Astronomy of the Ancient Greeks and Mayas: A Comparison of Scientific Observations and Innovation

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Abstract

The historical narratives regarding the ancient Maya have been extremely inconsistent since colonial days. The early twentieth-century historians' enthusiastic praise for the genius of the ancient Maya ended with a pendulum swing of reverse sentiment in later writings. The differing perspectives espoused on the ancient Maya historical narratives are in stark contrast to those of the steadier historical analyses associated with the ancient Greeks. It is this contrast that provides the intriguing backdrop to a comparison between a topic of utmost importance to both the ancient Greeks and Mayas: astronomy. The following is such a comparison.

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Chapter I.

Introduction

Western Civilization has been heavily influenced by the ancient Greeks. Modern Western astronomy is nearly exclusively founded on the ideas espoused by the great Greek astronomers of antiquity; though their knowledge was derived, in part, from earlier people and neighboring civilizations, such as the Egyptians and Babylonians. The West's longstanding predisposition towards early Greek scientists has reduced the influence other ancient civilizations have had on the development of Western astronomy.[1] Over time, Western academia broadened historical inquiry to include other ancient civilizations as they became known to Western scholars.[2] Since the Spanish encounter with Mesoamerica in the sixteenth century, the impressive Maya civilization has changed Western academia's near unrivaled celebration of the Greeks in ancient astronomy.[3] The turbulent history of Europeans' interactions with the ancient Maya has resulted in a lot of misinformation surrounding the ancient Maya and their standing in the field of astronomy.[4] A comparison brings both the ancient Greek and Maya astronomers into a

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[1] Herbert J. Spinden, "Ancient Mayan Astronomy," *Scientific American* 138, no. 1 (1928): 10.

[2] Herbert Spinden, *A Study of Maya Art: Its Subject Matter and Historical Development* (Cambridge, MA: The Museum, 1913).

[3] William Fash, "Changing Perspectives on Maya Civilization," *Annual Review of Anthropology* 23 (1994): 187.

[4] William Fash, "Changing Perspectives," 187.

more balanced view without the traditional favoritism toward the one or historical prejudice against the latter.

The nature of astronomy, it being a science, provides a very concrete area of study as a basis for understanding the level of innovation and intellectual curiosity of both the ancient Greeks and Mayas. A comparison of concrete subjects, such as astronomy, provides an objective methodology that yields interesting and unbiased results, when properly employed. The current literature on such an inquiry has been either too broad or too narrow to provide a comparison of the two ancient civilizations' astronomical observations and innovations. Historians have kept to the extremes of the Big Histories that include all ancient civilizations, or a very focused approach that only delineates one civilization.[5] The long-celebrated ancient Greeks will be better understood and placed in clearer global context through an in-depth comparison with the advanced ancient Maya astronomers. The methodology of comparative analysis will allow for better understanding of both the ancient Greeks and Mayas and their scientific acumen and application in the field of astronomy.

The following research was conducted in an attempt to understand, more fully, both the ancient Greeks and Mayas and their respective observations and innovation in the field of astronomy. Running throughout this comparison is an underlying theme. This foundation of research examines the influence both these ancient societies have had on Western astronomy today. To that end, this thesis poses and addresses the following four questions:

[5] William Fash, "Changing Perspectives on Maya Civilization," *Annual Review of Anthropology* 23 (1994).

1) What disparities between the ancient Greeks and Mayas require consideration in conducting a comparison of the two civilizations that may have affected the outcome of their astronomical pursuits? The object of this Chapter is to highlight the exceptional qualities of the two unique societies, to examine the advantages and disadvantages that contributed to their respective levels of scientific aptitude in the study of astronomy, and to conduct a brief literary review to understand how academia has approached the ancient Maya in histories. The shared passion and impressive accomplishments of the ancient Greek and Maya astronomers provide interest to a comparative study. The differences and individual challenges the ancient Greeks and Mayas were faced with are important in understanding the significance of their work in the field of astronomy, in the context of their known world.

2) How was the observation of constellations manifested in the religion of the ancient Greeks and Mayas? And which constellations overlapped and were recorded by both civilizations? The second of these intriguing questions highlights the differences and similarities of how each culture approached the same observable celestial objects. The use of constellations in mythology is also an important aspect of both cultures. The cult of astronomy will be discussed regarding how it related religion and science for both the ancient Greeks and Mayas.

3) How was the methodology of calendar making similar and different in ancient Greece and the Maya world? Both the ancient Greeks and Mayas created several different calendar systems. The Gregorian calendar used in Western civilization today is a solar calendar created in the mid sixteenth century. It evolved out of the lunar calendar of the ancient Greeks and the Julian calendar of the Romans (commissioned by Julius Caesar, but again, created by Greek astronomers).[6] The numerous methods of calendar making and their significance to the two respective cultures creates an interesting topic of comparison. The fact that Western astronomy eventually adopted a solar calendar, very similar to the ancient Maya's original ancient solar calendar, provides insight into the overarching discussion regarding the influence of the ancient Greeks and Mayas on Western astronomy.

4) To what degree did the ancient Greeks and Mayas employ the use of celestial navigation? It is well known that both the ancient Greeks and Mayas are credited with mastering celestial navigation.[7] Primarily referring to navigation at sea, celestial navigation is any form of navigation that utilizes the position of celestial objects for direction. However, mastery of such a skill is

[6] Pope Gregory XIII, *Inter Gravissimas, 1581*, trans. Bill Spencer 1999 (accessed Sept. 9, 2019), <http://www.bluewaterarts.com/calendar/NewInterGravissimas.htm>.

[7] Karen Parker, "Past in Pieces: Ruins Overlooking the Caribbean Reveal Once-Thriving Maya Maritime Community," *McClatchy − Tribune Business News,* November 25, 2007. <http://search.proquest.com.ezp-prod1.hul.harvard.edu/docview/463541873?accountid=11311>.

somewhat subjective; thus, understanding both civilizations' precise level of achievement requires in depth comparative analysis. To what degree the ancient Greeks and Mayas employed celestial navigation is a difficult topic because of the limited sources available as evidence. Nonetheless, the subject of celestial navigation can be used as a litmus test for the practical employment of the more theoretical knowledge of astronomy for both the ancient Greeks and Mayas. In other words, celestial navigation can show how effective the knowledge acquired by astronomers was in benefitting their respective societies.

The ancient Greeks and Mayas shared a fascination with mathematics and astronomy that was recently termed "a principle of commensuration," by leading Mayanist scholar, Dr. Anthony Aveni, Professor Emeritus at Colgate University.[8] His remark posits that astronomical understanding is in direct correlation to the time and effort the ancient Greeks and Mayas devoted to the topic of astronomy. The two cultures' enthrallment with mathematics and astronomy went beyond middling curiosity or hackneyed inquiry. The ancient Greeks and Mayas have both left evidence of a truly unique fervor for astronomy. Their fastidious record-keeping has been a boon for this research and for other historians, archaeologists, and ethnologists who have attempted to piece together the past.

[8] Anthony F. Aveni, William Saturno, and David Stuart, "Astronomical Implications of Maya Hieroglyphic Notations at Xultún," *Journal for the History of Astronomy* 44 (2013): 11.

Today, historians must work with the conscientious understanding that publications can have negative effects for the Maya currently living in Mesoamerica.[9] The Greeks have had the advantage of autonomy in keeping their past preserved, unlike the Maya, who have lived under threat of cultural suppression since the Spanish conquest. Beyond simply adding to the long line of historical publications, this thesis has been conducted with the hope of being able to bring a more balanced understanding to the academic world, of the ancient Greeks and Mayas. This thesis also aims to present the Greeks and Mayas living in the world today with an account that lends credence to their appreciation for their ancestors' extensive and astounding endeavors, in mathematics and astronomy, to interpret and understand the night sky.

[9] William Fash, "Changing Perspectives on Maya Civilization," *Annual Review of Anthropology* 23 (1994): 198.

Chapter II.

Definition of Terms

Age of Exploration. This period began with Prince Henry founding the School of Navigation and initiated the first prod of Europeans in the New World.

Cizin (or Kisin). This is the name of the important god of death in ancient Maya mythology.

Calendar Round. The ancient Maya Calendar Round was the 52-year completion of the two correlating Haab' and Tzolk'in calendars.

Copán. Copán was a learned Maya city ruled over by a dynasty of 16 rulers for four centuries, from A.D. 426-822. It is one of the most informative archaeological sites of the ancient Maya civilization: located in Honduras near the Guatemalan border.

Constellation, Rattlesnake. A Maya constellation in which the tail encompasses the Greek constellation, *Pleiades*. The head includes stars from *Aldebaran* from the Greek constellation, *Hyades.*

Constellation, Seven Macaw. An important Maya Mythology character. The stars in this constellation are shared in part with the ancient Greek, *Ursa Major* and known colloquially in the West as the *Big Dipper*.

Constellation, Scorpion. A name belonging to two completely different star groupings created distinctly by the Greeks and Mayas.

Constellation, Turtle. A Maya constellation that includes some of the same stars of that of the Greek constellation, *Gemini*.

Chancenote. The name of a village founded by the Spanish during their colonization and conversion of the Maya.

Day Glyphs. The Day Glyphs were twenty symbols which represented the repeating twenty days of the ancient Maya tzolk'in ritual calendar of 260 days.

Golden Ratio. The Golden Ratio was the ancient Greek name for a particularly appealing ratio of two quantities equaling a larger ratio, primarily discussed in architecture.

Haab'. The haab' was the ancient Maya equivalent to the 365-day solar year calendar.

Heliacal Rising. A heliacal rising is the annual appearance of a celestial object that is observable from the same location and date.

Hellenistic Period. The time period acknowledged to be the birth and flourishing of Greek culture, from 323 B.C. to 30 B.C.

Historiography. Historiography is the craft of historians. The term is used to discuss particular historical approaches in their specified school of thought.

Iconoclasm. The act of destroying symbols or idols. In this particular context, referring to the iconoclasm performed by Catholic Spaniards toward the Mayas.

K'atun. The name of an increment of time used in ancient Maya calendar making equal to 7200 days (20 "vague year" periods, of 360 days each).

Neolithic Revolution. So-named for occurring during the Neolithic time period beginning around 10,000 B.C., the Neolithic Revolution is a term used to describe the important shift from nomadic to sedentary cultures with horticulture and incipient agriculture.

Node. The point of a celestial object that is either ascending or descending in reference to the observed plane.

Oracle of Delphi. This important title was bestowed on the women who served as prophetesses at the Temple of Apollo, in ancient Greece.

Polaris. The name of the star visible to the ancient Greek, which represented true North. Used by them in celestial navigation.

Priest-Astronomers. Used by historians, ancient Greek and Maya astronomers are given this title when their astronomy is interrelated with astrology and religion.

Stela. The Maya created many monumental tablets written in hieroglyphs on monolithic vertical stone slabs (stelae), hundreds of which are still legible today.

Tikal and Calakmul. The names of two very large, important ancient Maya cities noted for their centuries-long conflict.

Tzolk'in. The Tzolk'in was the 260-day ritual calendar of the ancient Maya.

Xultún. Classic period city of the ancient Maya which was located in the northwestern part of present-day Guatemala.

Yearbearers. Yearbearers were the named days that were recurring in order as the first day of the 365-day year, and identical in the ancient Maya Calendar Round.

Zodiac. Zodiac is the Greek astrological term for the twelve divisions of the night sky and their shifting cycles.

Zodiac, Maya. The Maya Zodiac, although broken up in like fashion and precision, has thirteen cycles, instead of the aforementioned twelve.

Chapter III.

Disparity in Research

The historiographical approach of comparison requires a caveat outlining limitations of research. Historical comparisons are challenging. The difficulty stems from the reality that rarely are the two subjects of comparison compatible in every aspect. Conducting a historical comparison has certain insurmountable challenges that affect the outcome of research. This is especially true when the comparison involves two vastly different ancient civilizations. The ancient Greeks and Mayas share some salient historical similarity, such as: both civilizations were conquered and colonized, both civilizations had clearly defined and impressive golden ages, and both civilizations have descendants living in the world today. However, a significant divergence exists in geography, time period, and each of the civilizations' effect on Western astronomy. Identifying these dissimilarities is an essential part of understanding the uniqueness of each civilization, their respective hardships, and ultimately provides context and deeper appreciation for each civilization's accomplishments.

Aveni was impressed by the similarities he found between the ancient Greeks and Mayas when he visited an important ancient Maya archaeological site. In the Classic Period city of Xultún, archaeologists discovered important ninth-century A.D. Maya inscriptions.[10] Archaeologists who discovered the murals, prior to Aveni's joining the research program determined the building, named Structure 10K-2, to have been a

[10] Aveni, Saturno, and Stuart, "Astronomical Implications," 11.

residential house with numerical calculations painted on the walls. In light of this discovery and Aveni's ruminative correlation between the Mayan writings to that of the ancient Greeks, he wrote, "the Maya concept of structuring time [is a] relationship whereby quantities are sought that relate to one another via a ratio of small whole numbers."[11] Aveni imagined that the wall from Xultún Structure 10K-2 was similar to modern-day black boards and utilized in the same way a mathematician might write and rearrange numbers today. He goes on to compare the two civilizations' unique fascination with numbers by quoting the ancient Ionian Greek philosopher Pythagoras: "There is geometry in the humming of the strings, there is music in the spacing of the spheres."[12]

The first step in analyzing the ancient Greek and Maya astronomy is understanding that their pursuit of astronomy was intrinsically correlated with their human condition. In other words, astronomy was the manifestation and outgrowth of these ancient people's need for purpose, reason, and knowledge. There were patterns to be found and cycles to be predicted. For example, the constancy of the eclipse seasons of Venus was worth the effort of disciplined observation and laborious record-keeping—the two civilizations providing modern academia with evidence of both.[13] The ancient Greeks' and Mayas' valorization of astronomy contributes to an intriguing comparison of the civilizations, because they were each so heavily invested in the subject.

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[11] Aveni, Saturno, and Stuart, "Astronomical Implications," 11.

[12] Aveni, Saturno, and Stuart, "Astronomical Implications," 11.

[13] Gabrielle Vail and Anthony Aveni, *The Madrid Codex: New Approaches to Understanding an Ancient Maya Manuscript* (Boulder: University Press of Colorado Press, 2004), 6.

Geographic History

One of the greatest factors in the development of astronomy in ancient Greece and the Maya area is the geographic differences between the two civilizations. The world of the ancient Maya was strikingly different than that of the ancient Greeks. The ancient Mayas observed the night sky from the flat plains of the Yucatan Peninsula, from the foothills surrounding the Classic city of Copán, from the subtropical rainforests of Palenque, and from the mountain cities in the southern Highlands. The ancient Maya world was roughly 325,000 square kilometers and was spread across areas of the present-day countries of Belize, Guatemala, El Salvador, western Honduras, and eastern-most Mexico.[14] In contrast, the Ancient Greek astronomers occupied a much smaller area of land, roughly 132,000 square kilometers, on the mountainous coastlines and islands of the busy Mediterranean Sea.[15]

[14] Fash, "Changing Perspectives," 182.

[15] Henry Bensinger, Ancient Greek Geography, (New York: Rosen Publishing Group, 2013).

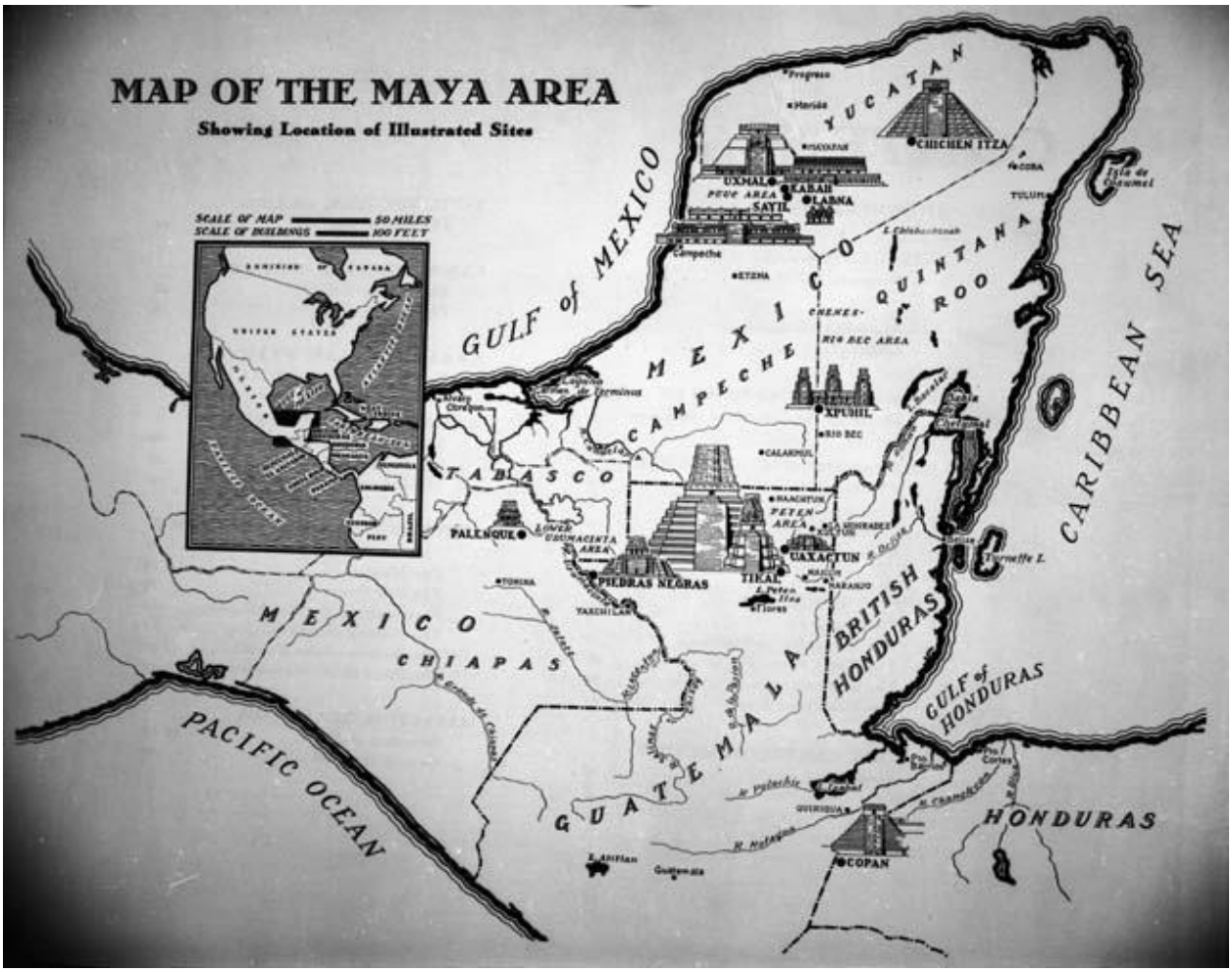

Figure 1. Map of the Maya Area by Tatiana Proskouriakoff
Showing Location of Illustrated Sites[16]

[16] *Map of the Maya Area: Showing Location of Illustrated Sites*, "Peabody Museum of Archaeology and Ethnology at Harvard University," Accessed on May 2, 2020, https://pmem.unix.fas.harvard.edu:8443/peabody/view/objects/asitem/search$0040/24/title-desc?t:state:flow=6d972ddd-0b87-43d0-9f63-b0ccdb8748dd.

Figure 2. Map of Ancient Greece
Map showing major metropolises and modern countries.[17]

The system of governance had surprising similarities between the ancient Greeks and Mayas. The city-state was a shared structure of society for both the ancient Greeks and Mayas.[18] Unlike the ancient Greek city-states which bordered each other and provided geographic homogeneity, the Mayas had some city-states which were surrounded by non-Maya people.[19] Interactions between city-states and surrounding non-

[17] *Map of Ancient Greece*, "National Geographic Society," Accessed May 6, 2020, https://www.nationalgeographic.org/education/classroom-resources/mapping/.

[18] William Fash, "Religion and Human Agency in Ancient Maya History: Tales from the Hieroglyphic Stairway," *Cambridge Archaeological Journal* 12, no. 1 (2002): 6.

[19] The Classic city of Copán is an example of this.

Maya ethnic groups naturally oscillated between peace and conflict for both civilizations.[20] The ancient Greeks had intense conflicts amongst themselves, for example, the Peloponnesian War. There is evidence of similar internal conflicts in ancient Maya civilization, for example, the long-lived war between *Tikal* and *Calakmul*. Between conflict, times of prosperity and peace generally allowed for both the ancient Greek and Maya to invest in the innovation of non-survival pursuits, like that of astronomy. Conflict with surrounding ethnic groups and inner disputes between city-states was a continual threat for the ancient Greeks and Mayas and may have disrupted their respective endeavors in astronomy. However, both civilizations existed after the *Neolithic Revolution*. The nature of social stratification in their post-Neolithic Revolution civilizations meant sedentary communities with diverse trades. These settlements provided continuity for astronomers to endure in pursuing their trade, relatively uninterrupted through times of both war and peace.

Causation of Age and Colonization

The celebrated golden age of the ancient Greeks and Mayas are termed their Classic Periods. The Greek Classic era is generally thought to run from circa 500 to circa 300 B.C.. The Maya Classic era is generally thought to range from circa A.D. 200 to circa 900. Both of these classic periods were before the *Age of Exploration*. Thus, the vast geographical distance between the two civilizations coupled with the lack of global exploration created a vast separation regarding the development which occurred

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[20] Fash, *Hieroglyphic Stairway*, 14.

independently in Central America and Southern Europe. In other words, the question of "who did it first" has no real bearing on a comparison between the two civilizations on the subject of astronomy. Because there was no real possibility of an interchange of ideas across the globe, an impressive understanding of astronomy was as much a breakthrough to the world of Mesoamerica as it was hundreds of years before, to the world of the Mediterranean.

The golden ages of ancient Greece and the Maya were a consequence of their respective geographic locations. Both civilizations were subject to the era in which they lived and the level of hostility they were met with upon being conquered. Classic Greek astronomers created schools to both further research astronomy, as well as teach about their extensive knowledge of astronomy. When Rome conquered Greece in the second century B.C., they allowed, encouraged, and commissioned Greek astronomers in these endeavors. The Mayas received much harsher treatment from their conquerors, the Spanish in the early sixteenth century. The Spanish colonial period for the Mayas initiated the turbulent history of the Mayas' extensive efforts at preserving their astronomical records and the Western world's attempt at interpreting them.[21]

The Cause and Effects on Western Astronomy and Literature Review

Conducting a literature review for the topic of astronomy of the ancient Greeks and Mayas produced very different results. Since the Romans valued the Greeks' contributions to knowledge in general, they set the stage for all of Western Civilization's appreciation of the Classic Greek astronomers. The history of the European Renaissance

[21] Vail and Aveni, *The Madrid Codex*, 8.

cemented the Greeks of antiquity as the premier authority on ancient astronomy, as well as several other subjects, in Western academia. The Spanish Conquistadors had no such appreciation for the Mayas. Their campaigns to reform, what they considered to be a heathen indigenous population led to iconoclasm and destruction of religious paraphernalia, which included mixed-use observatories and astronomical records on paper.[22] The Spanish considered ancient Maya astronomy a manifestation of their impermissible pagan ways. The notorious ecclesiastical judge from a Spanish parish founded in *Chancenote,* Pedro Sanchez de Aguilar, wrote home listing his grievances with the ancient Mayas and their determination to continue their native rituals, despite Spanish opposition, in secret.[23] The bulk of what is known today, therefore, is a result of codices that were preserved by the Mayas through the censorship era of colonization, oral tradition, and what archaeologists have been able to painstakingly piece together.[24] It is also important to bear in mind in any ancient Maya research that, even with the extensive work done in the fields of history and archaeology, the Mayas have only been brought from the "margins of prehistory into merely liminal history."[25] The Mayas' story of having to reconstruct their history in Western academia is very different than the ancient Greeks, who were able to author most of theirs.

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[22] Vail and Aveni, *The Madrid Codex*, 8.

[23] Pedro Sanchez de Aguilar, *Informe Contra Idolorum Cultores (1603)* (Merida: E. G. Triay e hijos, 1937), 181.

[24] Mayan codices, the *Dresden Codex*, the *Madrid Codex*, and the *Paris Codex,* were preserved on their original bark medium and written in Mayan Hieroglyphs. Gabrielle Vail, "The Mayan Codices," *Annual Review of Anthropology* 35 (2006): 498.

[25] N. Hammond N., quoted by Fash in "Changing Perspectives," 194.

The Maya codices are now known to be compilations of works written from a wide time period.[26] They have been described as comparable to "anthologies of English literature, in which authors from different centuries are all included in one volume."[27] The nature of the ancient Maya system of compiling earlier records gives the codices much value, because they provide a more comprehensive look into ancient Maya history. Since the initial blow of colonization, historians have turned their attention to ancient Maya astronomy with very different intents and conclusions.

The nineteenth century and early twentieth century scholars took an eager interest in the ancient Maya that was sparked by impressive archaeological findings. Anthropologist and archaeologist Herbert Joseph Spinden (1879-1967) studied at Harvard University and conducted research under his mentor, Professor Alfred Tozzer.[28] Spinden's findings have significantly contributed to the foundational archaeological research, specifically in art, regarding the ancient Maya civilization.[29] The early works by Spinden and Tozzer, as well as other archaeologists have helped reveal the advanced accomplishments of the ancient Maya astronomers. The ancient Mayas' accurate understanding and predictions of complex scientific concepts has significantly altered the historical viewpoint of the Maya. The ancient Maya are now properly understood as a

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[26] Aveni, "Ancient Maya Astronomical Tables," 717.

[27] Vail and Aveni, *The Madrid Codex*, 6.

[28] Herbert Spinden, *A Study of Maya Art: Its Subject Matter and Historical Development* (Cambridge, MA: The Museum, 1913); and Herbert Spinden, *The Reduction of Mayan Dates* (Cambridge, MA: The Museum, 1924).

[29] An example of a major recent work that relies heavily on Spinden's work: David H. Kelley, and E. F. Milone, *Exploring Ancient Skies: An Encyclopedic Survey of Archaeoastronomy* (New York: Springer, 2005).

much more advanced society than they had been credited with previously. Spinden's work in particular has helped to establish the ancient Maya of Mesoamerica as innovative and sophisticated.

William Fash, the current Bowditch Professor of Central American and Mexican Archaeology and Ethnology and Archaeology Program Director at Harvard University, addressed the effects early publications had on the historical narrative of the ancient Maya civilization. He wrote,

> Earlier Western academics had put the Maya on a cultural pedestal; some publicity seekers seem to delight in knocking them from it. Sensationalist accounts of gory blood sacrifices, sexual mutilation, and the fall of the Maya based on their 'bloodlust' and 'penchant for warfare' have been common in the mass media.[30]

Pendulum swings such as the aforementioned—from the excitement of the early twentieth century archaeologists to these publicity seekers—have resulted in a very inconsistent understanding of the ancient Maya. The ancient Maya have been painted in a variety of different ways in academia: from anywhere between warmongers to "harmonious" calendric observers, above common trivial tribal pursuits.[31] Recent publications have been fairer, since archaeologists and ethnologists have produced evidence that has required a more just account of the ancient Maya civilization. Still, the ancient Greeks are at a huge advantage for the simple fact that their own publications, so well-known and translated in every form in Western Civilization, have been able to tell their own story and hold account for themselves.

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[30] Fash, "Changing Perspectives," 187.

[31] Fash, "Changing Perspectives," 183.

The continuity of culture from the Greeks of antiquity through the whole of Western Civilization has created a familiarity between modern and ancient scholars that is evidenced in academia.[32] This is especially true in the field of astronomy in which Western historians have used the vernacular and technical understanding provided by the ancient Greeks in research and publications of ancient Maya astronomy.[33] Because of this, ancient Greeks have always had a role in scholarly publications about ancient Maya astronomy. The pairing of the two civilizations has often grown out of necessity due to Western Civilization's heavy reliance on the ancient Greeks for vocabulary and vernacular of basic astronomical subjects. The history of Western language in itself means that a publication written in English on ancient Maya astronomy will always reference the ancient Greeks, either directly through explanation, or indirectly through vocabulary. Furthermore, it would be impossible to write an article on the topic of astronomy without ancient Greek influence, because the very concepts and terminology were cemented in Western linguistics by them. The ancient Greeks gave Western academia the language of astronomy that is still in use today.

The aforementioned coupling of the ancient Greeks and Mayas in academia has yet to be deliberately employed in a comparison of the two in the field of astronomy. An intentional comparison of the ancient Greek and Maya astronomers will help to unravel some of the remaining mystery of the intricacies of the ancient Maya culture and will

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[32] Nicholas Campion, "Astrology in Ancient Greek and Roman Culture," *Oxford Research Encyclopedia of Planetary Science,* 23 May 2019.

[33] Susan Milbrath, *Star Gods of the Maya: Astronomy in Art, Folklore, and Calendars*. 1st ed. Linda Schele Series in Maya and Pre-Columbian Studies (Austin: University of Texas Press, 1999).

give the well-known ancient Greeks much-needed global context. As of the present, historical analyses have either provided too broad and uncomprehensive publications on ancient astronomy that include a larger cast of civilizations along with the ancient Greeks and Mayas, or have provided a singly focused history of the astronomy of one or the other ancient civilization.[34]

The main considerations in a comparison of observations and innovation between the astronomy of the ancient Greeks and Mayas are: the time period differentiation, their figurative and literal place in the world, and their post-classic period history. The ancient Greeks have been the focal point in much of Western academia. The ancient Mayas have had comparatively little attention—as mentioned, only having just been brought out of the "margins of pre-history."[35] Despite these manifold differences, the two civilizations hold striking similarities in their dedication to record keeping and their evident appreciation for astronomy.

[34] William Fash, "Changing Perspectives on Maya Civilization," *Annual Review of Anthropology* 23 (1994): 198.

[35] N. Hammond, quoted by Fash in, "Changing Perspectives," 194.

Chapter IV.

Constellations

Constellations were very important to the ancient Greeks and Mayas. Grouping stars together was a practice that illustrated mythological characters for both civilizations. The ancient Greeks surveyed the sky from a latitude of roughly Thirty-Eight Degrees North. The ancient Maya were further south at a latitude of roughly Eleven Degrees North. In other words, they both identified constellations that include stars that were outside of the other's perimeter of observation. However, the vast majority of their respective night skies were viewable in both locations and they found several similar illustrations in the stars.

Both the ancient Greeks and Mayas had a comparable set up of dividing the year into sections of the everchanging night sky. These sections, called zodiacs, evenly broke up the sky with the visible stars for a particular time period: the Greek Zodiac had twelve signs; the Maya Zodiac, had thirteen signs.[36] The Greeks adopted their zodiac from the earlier Babylonians. The set of twelve signs was already a fairly concrete concept in their part of the world, owing in part to the Hellenistic period and Alexander the Great's early attempt at globalization. The zodiacs are the basis of astrology for both the ancient Greeks and Mayas. The nature of astrology, combining observable science with mythology, played a crucial role in the two civilizations' significant correlation between religion and science for predictive purposes.

[36] The thirteen signs of the ancient Maya zodiac are catalogued on pages 23 and 24 of the *Paris Codex*.

Similarities in Ancient Greek and Maya Constellations

The history of how the ancient Greeks and Mayas came to influence Western Academia, as discussed in Section III Disparity in Research, highlighted the concept of the necessity of the use of ancient Greek astronomy in understanding and translating ancient Maya astronomy. That Greek vernacular, if nothing else, connects the two civilizations in Western understanding. The topic of constellations sheds light on the necessary coupling of the ancient Greeks and Maya in Western academia. Researchers have inevitably used the well-known ancient Greek constellations to locate and direct others in finding ancient Maya constellations.

In the vast cosmos, the grouping of certain stars is so defined that they appeared, to observers across the world, to be distinctly grouped. Dr. Susan Milbrath, Emeritus Curator of Latin American Art and Archaeology, Department of Natural History, Florida Museum of Natural History, highlighted some of the important ancient Maya constellations in her book, *Star Gods of the Maya: Astronomy in Art, Folklore, and Calendars*.[37] Her book chronicles some of the significant ancient Maya constellations and discusses their relationship in the night-sky to Western constellations, adopted from the ancient Greeks.[38] Milbrath notes another distinction between ancient Greek and Maya astronomy, that the ancient Mayas' "knowledge of rising stars and constellations is derived from predawn observations rather than the dusk observations common in Western astronomy (that is, derived from the Greco-Roman tradition brought over from

[37] Susan Milbrath, *Star Gods of the Maya: Astronomy in Art, Folklore, and Calendars*. 1st ed. Linda Schele Series in Maya and Pre-Columbian Studies (Austin: University of Texas Press, 1999).

[38] Milbrath, *Star Gods*, 243.

Europe)."[39] The most recognizable of these distinctly grouped stars—ancient Greek's Great Bear, and Western civilization's most recognizable "Big Dipper," in Greek, *Ursa Major* is connected with several different mythologies throughout the ancient Maya world, depending on specific location. Despite the variations throughout the region of ancient Maya there is a similarity to the dipper in the recurring image of a "cupped hand" or "bowl."[40] The three distinct stars that are used to identify the ancient Greek constellation Orion (his belt stars) are significant in the ancient Maya as either three king or "Marías," again depending on the location of the myth in the ancient Maya world. The similarities in these constellations show the utilization of distinctly bright stars in ancient Greek and Maya mythology. Even more amazing than the circumstance of the ancient Greeks and Mayas creating signs for the same grouping of stars, despite there being billions of stars to choose from, is the inexplicable phenomenon of the two entirely removed civilizations creating the *same* sign for the same sets of stars. For example: the summer constellation with includes the big red star *Antares* was aptly named *Scorpion* by both civilizations.

The Creation of Mythology Tied to Specific Constellation Characters

Naming constellations has been a common practice throughout the world in different eras and with different cultural and ethnic groups. It was a great way to remember the map of the stars in the night sky. Creating characters and telling stories

[39] Milbrath, *Star Gods*, 37.

[40] Milbrath, *Star Gods*, 38.

about them was an exercise frequently practiced throughout the ancient world: a practice found from the northern Inuit to the Jaina of India. Some of the civilizations who created stories with their stars used astrology-based mythology as a central part of their religion. The ancient Greeks and Mayas were such civilizations—integrating astronomy and mythology extensively into their religion. The role of astronomy, therefore, was intrinsically connected with ancient Greek and Maya mythology.

To the ancient Greeks and Mayas, the characters in the constellations and their stories were theology and divine manifestations. *Pleiades* played a more important role in Maya astrology, than it did in ancient Greek astrology.[41] In ancient Greek mythology, the *Pleiades* are a cast of insignificant characters that are portrayed in supporting roles, dwarfed by more prominent and popular Greek gods and heroes. Not so among the ancient Maya. The *Pleiades* constellation played an important role, not only to ancient Maya mythology, but also and more significantly to the almanac seasons for planting the ever-important maize crop.[42] Ancient Greek and Maya constellations were a tool in astrology which facilitated the interplay between the ancient astronomers and their connection to the cosmos.

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[41] Alexandre Tokovinine, Barbara Fash, and William L. Fash, "House of New Fire: at Teotihuacan and Its Legacy in Mesoamerica," in *The Art of Urbanism: How Mesoamerican Kingdoms Represented Themselves in Architecture and Imagery,* edited by William L. Fash and Leonard López Luján. (Dumbarton Oaks Pre-Columbian Symposia and Colloquia, Washington: Distributed by Harvard University Press, 2009), 206.

[42] Milbrath, *Star Gods*, 38.

Relationship between Observable Astronomy and Religion

The great accomplishments in astronomy of the ancient Greeks and Mayas is indicative of the significance of observable astronomy to each culture's religious beliefs and practices. In other words, both civilizations invested heavily in the science of astronomy, because of the religious implications they perceived in the movement of the heavens. The result of this investment in the science of astronomy is that the ancient Maya people are believed, by many, to be "on par" with the ancient Greeks and their long-celebrated virtuosity.[43] Rain, agriculture, hunting, and battle were major concerns in the ancient world that both the Greeks and Mayas attempted to predict, explain, or request aid for, through their interactions with the night sky.

The almanacs and tables were used by the ancient Greeks and Mayas to predict certain events or general overarching good or bad luck.[44] In his personal account, *Relación de las Entradas que Hize a la Conversión de los Gentiles Ytzaex,* Franciscan Friar Avendaño y Loyola wrote that the Mayas "painted figures and characters, they have foretold their future events."[45] This seventeenth century account is considered proof of Europeans' firsthand witness of Maya bark paper codices "that contained native calendars and *K'atun* prophecies."[46] The role astronomical prophecy played for the

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[43] Aveni, "Ancient Maya Astronomical Tables," 714.

[44] *Britannica Academic*, s.v. "Almanac," accessed May 31,2020, https://academic-eb-com.ezp-prod1.hul.harvard.edu/levels/collegiate/article/almanac/1606.

[45] Fray Andres de Avendano y Loyola*, Relation of two trips to Peten: Made for the Conversion of the Heathen Ytzaex and Cehaches* (1696), ed. Frank E. Comparato, trans. Charles P. Bowditch and Guillermo Rivera (Culver City: Labryrinthos, 1987), 33.

[46] Vail and Aveni, *The Madrid Codex*, 5.

ancient Greeks and Maya civilizations was imperative, because it gave a sense of control over an otherwise very precarious future.

Anthropologist Prudence M. Rice believes that the accuracy of the Maya astronomy predictions gave ancient Maya rulers their initial rise and claim to power.[47] The ancient Mayas had a similar theology to the ancient Chinese with their concept of the *Mandate of Heaven*. It has been re-termed, "Mantle of Heaven" to give the same idea of divine right to rule.[48] Rice suggests in her book, *Maya Calendar Origins: Monuments, Mythistory, and the Materialization of Time,* that astronomy-based weather pattern and eclipse predictions could have been a litmus test for the legitimacy of rulers.[49] In other words, the ability to predict the future through the science of astronomy was considered by the ancient Mayas to be a divine manifestation of divinely appointed rulers.

In ancient Greece, Cicero declared that all major elite social events and decisions of state were done at the behest of the Oracle of Delphi, from Apollo's temple.[50] The importance of astrology to the ancient Greeks lies in their perception of astrology's ability to connect people with the divine cosmos. The ancient Greeks' extensive patronage to the Oracle of Delphi displayed the significant role that divine

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[47] Prudence M. Rice, *Maya Calendar Origins: Monuments, Mythistory, and the Materialization of Time* (Austin: University of Texas Press, 2007) 1-204, accessed June 2, 2020. muse.jhu.edu/book/3149.

[48] Barbara Fash, William Fash, Sheree Lane, Rudy Larios, Linda Schele, Jeffrey Stomper, and David Stuart, "Investigations of a Classic Maya Council House at Copán, Honduras," *Journal of Field Archaeology* 19, no. 4 (1992): 437.

[49] Rice, *Maya Calendar Origins*, 1-204.

[50] Nicholas Campion, "Astrology in Ancient Greek and Roman Culture," *Oxford Research Encyclopedia of Planetary Science,* 23 May, 2019; accessed 3 Jun. 2020. https://oxfordre.com/planetaryscience/view/10.

communication had in ancient Greek civilization: to them, astrology "could be used to predict individual destiny, avert undesirable events, and arrange auspicious moments to launch new enterprises."[51]

The correlation between science and religion—or more specifically, astronomy and mythology—was interwoven extensively throughout ancient Greek and Maya culture. This extensive interweaving makes it difficult to find primary ancient Greek and Maya documentation that discusses one subject and excludes the other. As in the case of the Madrid codex for the ancient Mayas for example, tables and almanac are written with equal significance and legitimacy.[52] The famous ancient Greek philosopher Plato wrote extensively about the importance of the relationship between religion, cosmology and astronomy.[53]

Western Academia and the Relationship of Astronomy and Religion

The modern disconnect between religion and science in Western academia today follows much more closely the prominent school of thought of Aristotle. Writing later than the time of Plato in ancient Greece, Aristotle believed that while religion was important for the social make-up of a society, it was by no means essential to scientific

[51] Nicholas Campion, "Astrology in Ancient Greek and Roman Culture," *Oxford Research Encyclopedia of Planetary Science,* 23 May, 2019; accessed 3 Jun. 2020. https://oxfordre.com/planetaryscience/view/10.

[52] For more on Maya Tables and Almanacs, see Chapter V, Calendars.

[53] Plato, *Plato, with an English Translation*, translated by Harold North Fowler (Cambridge, MA: Harvard University Press; London: W. Heinemann, 1955).

progress.[54] Finding a similar dissenter in the ancient Maya world seems to be an impossible task—writings with any such flavor of atheism, if they ever did exist, are no longer known. Although Aristotle has a reputation now as being less pious than his contemporaries, his discussion of religion and science, even to argue the importance of separating the two, is in itself evidence of the prolific interconnectedness of the two subjects in ancient Greece at the time.

Aveni addressed the danger of using what he termed, "rational" Western thought, when attempting to classify the use of ancient Maya structures.[55] In his book, *E Groups: Astronomy, Alignments, and Maya Cosmology* written with Anne S. Dowd, Aveni explains that an ancient Maya structure that was clearly identified by archaeologists as having been for the purpose of ritual did not automatically exclude the possibility of it having been used for science-based astronomy. He was concerned that the positioning of certain buildings, uncovered in ancient Maya archaeological sites, disqualified the buildings from earning the title of "observatories" in the eyes of Western scholars. [56] Though they were later acknowledged to be observatories, they initially were denied the title because the buildings didn't follow the "rational" ideas, or norms, of what an observatory ought to look like to the Western eye.[57] In the past, Western archaeologists and ethnologists have had a difficult time finding a balance between the benefit of their

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[54] Aristotle*, Aristotle's Politics: Books I. III. IV.,* translated by Immanuel Bekker, Immanuel, W. E. Bolland, and Andrew Lang, 1st ed. (London: Longmans, Green, 1877).

[55] Anthony F. Aveni, and Anne S. Dowd, "E Groups: Astronomy, Alignments, and Maya Cosmology," *in Maya E Groups, Maya E Groups,* ed. David A. Freidel et al. (Gainesville: University Press of Florida, 2017) 87.

[56] Aveni and Dowd, "E Groups and Maya Cosmology," 87.

[57] Aveni and Dowd, "E Groups and Maya Cosmology," 87.

own education and not allowing that education to bias their understanding of the ancient Maya people. In other words, scholars are becoming increasingly more aware of the need to set aside their Western knowledge and ethnocentrism at times, in order to understand, and at times learn from, the ancient Maya astronomers.

The long line of scholars that have passed nearly unbroken since the time of the classic Greek astronomers have cemented the ancient Greeks' position of prominence in Western astronomy. A consequence of this continuity of scholarship has hindered Western academia's ability to make inquiries into other civilizations without preconceived notions. While it is somewhat intuitive, it is worth pointing out the inevitable human condition of bias, because of the very real effect the history of a scholar's education and value system has on the historical narratives which that scholar writes.

Constellations were an important part of ancient Greek and Maya astronomy. For scholars today, a comparison of the two civilizations' recorded constellations shows a huge investment by the ancient Greeks and Mayas into the observation of stars. The mythology created around the characters in the stars played a salient role in their respective theologies. The Zodiacs were an important tool, not just for ordering mythology, but also for assigning seasons to almanacs for practical activities such as planting crops.[58] The major role religion played in ancient Greek and Maya culture made constellations and their zodiac astrology an imperative part of the fabric that made up their worldview, life pursuits, and lifestyles.

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[58] Milbrath, *Star Gods*, 38

Chapter V.

Calendars

In *The Madrid Codex: New Approaches to Understanding an Ancient Maya Manuscript,* Gabrielle Vail and Anthony Aveni address the insurmountable challenges Western scholars have when they attempt to understand or interpret the ancient Maya calendric system through their preconceived notions surrounding the Western concept of time.[59] Similar to the case of the misclassification of ancient Maya observatories, early Western scholars misrepresented ancient Maya calendars. The ancient Greeks and Mayas' systems for measuring and tracking time were so dissimilar that these early scholars were unable to grasp the ancient Maya structure of time.[60] Eric Thompson, a Mayanist scholar from the early-mid twentieth century wrote that if the ancient Greeks had engaged the ancient Mayas in a conversation of "the philosophical aspects of time" the Greeks "would have been at sea."[61] Thompson believed that the ancient Mayas were theoretically more advanced, in the concept of time, than the ancient Greeks.[62] The

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[59] Vail and Aveni, *The Madrid Codex*, xx.

[60] Harvey M. Bricker, Anthony F. Aveni, and Victoria R. Bricker, "Ancient Maya Documents concerning the Movements of Mars," *Proceedings of the National Academy of Sciences of the United States of America* 98, no. 4 (2001): 2110.

[61] Eric S. Thompson, *The Rise and Fall of Maya Civilization*. 1st ed. Civilization of the American Indian Series; v. 39 (Norman: University of Oklahoma Press, 1954), 137.

[62] Thompson, *The Rise and Fall of Maya Civilization*, 137.

intellectual disconnect has, for both Western culture and academia, shrouded the ancient Maya in mystery that is still perceivable in many publications today.

Having such vast differences in perspective has provided an interesting look at how two opposite mindsets approached the same astronomical problem. The case of the visible planetary path of Mars provides a very tangible example. Western astronomy and the ancient Maya have diverse histories delineating their different approaches to the mathematical and astronomical discussions surrounding the movement of Mars. A very compelling article appeared in the Journal of *Proceedings of the National Academy of Sciences of the United States of America* that outlined the opposing approaches and their effects. The article's conclusion highlights the results of the theoretical approach of Western astronomy compared with the practical approach of the ancient Maya:

> Close examination of ancient Maya documents concerning the movements of Mars provides a fuller picture of Maya planetary knowledge by offering an example from a pre-Columbian American civilization of alternative approaches to very familiar astronomical phenomena. While Kepler solved the sidereal problem of Mars by proposing an elliptical heliocentric orbit, a daring leap for its time, equally ingenious Maya astronomers, operating in a less abstract, earthbound frame of reference, managed to discover a pair of time cycles that not only accurately described the planet's motion but also married it to other cosmic and terrestrial concerns.[63]

The article acknowledged the different academic framework employed to work through the same astronomical puzzles. The mathematical equations of the ancient Greeks and Mayas were sound but arrived at by very dissimilar means.

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[63] Aveni, Bricker, and Bricker, "Ancient Maya Documents concerning the Movements of Mars."

The ancient Maya sidereal cycle of Mars is one of many impressive astronomical feats by the ancient Maya astronomers—the most sophisticated of their tables is the sidereal cycle of Venus, which is accurate to within one day every 584 years.[64] The most accessible place to find these calculations is the Dresden Codex. The Venus sidereal calculations are dated through several cycles of the Venus canonic synodic cycle, which of course means that these tables span a time-period of thousands of years.[65] The power of prediction, as discussed in the previous chapter, is truly striking when ancient Maya astronomers were able to equip rulers with this type of astronomical knowledge which spanned millennia.

Cause and Effect of Misunderstanding in Scholarship

One of the great challenges Western scholars have had with understanding the ancient Maya calendric system, is the difficulty of the synchronization of seemingly unrelated calendars. The extant codices of the ancient Maya are "almost exclusively" related to religion or astronomy.[66] Scholars classify the information found in the three authenticated codices known today as either "tables" or "almanacs." Tables are classified as belonging to the *Long Count* calendar; whereas, almanacs are related to the 260-day ritual calendar. Both tables and almanacs in the Maya codices "frequently refer to

[64] William A. Saturno, David Stuart, Anthony F. Aveni, and Franco Rossi, "Ancient Maya Astronomical Tables from Xultun, Guatemala," *Science* 336, no. 6082 (2012): 716.

[65] Saturno, Stuart, Aveni, and Rossi, "Ancient Maya Astronomical Tables," 716.

[66] Vail and Aveni, *The Madrid Codex*, 5.

astronomical events, such as solar eclipses and the positions of certain planets and constellations in the night sky."[67]

The ancient Greek calendars were written almost exclusively on the base increments of days. It has recently become a point of importance to scholars of ancient Maya calendar systems to highlight that some ancient Maya tables and almanacs are written in larger increments.[68] The preconceived notion of days was inherited by Western scholars from the ancient Greeks and became a stumbling block in the early *days* of attempting to decode the ancient Maya calendar systems. Astronomer Carl D. Callaway termed the significant ending of the 13th B'aktun period (an ancient Maya B'aktun was just over 394 years) to the beginning of the next as "Era Day."[69] This period ending has been acknowledged as having the significance to the ancient Maya as the Millennium, or Y2K, had to the West in A.D. 2000.[70] The ancient Mayas had dates and period endings, such as *yearbearers,* which had a similar special recognition to their popular recognition of A.D. 2012, that were used in the tables and almanacs as increments of significance.[71] The difference between a day and a 394-year increment is great and added confusion to Western scholars who are not accustomed to such large intervals in calendar making. The

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[67] Vail and Aveni, *The Madrid Codex*, 5.

[68] Vail and Aveni, *The Madrid Codex*, 16.

[69] Carl D. Callaway, "Cosmogony and Prophecy: Maya Era Day Cosmology in the Context of the 2012 Prophecy," *Proceedings of the International Astronomical Union* 7, no. S278 (2011): 193.

[70] Robert K. Sitler, "The 2012 Phenomenon Coems of Age," *Nova Religio: The Journal of Alernative an Emergent Religions* 16, no. 1 (August 2012), 61-87.

[71] Vail and Aveni, *The Madrid Codex,* 134.

use of the B'aktun in ancient calendar-making gives testimony to the far-sightedness of the ancient Maya. It has only been within the last few decades that scholars have revisited the ancient Maya codices with the newly recognized concept of inconsistent increments in mind and with better understanding.[72]

One of the great advantages modern scholars have, that was wanting for their predecessors and that has allowed for a correlation between Maya and Western calendars, is the hand-held computer.[73] Being able to test hypothesis easily has been a boon to historical inquiry in contrast to the tedious work of the long-hand calculation system record at Late Classic Xultún and in later Maya codices. When the difficult calculations were no longer such a time-consuming burden to scholars, finding the proper increment being used in the ancient Maya codices became a much more attainable achievement through the simple process of hypothesis, tests, and eliminations.

The far-sightedness of the ancient Mayas is another distinguishing factor between their civilization and that of the ancient Greeks. Beyond the hundreds of years within a B'aktun cycle, the ancient Mayas created an extensive linear timeline of real, imagined, and prophetic significant events within their impressive Long Count. The Long Count begins with a "mythological starting date" that dates back to 3114 B.C.[74] The extensive Long Count gives the ancient Maya the illusion of agelessness to readers (connecting themselves to earlier times retrospectively) while at the same time anchoring individual

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[72] Vail and Aveni, *The Madrid Codex,* 228.

[73] Vail and Aveni, *The Madrid Codex*, 15.

[74] Vail and Aveni, *The Madrid Codex,* 137.

astronomical and historical events in a fixed, linear sequence. Their creation of such a timeline seems to carve out a distinguished place of belonging among the most sophisticated thinkers in the ancient world—especially since so many of the more recent dates were confirmed by archaeologists to be actual historical events in Mesoamerica.[75]

Professor Herbert Spinden, (see Chapter III, Disparity in Research), credited by the editor of the *Scientific American Journal* as being "one of the foremost authorities of Maya research" in the early twentieth century, was certainly impressed with the long-lasting spirit of the ancient Maya.[76] Spinden titled one of his articles, "Ancient Mayan Astronomy: When Most of Our Ancestors Were Untutored Barbarians, the Mayan Priest Astronomers Had Developed Their Science to a Mathematical Precision."[77] The title of his article certainly rates the Maya astronomers as much more advanced than their Western contemporaries. He opens his article by claiming that "at about the time Thales, first philosopher of Greece, was observing the course of the Sun and planets and wondering how the world was made, a still greater astronomer lived in the Yucatan Peninsula."[78] Spinden was thoroughly impacted by the ancient Maya and their Long Count.

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[75] Fash, "Changing Perspectives," 183.

[76] Orson Desaix Munn II, Editor commentary on Spinden's Mayan Astronomy article, *Scientific American Journal*, January 1928, page 9.

[77] Herbert J. Spinden, "Ancient Mayan Astronomy," *Scientific American* 138, no. 1 (1928).

[78] Herbert J. Spinden, "Ancient Mayan Astronomy," *Scientific American* 138, no. 1 (1928): 10.

Complex calculations were an interest, and strength, that both the ancient Greeks and Mayas shared. The ancient Maya calendar keepers sought "harmony between sky events and sacred rituals."[79] Similarly, the ancient Greeks were so delighted with a particular rectangle formula that it became known colloquially as *The Golden Ratio*. Archaeologists, Vail and Aveni have frequently noted the resemblances between the ancient Greeks' and Maya's tendency to tinker with numbers. They wrote that "there exists a 'science of numbers' apposite to their use to tally quantities of things [and] time."[80] The theme of mathematical rules and hypothesis is strong in the writings from both cultures. There is a potent similarity, specifically between Maya almanacs and the great ancient Greek mathematician Pythagoras' preoccupation with the relationship of numbers.[81]

Differing Approaches to the Lunar Cycles and Solar Years

Much remains unknown about the ancient Maya calendric system. New theories are still being brought forward and tested. One difference is clear though: the ancient Greeks were more comfortable publishing a calendar with acknowledged inaccuracies than the fastidious ancient Mayas. The question of the lunar cycle and solar year has been a point of difficulty for calendar makers since the beginning of their craft. Because the two cycles never align perfectly, calendar makers of the present Gregorian Calendar

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[79] Saturno, Stuart, Aveni, and Rossi, "Ancient Maya Astronomical Tables," 717.

[80] Vail and Aveni, *The Madrid Codex*, 17.

[81] Anthony Aveni, William Saturno, and David Stuart, "Astronomical Implications of the Maya Hieroglyphic Notations at Xultún," *Journal for the History of Astronomy* 44, no. 1 (2013): 11.

system, in place in the West today, created a leap year.[82] The leap year inserts an extra day into the calendar cycle every four years to account for the uneven solar and lunar timeframes. Ancient and modern calendar makers are faced with the difficulty of the rotation of the Earth, which creates increments of days, and the solar year, which does not break evenly on a day in the lunar cycle. The Earth's revolution around the sun, which technically includes just above a fourth of a 24-hour day, wreaks havoc on the even 365-day solar year.

The Attic Calendar of the ancient Athenians (the most prominent calendar of the ancient Greeks and the one which will be used to compare the two systems in this thesis) handled the problem of days and years differently. They put more emphasis on the lunar cycle, by inserting an entire extra month whenever the solar and lunar gap became large enough to accommodate a thirteenth month. There is no evidence of a leap year, or month, in the ancient Maya calendar system.[83] The calendars which they used most often were the ritual calendar, called the *tzolk'in,* and the 365 day solar year calendar, called the *haab*'.[84] The solution for how ancient Maya almanacs and tables skirted the seemingly inevitable pit fall of occasional calendar adjustments (in the form of periodically inserted additional days or additional months) lies in the aforementioned

[82] Pope Gregory XIII. *Inter Gravissimas, 1581*. Translated by Bill Spencer, 1999 <http://www.bluewaterarts.com/calendar/NewInterGravissimas.htm>.

[83] Vail and Aveni, *The Madrid Codex,* 16.

[84] Vail and Aveni, *The Madrid Codex,* 132.

increment system the Maya used, which occasionally operated outside of the confinement of days.[85]

Despite the ancient Greeks' strong influence on Western astronomy,[86] the Attic calendar is not extant like the tables and almanacs of the ancient Maya found in the Paris, Dresden, and Madrid codices and the painted wall at the Late Classic site of Xultún. The Attic calendar was not preserved through the ages; thus, there are contradicting ideas regarding its contents which are based on differing historical accounts—even ancient accounts with conflicting information.[87] While scholars struggle to understand the ancient Maya calendar system, they argue about long understood details of the ancient Greek calendar system.

Similarities in the Use of Multiple Calendar Systems

The Gregorian calendar used today is a singular calendar that encompasses all scheduling. Both the ancient Greeks and Mayas had multiple calendric systems for different occasions. As mentioned above, the ancient Mayas had the distinction of ritual and technical aspects of time in their systems that scholars refer to respectively as almanacs and tables.[88] The ancient Greeks had a similar system of calendar making which combined definitive and more fluid events. A remnant of this more holistic

[85] Vail and Aveni, *The Madrid Codex,* 228.

[86] See introduction for the predisposition of Western astronomy toward the ancient Greeks.

[87] The famous ancient Greek Thucydides is an example of an account that mentions details about the Attic calendar.

[88] Vail and Aveni, *The Madrid Codex*, 5.

approach to calendar making is found today in farmer's almanacs in Western culture. Beyond the zodiac calendars that are covered in Chapter IV of this thesis, the ancient Greeks and Maya detailed the proper times for an array of life's important occurrences and the likeliest time for a favorable outcome during specific celestial events.

A singular point of differentiation on calendar making is the idea of favorite numbers. Be it superstition or a manifestation of the cultural appreciation for the appeal of a specific number (similar to the afore-mentioned ancient Greek *Golden Ratio*), the fact remains that both the ancient Greeks and Mayas had certain numbers that they used significantly more frequently than the rest. The ancient Greeks used an even dozen as often as possible: twelve months in a year with twelve zodiac signs; and again, in their mythology, with the number of gods and titans. The ancient Mayas likewise used the number thirteen: "years and other time periods grouped in thirteens were of deep cosmological significance to the ancient Mayas, forming the foundation of their 'Grand Long Count' Calendar."[89] Thirteen is also the number of coefficients used in correlation and cycle with the ancient Maya *Day Glyphs* of the *tzolk'in* calendar.[90] Though the reason is vague beyond religious implications, the two cultures are undoubtedly united in their respective numeric favoritism within the numerology that each developed. The ancient Mayas, for example, developed an 819-day count, which was enormously popular and found on virtually all of the inscriptions with Long Count dates, in the Classic Period. The reasons for the selection of this particular number remain a complete mystery to Western scholars.

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[89] Saturno, Stuart, Aveni, and Rossi, "Ancient Maya Astronomical Tables," 715.

[90] Vail and Aveni, *The Madrid Codex,* 132.

Calendar Making Conclusion

Calendar making was an important aspect of life for both the ancient Greeks and Mayas. Documenting and recording the scheduling events in astronomic cycles helped them to predict their futures and give them a sense of what was to come. It was also an overtly religious activity for the ancient Mayas. Calendar making was done by "priest-astronomers" in a very ritualistic manner.[91] The ancient Greeks and Mayas were concerned about the accuracy of their calendar making and respectively addressed the difficulty of the lunar cycles and solar years in their own creative ways. Astronomy allowed the ancient Greeks and Mayas a practical outlet for their religious observances. Astronomers from both cultures shared a unique relationship with mathematics.

[91] Herbert J. Spinden, "Ancient Mayan Astronomy," *Scientific American* 138, no. 1 (1928).

Chapter VI.

Celestial Navigation

In observing the continuously changing night sky, the rotations, revolutions, and orbits of all the celestial objects, the ancient Greek and Maya astronomers recognized the significance of one constant. The unmoving position of true north. *Polaris*, which is also aptly named the *North Star,* is found inside the ancient Maya *Chimalmat* constellation and the ancient Greek *Ursa Minor* constellation. The meaning of such continuity in such a seasonal sky was not lost on astronomers from either civilization. Both the ancient Greeks and Mayas harnessed the power of true north in mastering one of the most nuanced arts—celestial navigation.

Maya Celestial Navigation

One group of ancient Maya living in the Northern Yucatan Peninsula and in Campeche, Mexico, the Chontal Maya, have been known to be seafaring far enough off the coast to have required the use of celestial navigation. There is evidence of much sea-faring trade between the Maya and the peoples of the islands of the Caribbean Sea, from early times all the way to the Spanish contact. The Chontal traders were very familiar with those waters. Ancient Maya ruins, like the town of Vista Alegre, have shown ample archaeological evidence of sea trade far up and far down the coastline with extensive

ocean fishing.[92] The range of these shoreline ruins are considered by many to be proof of ancient Maya celestial navigation.

The methods of celestial navigation employed by the ancient Greeks and Mayas are a mixture of similarities and differences. The complexity of the Madrid Codex maps and calculations are evocative of the advanced navigation abilities of the ancient Mayas. Astronomical principles were so well known beyond astronomers, as to be known and of beneficial use to the laymen. Point of references for ancient Maya navigators were centered on the position of the land and sky from the city of the navigator. The ancient Greeks navigated similarly, using their knowledge of the Mediterranean Sea and its land/seamarks as points of references in relation to the night sky and the ever-present *Polaris*. This style of celestial navigation is similar in form to what would later be termed *dead reckoning,* where sailors use their general knowledge and sense of position to determine their actual position.

Greek Celestial Navigation

Celestial navigation was so much a part of ancient Greek culture, and consequently their Roman conquerors, that it found its way into verse and prose. In the classic text Virgil's *Aeneid*, the character Aeneas explains celestial navigation to Pallas as charting a course in the stars before setting sail and following that path through the night.[93] The simplicity of Pallas' explanation, though slight proof of celestial navigation

[92] Roy Jaijel, Jeffrey B Glover, Dominique Rissolo, Patricia A Beddows, Derek Smith, Zvi Ben-Avraham, and Beverly Goodman-Tchernov, "Coastal Reconstruction of Vista Alegre, an Ancient Maritime Maya Settlement," *Palaeogeography, Palaeoclimatology, Palaeoecology* 497 (2018): 25-36.

[93] Virgil, *Aeneid* 10. 160-162.

among the ancient Greeks and Romans, is perhaps indicative of their rudimentary understanding of the skill. The ancient Greeks had a major advantage over the ancient Maya—the ability to learn from their seafaring neighbors. The Phoenicians were famous in the ancient Mediterranean world for being highly accomplished sea navigators: "Both Strabo and Pliny admired their superior celestial navigational skills."[94] The temperate climate of the Mediterranean was also an advantage for celestial navigators in ancient Greece who were afforded more night-time observations throughout the year. Whereas their Maya colleagues were hampered by rainstorms during the day and the night for half—or more—of every year.

Similarities and Differences in Celestial Navigation

Beyond the rudimentary knowledge of celestial navigation that Aeneas displays in his discourse with Pallas, there is evidence of complex instruments being invented and used for the sake of celestial navigation by both the ancient Greeks and Mayas. An ancient Maya glyph was identified by scholar Adrian Digby as representing an instrument that functioned similarly to the Western sundials and astrolabes.[95] The instrument was named "crossed trapeze" by Digby, because of its trapeze-like mechanism.[96] The ancient Maya trapeze instrument would have been in alignment during solstices and creating

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[94] Georgia L. Irby, ed. *A Companion to Science, Technology, and Medicine in Ancient Greece and Rome*, (Hoboken: John Wiley & Sons, Incorporated, 2016), 1019. Accessed May 24, 2020. ProQuest Ebook Central.

[95] Adrian Digby, "Crossed Trapezes: A Pre-Columbian Astronomical Instrument," in *Mesoamerican Archaeology: New Approaches*, edited by Norman Hammond (Austin: University of Texas Press, 1974), 271.

[96] Digby, "Crossed Trapezes: A Pre-Columbian Astronomical Instrument," 271.

angles as the year progressed and the shadows moved. This aspect of the device reminded Digby of a comparable device invented by the Ancient Greeks. He wrote,

> A similar principle was employed by the Alexandrian astronomer Hipparchus, who set up a ring parallel to the equator, which is of course the same angle of elevation as the trapezes would assume when pointed toward the sun at the equinoxes. With Hipparchus's ring the shadow cast would only be a straight line when the rays of the sun were directly in line with it. At other times than the equinoxes the ring would have cast a shadow in the form of an ellipse of greater or less thickness. According to the declination of the sun. With this simple device he was able to discover the precession of the equinoxes. In passing we may wonder what calculations and astronomical discoveries the ancient Mesoamerican astronomers were able to make with their rather more advanced counterpart to Hipparchus's ring, and what calculations based on observations with a device like this may not still remain hidden in the Maya inscriptions.[97]

The similarities of the two instruments and their astrolabe qualities is what classifies them as celestial navigation tools. Digby suspected the ancient Maya trapeze instruments were created to be small and light-weight, so they were more convenient in travel. The same reasoning led him to believe the instruments were constructed using wood—this would also explain the lack of artifacts.[98]

The major difference between the ancient Greeks' and Mayas' methods of celestial navigation is that the ancient Mayas used their extensive knowledge of the entire night sky to navigate based on their relative positions to points of reference. The ancient Greeks primarily used the star *Polaris* to find their way within the four points of direction. Polaris was a mainstay for the ancient Greek navigators who could easily locate it with the naked eye on clear nights. However, the star was much hazier (if at all visible)

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[97] Digby, "Crossed Trapezes: A Pre-Columbian Astronomical Instrument," 278.

[98] Digby, "Crossed Trapezes: A Pre-Columbian Astronomical Instrument," 271.

to the ancient Maya due to their geographic location, being much more to the south. Neither the ancient Greeks nor the Mayas used the more common modern navigation methods which require a knowledge of the more modern concepts of longitude and latitude. This is because the comprehensive world was less known than the observable night sky.

Celestial Navigation Conclusion

In conclusion, the necessity for accuracy was less imperative for the ancient Greeks whose sea voyages around the Mediterranean were hedged in by land, unlike the ancient Maya who were in danger of the vast abyss of the Atlantic Ocean. The subject of celestial navigation provides an opportunity to test just how much the knowledge of the elite class of ancient Greek and Maya astronomers trickled down to the lower classes—namely traders. It is clear that both civilizations did have enough scientific knowledge of astronomy to make celestial navigation possible for the ancient Greeks and Mayas.

Chapter VII.

Conclusion

The ancient Greeks and Mayas shared a unique affinity and appreciation for numbers. This fascination led to their respective innovations in the scientific field of astronomy and which subsequently permeated their culture and religion. Western academia has predominantly produced scholarly works privileging the ancient Greeks over other ancient civilizations. The ancient Maya are no exception. Their turbulent history with the Europeans led to a very different Western-composed historical narrative than the Greeks received. This thesis analyzed the progression of scholarly thought toward the ancient Greeks and Maya in order to provide the Greeks with a compatible comparison that is wanting in earlier histories. By so doing, the astounding accomplishments of the ancient Maya astronomers are continuing to emerge from the realms of mystery and misunderstanding produced by the Colonial Era. The compatibility of the ancient Greeks and Mayas lay in their shared fascination with science and mathematics, for predictive ends.

The vast differences in their respective known worlds required a lot of delineation, early in this thesis, to acknowledge the unavoidable reality of exterior factors that played a role in the causation of astronomical innovation.[99] In other words, there are variables at play, unique to each civilization, that could potentially affect the outcome of a direct comparison—variables that need explanation or, at the very least,

[99] See Chapter III, "Disparity in Research."

acknowledgment. Chapter III, "Disparity in Research," addresses the insurmountable variables of geography, time period, and scholarly effect on Western academia. Bearing these inevitabilities in mind, it is clear that a comparison of the ancient Greeks and Mayas, through historical inquiry into the observable and applicable astronomy, has given the long-praised ancient Greek accomplishments a more accurate global perspective. Moreover, the comparison provided a more comprehensive understanding of the lesser-known ancient Maya astronomers.

A review of the two ancient civilizations and their constellations has shown the fascinating happenstance of a few identical constellations.[100] It has shown how the ancient Greeks and Mayas created a very similar system of mythology that related constellations to theology. Most significantly though, the comparison has revealed the two cultures' similar intrinsic interconnectedness between religion and science, mythology and astronomy. Constellations were viewed by both the ancient Greeks and Mayas as the divine illustrations of human connection with the cosmos.

Despite the similarities found between the ancient Greeks and Mayas in their approach to constellations, comparing the calendric systems proved vastly different.[101] The method of calendar making is founded on each culture's concept of time. Since the dissimilarities of the ancient Greeks and Mayas were so great on the topic of time, their calendars were likewise very dissimilar. Chapter V of this thesis also discussed the challenge of solar, lunar, and day increments in calendar making and the different

[100] See Chapter IV, "Constellations."

[101] See Chapter V, "Calendars."

methodologies both civilizations employed. The Maya were much more concerned about accuracy in calendar making than the Greeks' calendar, which seemed much simpler and practical for the laymen.

The topic of celestial navigation allowed for a limited look into the practical application of the heady knowledge of astronomy—which both civilizations had in abundance.[102] Though the evidence available regarding celestial navigation is limited, an inquiry into how the laymen were benefitted by the knowledge of the esteemed astronomers provided a more holistic understanding of astronomy for both the ancient Greeks and Mayas. It is clear that both civilizations did make use of celestial navigation for trade and conquest.

While ample and intriguing information is available regarding the ancient Greeks and Mayas' knowledge of astronomy, the limitations of research on the topic of astronomy in ancient Greece and Maya are extensive. Beyond the research difficulties expressed in Chapter I, Disparity in Research, there remains the overarching problem that many historians feel in their craft: how to do justice to the astounding work of the entire duration of two of the most advanced and impressive ancient civilizations on a topic that encompassed their most devoted passion.

Acknowledging modern inability, despite all our technology, to condense the realities of ancient civilizations into a two-dimensional document is certainly a step in the right direction toward a more holistic appreciation for the intricacies of human life in the ancient world. The type of research as has been conducted in this thesis highlights the

[102] See Chapter VI, "Celestial Navigation."

magnanimous task of cultural preservation that the ancient Maya calendar keepers attempted through the years of censorship brought on by the Spanish colonial period.[103]

In conclusion, returning to the underlying theme that was addressed in Chapter I, Introduction, modern Western astronomy resembles certain attributes belonging to both the ancient Greek and Maya astronomers. Western constellations were exclusively inherited from the ancient Greeks. Even modern scholars are not in agreement as to the proper orthography to use in the ancient Maya constellation names. Ancient Maya orthography differs because some spelling came from the colonial period, Spanish friars, and some came from epigraphers' recent phonemic alphabet.[104] Calendar making graduated from the original Attic calendar of the ancient Greeks, through the commission of the Romans to the Greek astronomers, to the solar calendar. The ancient Greeks' transition from lunar to solar was named after the commissioner as the Julian Calendar. The modern Gregorian calendar of the West has similarities to both the Julian and ancient Maya calendars: their solar year and lunar month combinations. The advantages of modern technology have outdistanced both the ancient Greeks and Mayas to make correlations seem very inconsequential regarding celestial navigation. It is impossible for the ancients to compete with advances like satellites and Global Positioning System (GPS). However, the father of these technologies is the creation of the magnetic compass, which continues the tradition, seen in the civilizations of both the ancient Greeks and Mayas, of a dependence on true North. In 1990, the space probe Voyager 1 took a final

[103] See Chapter III, "Disparity in Research."

[104] Vail and Aveni, *The Madrid Codex, xx.*

photograph of the Earth from a distance of over 40 AU. When astronomer Carl Sagan saw the "Pale Blue Dot" in the vast cosmos he wrote,

> It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another and to preserve and cherish the pale blue dot, the only home we've ever known.[105]

Here skywatchers remain to this day, as were the ancient Greeks and Mayas, captivated by our own insignificance.

[105] Carl Sagan, *Pale Blue Dot* (New York: Random House, 1977), 6-7.

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