the library was thought to accommodate between 200,000 and 700,000 books, separated into two sectors. Books were arranged into the following subjects: rhetoric (technique of persuasion); law; epic (long poems from ancient oral tradition); tragedy; comedy; lyric poetry (poems which expressed emotions or feelings); history; medicine; mathematics; natural sciences and others. Not only was the library a place of intelligence but it also accommodated around one hundred scholars who performed research in the library. Sadly, however, due to several reasons that will be explored in this essay, the library saw a slow decline and it was destroyed during the year 275CE during an invasion devised by the Roman emperor at the time, Aurelian.

In order to evaluate the aspects of the decline of the library, we need to consider the environment in which it was situated. During 48BCE, Julius Caesar became involved in a war with Cleopatra, and Alexandria was soon besieged by land and sea. Caesar began to think that the only way he could defeat the incoming forces was to set the fleet on fire – in this way he managed to secure a better position to defeat them. However, authors such as Plutarch report that the fire spread from the boats to the dockyard and eventually destroyed the library.

After this initial destruction, an attempt was made to restore the library. However, during the period of Roman rule, the library was not directly destroyed, but slowly diminished due to the lack of academic popularity. This was mainly because membership of the library was not granted for academic distinction (which, it had been previously) but instead for power or work in the military. As a result, scholars were no longer required to carry out research or teach, and so the reputation of the library started to decline. In contrast, many other libraries around the Mediterranean began to prosper and develop, adding to the depreciation of the library's reputation. Due to the lack of scholarly enthusiasm and interest, the value of the library decreased.



In addition to the decrease in interest in the library, religious tension also contributed to this decline. In 254CE, Alexandria comprised mostly of Greeks and Jews. However, over time, Christian thought spread through the scholars of Alexandria and, as a result, there was a discrepancy in belief. Minor wars and riots occurred in Alexandria due to the rise in Christianity, which challenged Jews in the area. Laelius Mussius Aemmilianus (a city prefect) declared himself emperor and ordered a siege in attempt to settle the chaos which probably damaged the library.

Finally, in 270CE, the final event that led to the complete destruction of the library was Aurelian's war with the Palmyrene Empire. After Alexandria was taken by the Palmyrene empire (thought as a subsection of the Roman empire), Emperor Aurelian (who reigned from 270–275) attempted to recapture the city. During the battle, the forces destroyed the quarter of the city where the main library was located. From this period, there was no interest in rebuilding the library after it had been destroyed.

Multiple sources recount the destruction and slow depreciation of the library through not only prose but also in poetry. Here is an example of a poem written by Constantinos Cavafy:

### GOD ABANDONS ANTHONY

*Translated by Alex Moskios*

When suddenly at midnight

An invisible troupe is heard passing by,

With exquisite music, and great voices –

Your good luck that just abandoned you,

Your failed work, your life's plans that

Proved to be illusions, do not uselessly bemoan.

Like one prepared for so long, like a brave man,

Bid farewell to Alexandria that leaves you.

Especially do not be fooled, do not say that

It was a dream, that you have not heard right –

Such vain hopes do not befit one like you.

Like one prepared for so long, like a brave man,

You who were equal and deserved such a city,

Walk with steady foot to the window,

And listen with emotion, but not with

Timid entreaties and unseemly grief,

Προ πάντων να μη γελασθείς, μην πεις πώς ήταν  
ένα όνειρο, πώς απατήθηκεν η ακοή σου  
μάταιες ελπίδες τέτοιες μην καταδεχθείς.  
Σαν έτοιμος από καιρό, σα θαρραλέος,  
σαν πού ταιριάζει σε πού αξιώθηκες μια τέτοια πόλι,  
πλησίασε σταθερά προς το παράθυρο,  
κι άκουσε με συγκίνησιν, άλλ' όχι  
με των δειλών τα παρακάλια και παράπονα,  
ως τελευταία απόλαυσι τους ήχους,  
τα εξαίσια όργανα του μυστικού θιάσου,  
κι αποχαιρέτα την, την Αλεξάνδρεια πού χάνεις.  
[1911]  
(Από την έκδοση) "ΑΠΟΛΕΙΠΕΙΝ Ο ΘΕΟΣ ΑΝΤΩΝΙΟΝ"

Σαν έξαφνα, ώρα μεσάνυχτ', ακουσθεί  
αόρατος θιάσος να περνά  
με μουσικές εξαίσιες, με φωνές -  
την τύχη σου πού ενδίδει πια, τα έργα σου  
που απέτυχαν, τα σχέδια της ζωής σου  
πού βγήκαν όλα πλάνες, μη ανωφέλετα θρηνήσεις.  
Σαν έτοιμος από καιρό, σα θαρραλέος,  
αποχαιρέτα την, την Αλεξάνδρεια πού φεύγει.

As your last pleasure, to the sounds,

The great organs from that mystic band,

And bid farewell to Alexandria you are losing.

Constantinos Cavafy is one of the best-known Greek poets. He was born of Greek parents in Alexandria in 1863 and died there in 1933, although he spent a significant part of his childhood in England. Alexandria is an important historical place in Cavafy's poetry and features in several of his poems. As well as portraying Alexandria as an all-important historical place with an individual beauty and intense life, Cavafy uses Alexandria as a metaphorical, sensual and mythical city. He particularly loves to use the decline and siege of Alexandria and likens this to the loss of an ideal, a dream. There are several poems about the decline of Alexandria such as *Alexandrian Kings*, *Alexandria of Myris* and *God Abandons Anthony*.

In his poem *God Abandons Anthony*, he concentrates on the historical events of the siege of Alexandria by Julius Caesar. However, over and above the actual loss of Alexandria for Mark Antony and Cleopatra, Alexandria in this poem signifies the loss of a dream. In this poem, Alexandria signifies all that Mark Antony has ever dreamt of in his lifetime, all that he has fought for and all that he is about to lose as Julius Caesar and Octavian are at the city's gates. And whilst for Mark Antony Alexandria symbolises power, wealth and the love of Cleopatra, for the reader Alexandria takes on a different meaning. It is here that the poet focuses his attention to the moment of loss, the moment that Alexandria slips through Mark Antony's fingers; it is during this moment that Cavafy is asking for self-containment, and the preservation above all of the most valuable human virtue: dignity ("like one prepared for so long, like a brave man...not with unseemly grief"). This poem has become an instruction manual of how to deal with defeat and loss for any modern reader. In parallel to this, the idea of Alexandria takes on the meaning of a dream fulfilled and the fall of Alexandria the loss of our hopes and dreams. Through Cavafy's poems, Alexandria becomes one of the most celebrated poetic symbols. Cavafy's poem expresses the intense love for Alexandria that the citizens had. He explores the fact that the loss of Alexandria during the siege damaged the people of Alexandria. This helps us understand the gravity of the downfall of Alexandria when learning about the effects of the siege.

In conclusion, the depreciation and decline of the great library can be attributed to a variety of factors including reign, religion, and the discouragement of scholarly attitude. As a result, many of the ashes of the documents and artefacts held in the library now lie beneath our feet – an event which should never be repeated. However, this incident has lots to teach us; we should

cultivate and allow valuable research and academia to prosper. People should not be able to buy their way into a high level of status (not merely in the academic field) but instead earn their way up, which could otherwise result in the situation where this power is located to depreciate itself. In addition, many citizens would rather purchase a book as a symbol of status rather than expand their knowledge with manuscripts in a library. This marginally decreased the importance of the library due to the fact that many people had no use for it, or simply didn't want to use it for its original purpose – a place of enlightenment. Furthermore, it was stated that one of the faults of the library was the fact that there was an overload of knowledge. This was described as a burden which decreased the value of this knowledge. One crucial factor in the decline of the importance of the library was the Siege of Alexandria. The poem mentioned earlier was written to express the grave effect the siege had on the lifestyle of the Alexandrians. It helps us understand what the effects were and how it contributed to the downfall of the library.

**Isabella Stumpfle and Henry Webster**

**What light is recent archaeology shedding on the lost cities of Canopus and Heraklion? You should research the techniques archaeologists are using and the challenges they face in this particular location as well as what is revealed about the cities and their culture.**

The archaeological findings of Canopus and Thonis-Heracleion have not only shed light on the happenings of the area of Thonis-Heracleion but have also given us information about all the trade in the ancient world. The excavation of these towns was a huge achievement from an archaeological perspective, as the entire city was buried underwater. The artefacts found give us strong evidence that Thonis-Heracleion was a huge trade centre, due to its geographical positioning, as there were rivers flowing throughout the city, similar to modern day Venice, which also led to it being an important trade centre in the Middle Ages. Until relatively recently, seas and rivers were the fastest route for trade, so a city filled with rivers made it arguably the best trade location between Greece and Egypt in the Ancient World.

The lost cities Canopus and Thonis-Heracleion were first spotted by an RAF plane in 1933. However, an excavation was only planned in the 1990s. The excavation of Thonis-Heracleion, led by Frank Goddio, presented many challenges. First of all, the entire site was covered by a thick sediment similar to clay, meaning Goddio and his team had to use specialist 3D mapping equipment to survey the ruins. First, they used 'side-scan sonar', which analysed echoes of soundwaves directed at the seabed to work out the shape of it. A 'nuclear magnetic resonance magnetometer' was then used to detect fault lines caused by the heavy weight of the buildings on weak sediment. The equipment was expensive and fragile, so safe transportation became an imperative precaution. Two months of probing and digging were required to explore the site, using a system known as SSPI, which conveys images of the archaeological evidence on the seabed or what is buried beneath it. Once the site had been fully mapped, Goddio could begin excavating the ruins. However, this was not the end of the problems.

In order to excavate, Goddio and his team would need to dive underwater, using specialist diving equipment to be able to see and swim through the murky water. An obvious problem was that there was a limited time that the archaeologists could be underwater. Much of the ruin was also buried beneath layers of sand and rock, which created a challenge of removing the rocks while preserving the artefacts underneath. The process of removing sand from the top of the



ruins took Goddio's team two months. Again, this was made harder due to the fact that it was underwater. It was also a challenge being able to see, as thick layers of algae made the visibility poor, and it was 10 meters underwater, not letting much light through. The team were also only able to excavate between October and June, further slowing down the process. These problems are what have led to the excavation taking three years, and research is taking place even to this day. They are a testament to the feat that Franck Goddio and his team achieved.

The discoveries in Thonis-Heracleion and Canopus were fascinating and very useful for historians. Ships, houses built from mud, large amounts of treasure and cultural symbols were all excavated, which shed light on how the city was abandoned. Cultural figures were predominantly Egyptian, such as temples to Egyptian gods including the god Amun and a statue to the pharaoh Hapi, the ancient Egyptian god of the annual flooding of the Nile. The flooding of the Nile was very important in Ancient Egyptian culture, and is still important now, due to it creating rich silt, allowing Egyptians to grow crops in an otherwise hot, dry country. Since the city was built on trading, the Greek and Egyptian cultures became interlinked in Thonis-Heracleion. Before the excavation, it was thought that Thonis and Heracleion were two different cities, but the *Royal Decree of Sais* from 380BCE shows that it was shared between Greeks and Egyptians. In fact, both Egyptian gods and Greek gods were worshipped by both cultures, such as Serapis, the Greek-Egyptian god of the Sun, around whose temple Canopus was built. The exploration of Alexander the Great allowed these cultures to thrive together here, from 400BCE all the way up to the Islamic Era. These relations arguably shaped Roman history, indirectly leading to the war between Octavian and Mark Antony. There is evidence that Alexander was hailed by religious leaders soon after he entered Egypt; he accepted their culture, and *vice versa*, allowing excellent respect and communication between the two nations. The archaeological findings in Thonis-Heracleion give us a fascinating viewpoint about contemporary events, solidifying our understanding of them.



A statue of Hapi, the god representing the annual flood of the Nile

Thonis-Heracleion had clearly become a vital connection between Greece and Egypt, and the fact that it survived the war between Octavian and Antony and Cleopatra was a testament to that, and how prosperous Alexander the Great's settlements were. However, this obviously did not last. The city collapsed due to constant building and people weighing down the weak sediment. This is a phenomenon that is currently being experienced by Venice, although there are other factors contributing to that. It seems that the sinking of Thonis-Heracleion represents a collapse from the influx of people, and if Venice had remained as busy as it used to be, it may have met the same fate.

**Maddie Wright and Oscar Wickham**



