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DELPHI AND COSMOVISION: APOLLO'S ABSENCE AT THE LAND OF THE HYPERBOREANS AND THE TIME FOR CONSULTING THE ORACLE

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Abstract: Keeping an exact calendar was important to schedule Delphic festivals. The proper day for a prophecy involved a meticulous calculation, which was carried out by learned priests and ancient philosophers. The month of Bysios on average is February, but in reality it could be any 30-day interval between January and March. Bysios starts with a New Moon, but the beginning of the month is not easily pinpointed and thus Bysios and the 7th day for giving an oracle cannot be identified according to the Gregorian calendar. The celestial motions of Lyra and Cygnus with regards to sunrise and sunset are related to the Delphi temple's orientation and the high altitude of steep cliffs of the Faidriades in front of it. Light from the rising Sun shines at the back of the temple where the statue of the god is located, while the appearance and disappearance of Lyra and Cygnus, two of Apollo's favorite constellations in the Delphic sky, mark the period of absence of the god to the Hyperboreans. This coincides with the 3-month interval from the end of December to the middle of March. During the later part of this period, on the 7th day of Bysios, the oracle was given. At any rate, the Delphic calendar was a lunar-solar-stellar one, and was properly adjusted to coincide with and preserve the seasonal movements of those constellations.

Keywords: Temple of Apollo, Delphi, Pythia, consulting, oracle, Hyperboreans, stars, sunrise, constellations

1 INTRODUCTION

The Temple of Pythian Apollo at Delphi was constructed in 550 BC, and is located on the Greek mainland on the southern slopes of the Parnassus mountain range (see Figures 1 and 2 for Greek localities mentioned in the text). The puzzling orientation of the Temple has been questioned by Salt and Boutsikas (2005) and Vassiliou (2007), while a preliminary investigation regarding sunrise locations and α Lyrae in relation to the landscape at Delphi has been introduced without any firm result by Liritzis et al. (2011). Much earlier orientation measurements were made by Penrose (1897), who discussed the complex setting of the Temple and the difficulty in drawing any definite conclusions. Lack of a thorough investigation led him to consider the importance for dating purposes of the heliacal setting of β Lupi.

The most recent working hypothesis regarding the northeastern-facing entrance of the Temple in relation to the oracles delivered by the Pythian priestess was made by Salt and Boutsikas (2005) who related the heliacal rising of the constellation Delphinus to the timing of the consultation of the Oracle at Delphi during the month of Bysios.

Here we revisit the orientation of the Temple in relation to Apollo's departure and return from the land of the Hyperboreans[1] and thus define the timing when Pythia[2] was able to give oracles.

Our work reinforces the infrequent and vague textural evidence and contemporary archaeoastronomical research indications that ancient Hellenic religion may have included ritual elements inspired by astronomy but connected with the properties of the god Apollo (Liritzis and Vassiliou, 2002; 2003; 2006). Moreover, one should bear in mind that the symbolic language employed by philosophers at the time was used to hide the prevailing beliefs (Liritzis and Coucouzeli, 2007). Further to the intentional orientation of the Temple, we examine the relevance of astronomical issues, ancient calendars, ancient sources that refer to triggering agents (Plutarch, Strabo and others) and hydrocarbon vapors (De Boer, et al., 2001) that affected Pythia in delivering oracles (Fontenrose, 1981). We also consider relevant archaeological data (Courby, 1927; Radet, 1901; Roux, 1976).

2 ORACLES AND ORACULAR DAYS

Apollo is a many-talented Greek god of prophecy, music, intellectual pursuits, healing, plague, and sometimes, the Sun. Writers often contrast the cerebral, beardless young Apollo with his half-brother, the hedonistic Dionysus, the God of Wine.

The site of the oracle of Apollo at Delphi was an *antron* (cave) or *adyton* (restricted inaccessible area) where, according to the geographer Strabo, fumes rose from the ground to inspire a divine frenzy (Jones, 1924: 9.3.5).

Plutarch and his friends in his *De Defectu Oraculorum* (*On the Obsolescence of the Oracles*) discuss the reasons why the oracle ceased to offer consultations, amongst which he recalls demons, gods, water and the 'spirit' of the deity that varied and changed in the course of time (see Sieveking, 1972). Current research-

Figure 1: Greek localities mentioned in the text. Soli in NW Cyprus and Tyane is in eastern Asia Minor are not shown on this map. For a close-up of the Delphi region see Figure 2, below.

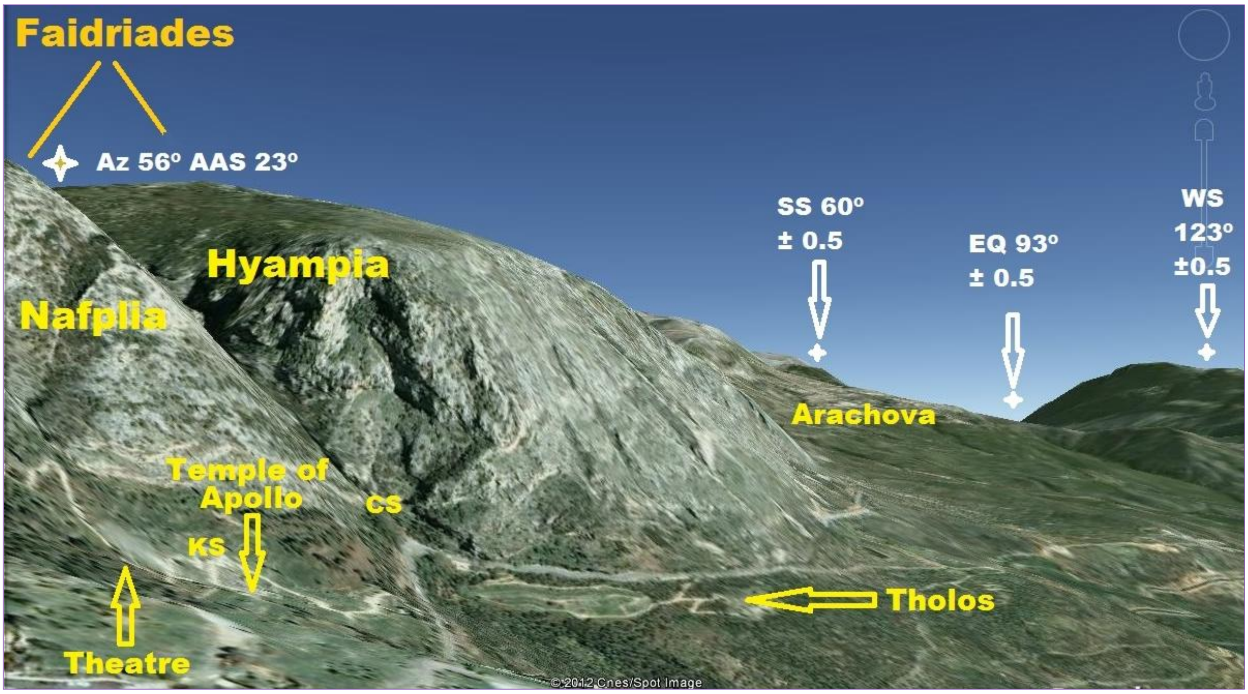

Figure 2: Localities in the vicinity of the Temple of Apollo at Delhi, together with the angular altitude of the skyline (AAS) of the Faidriades and summer and winter solstices (SS and WS) and equinox (EQ) azimuths. CS and KS are the Castalia and Kerna Springs, respectively, while the Faidriades Spring, between Nafplia and Hyampia, is not visible here. The Livadhi Valley is to the left, and beyond the top of this photograph.

ers interpret this theologically, culturally or politically.

The ancient literature provides useful information regarding the determination of the days suitable for delivering oracles to individuals or city representatives.[3] Plutarch (*Moralia*, 389c) mentions Apollo's absence from Delphi for the three winter months (see Sieveking, 1972). Parke (1943) thinks that when Plutarch (*Questiones graecae*, Stephanos 292 E-F) refers to months when oracles were given he does not include the winter period. But taking into account that an extra month could be added to the solar year as an intercalary month, this period varies and could extend to mid March.

Initially, in older times the oracular day was the seventh day of the lunar month of Bysios, the birthday of Apollo (which was sometime between the end of January and the middle of March). This day was calculated from the New Moon that marked the beginning of the month. For example, in 412 BC, Euripides' tragedy *Ion* refers to the appropriate day for a consultation to Xouthos, who transmits the mythical report to the Late Bronze Age (Hannah, 2005; Roux, 1976).

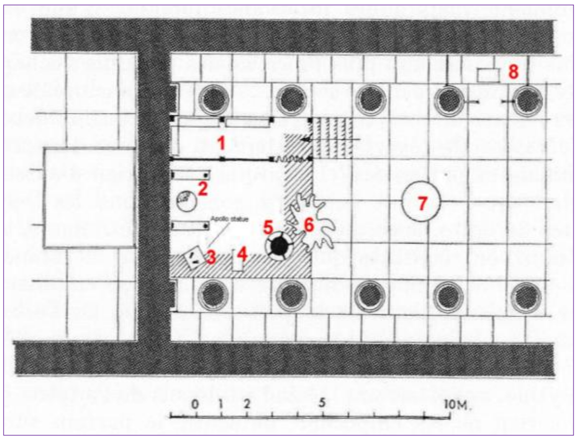

Figure 3: A reconstructed ground plan of the Temple of Apollo, the *adyton* and the positions of statues etc. based on ancient texts. Key: 1 = *oikos*, the waiting room for the opropoi. 2 = the beehive-shaped stone *omphalos*. 3 = the statue of Apollo. 4 = the tomb of Dionysos, the son of Semeli. 5 = the *adyton* where vapor ascend while Pythia is sitting at the tripod. 6 = the secret laurel tree. 7 = Estia's room. 8 = the sanctuary of Poseidon (after Roux, 1976: 134).

Later, the priestess was consulted once on the seventh day of the month, nine times a year, except during the three months when Apollo was absent. So nine times each year the priestess mounted the tripod, entered a trance state and spoke for the god. These sessions were held on 'Apollo's Day', the seventh day after each New Moon in spring, summer and fall.

This could be partially verified, but at a later date, by Plutarch's work *Oracles at Delphi no Longer Given in Verse* (398 A), where Boethos, an epicurean skeptic, and one of his companions discuss the Temple of Apollo at Delphi: " … it is not sufficient that the god confines [himself] in a mortal body once a month …" (Sieveking, 1972). So when this fictitious conversation was taking place (i.e., during Plutarch's lifetime) the oracle was probably not as active, and in the following paragraph Plutarch says that in his day only one Pythian priestess was required, while elsewhere (*Moralia* 414 B) he states that in earlier times two full-time Pythian priestesses were employed and a third acted as a backup, (Sieveking, 1972). Taking into account the large numbers of visitors to Delphi, and the various exceptions in granting the right of priority oracles (*promanteia*) found on inscriptions, rather we have to entertain the possibility that the Pythian priestess was giving oracles more than once a month, at least during Classical and Hellenistic times. Two such active periods were the meetings of amphictyonic reunion during autumn (in mid-September, probably around the autumn equinox), and in spring (in mid-March, probably around the spring equinox), which is attested also on inscriptions (e.g. see Lefevre, 1991).

Plutarch (see Sieveking, 1972) also states that in very early times the Pythian priestess gave oracles just once per year, quoting Callisthenes (who wrote his *Hellenika* narrative sometime between 356 and 327 BC,[4]) and Anaxandridis (a Delphian contemporary of the third century B.C, historian Polemon, and writer of two books: *On the ill-omened Pylae oracular days in Delphi* and *On the Delphic Oracle*). Therefore, oracles were given once per year at least until the middle of the fourth century BC, and from that time on they were given monthly. It is not feasible to determine what this day was with respect to the present Gregorian Calendar due to the complex movement of the Moon and the insertion of an extra month in the middle of winter every 3, 5 and 8 years which would bring the month back into its proper season, and complexities that existed between the calendars of the different Greek city-states (see below, and also Manitius, 1898: 8.33).

Later on, as early as 480 BC, the oracles were delivered on the seventh day of the month for nine months, except during the three months that Apollo was absent. However, the priestess would sometimes provide oracles on ill-omened days, so exceptional appeals for an oracle could be made at other times. Initially Pythia could usually be consulted on the seventh day of each month—if this was not an inauspicious day—except when the gas flow in the sanctuary was too strong. Geological factors therefore could influence the successful functioning of the Temple of Apollo at Delphi.

Delphi was an amazing center of information at that time and of all the oracle sites Strabo considered it amongst "... the most reliable." (Jones, 1924: 9.3.6). However, politics exerted an influence, as the prestige of this oracle made Delphi the most important, influential and wealthy sacred place in the entire Greek World. For at least a thousand years, the pronouncements of the Delphic oracle offered divine guidance on issues ranging from the founding of colonies to declarations of war, to advice on personal issues (Spiller et al., 2002)

It transpired that Pythia was giving oracles amidst hallucinogenic hydrocarbon gases at the sanctuary, which are now known to have been released by trapped bituminous material in a seismic fault located below the rear of the Temple of Apollo (Hollinshead, 1999).[5] This current interpretation runs counter to the earlier opinion pronounced by Amandry (1950), the French excavator of the Temple, who maintained that there was no archaeological evidence in the Temple itself to support the belief in a fissure or gaseous emission. Moreover, he claimed that such an emission would be geologically impossible in the limestone rocks of Mount Parnassus (Figure 2), and he wrongly stated that such vapors are only produced in volcanic areas. Figure 3 shows a plan of the Temple and the location of the *adyton* which funneled the vapours up into the Temple.

The Temple of Apollo at Delphi is now known to be sited at the intersection of two major tectonic faults, the Kerna and Delphi Faults (De Boer et al., 2001) that are part of the Corinth rift zone, a region of crustal spreading. Subvertical fissures existed underneath the Temple (Courby, 1927, II: 66 and Figure 45), and sheets of travertine along the largest north-northwest faults (De Boer et. al., 2001: Figure 3) provided a pathway along which groundwater enriched with light hydrocarbon gases rose to the surface (see de Boer and Hale, 2000: Figure 7; Muller, 1992: Figure 2).[5] Even today, the smell of hydro-carbons has been reported in the vicinity of the Temple of Apollo, as well as in the modern town of Delphi.

Evidence of recent geological activity relating to one of these faults includes earthquakes and landslides. In addition, methane, ethane and ethylene are released along these seismic faults, but the most active vent occurred beneath the Temple of Apollo. These biogenic (bituminous) gases are shallow subsurface gases (in contrast to thermogenic gases which are from deep-seated sources), and when they are present visitors to the Temple would have experienced an altered mental state. Ethylene, the most unstable and powerful hallucinogen of the three, is often described as sweet-smelling, and even in small quantities can produce euphoria (De Boer et al., 2001; Etiope et al., 2006; Littleton, 1986).

These gases were first detected by De Boer et al. (2001) when they were researching the Kerna Spring to the north of the Temple, and they were subsequently detected, but in much lower volumes at the Castalia Spring and the Faidriades Spring (see Figure 2). Springs were traditionally associated with the cult of Apollo at Delphi, and along the Kerna Fault there were at least six springs. Of those springs that were known in antiquity only two are still flowing today—at Castalia and Kerna. During geological times, migrations of springs along faults were common in regions with frequent seismicity.

Normally, at any one time, there is a reciprocal relationship between gas production at a spring and the water flow: that is, as the amount of water in a spring increases gas production reduces. But there is one exception. If the water flows from a deep-seated aquifer and flows through a shallow gas-bearing reservoir then in that case we can expect more gas with more water production. In regions where there are seismic faults with bituminous gases this status also may change with the passage of time, as tremors may cause changes in the location of water and gas fissures.

Variations in temperature (T) also influence gas production, according to the following equation:

$$PV = nRT \quad (1)$$

where P is pressure, V is volume, n is the number of moles of gas, R is the universal gas constant, and T is in Kelvin.[6] Thus, if T changes and the number of moles is kept constant, then either P or V, or their product, will change in direct proportion to the temperature.

The gaseous emissions at Delphi are known to have been variable, and a likely explanation is the seasonal variations that were associated with temperature and water flow. At Kerna, the climate was warmer and there was increased rainfall during at least the first half of first millennium BC, and the volume of water reaching the Temple had naturally diminished, but was more pronounced after spring and in the summer. This was because of reduced snow cover on Mount Parnassus, and drainage of the Livadhi wetlands valley (Figure 1) below where the water entered fractures in the calcitic bedrock and made its way southwest into the Telphousa/ Kerna fault zone. This implies that there was less water during winter, while more snow and rainfall during the winter months led to the filling of the water reservoirs and abundant water flow in the springs during spring and summer.

Consequently there were seasonal variations in gas flow through the fissures at the *adyton*, most obviously during winter when the temperature was lower and the water flow was also reduced. Thus, during the winter months the 'pneuma entousiastikon' (= spirit of euphoria) was rarely triggered due to the absence of gas, and this also was the time when Apollo was away, in the land of the Hyperboreans.

There are numerous ancient reports from Classical, Hellenistic, Roman and proto-Christian times about the Delphi oracle. However, all are vague as to how the day to deliver an oracle was determined (e.g. see Falconer, 1923: Div. 1.37-38, 1.115, II.57.117; Jones, 1918: 10.24.5; Jones, 1924: *IX*, 3, 416-425; Rackham, 1952; Sieveking, 1972: *Moralia*, 38, 387; *De defectu oraculorum*, 409e-438d).

How then was the ideal day for a consultation defined? The answer is found in the sky, with the constellations of Lyra and Cygnus, which were associated with Apollo.

Table 1: Orientation measurements from the Temple of Apollo at Delphi, looking due northeast and southwest from the rear and the entrance of the Temple (latitude: 38° 25′ 55.4″, longitude: 22° 30′ 2.5″).

Location in The Temple	AAS (°)	Azimuth (°) (corr: + ~3.5°)
From the rear northeast foundation line (the *opisthodomos*) to Hyampia	27 ± 1	56 ± 2
From the entrance to Hyampia	35 ± 1	56 ± 2
From the *opisthodomos* to the intersection of the two cliffs of Faidriades	23 ± 1	56 ± 2
Towards the southwestern side (distorted sides)	4.5 ± 0.5	228 ± 2*

* Penrose (1893: 189) published a value of 227.88° for β Lupi.

3 THE ORIENTATION OF THE TEMPLE OF APOLLO AT DELPHI

Orientation measurements from the Temple in a southeastern direction give azimuths of between 112° and 124° and altitudes of 3.5 ± 2°, which together with Google Earth simulations indicate interesting sunrises throughout the year.[7] We can relate these to Apollo's departure for and return from Hyperborea, the delivering of oracular consultations, and the first illumination of the statue of Apollo in the *opisthodomos* of the Temple at the time of the winter solstice.

Using a magnetic compass with clinometer and a GPS, azimuths and the angular altitude of the horizon or skyline (AAS) were taken. The calcitic environment does not affect azimuth values taken with a compass. Measurements were taken frequently between 2004 and 2012. Table 1 gives the mean measurements and calculated declinations. Azimuths were taken along the length of the parallel foundations, which have been distorted by slumping of the area because of the seismotectonic setting of the Temple. We also observed a curving rise in the middle of the Temple, while a downward displacement of the southeastern foundation by about 10-15 cm, hence actual fracturing, was also noted by De Boer (2007). These made azimuth measurements problematic, leading to a larger than usual error.

In fact, light from the rising Sun illuminates the Temple of Apollo from the southwest (i.e. the rear where the chasm and golden statue of Apollo are located) to the northeast (i.e. the entrance of the Temple), and touches Hyampia, which is the right hand one of the two Faidriades cliffs, at the Castalia Spring (see Figures 2 and 4). It should be noted, also, that sunlight earlier illuminates the peripteral Tholos, at the entrance to the sanctuary and at a slope of 8° downwards from the Temple, something that may be related to the Temple.

Lighting within the temple is an open question. Although the existence of windows is not supported, door and window openings in ancient Greek temples (*naos*, in Greek) were spanned with a lintel, which in a stone building limited the possible width of the opening. The distance between columns was similarly affected by the nature of the lintel, columns on the outside of buildings and carrying stone lintels being closer together than those within the temples, which carried wooden lintels. Door and window openings narrowed towards the top. Given the absence of windows, the main light in a temple entered through the door, but it also has been suggested that some temples were lit from openings in the roof. A door of the Ionic Order at the Erechtheion in Athens is 17 feet high and 7.5 feet wide at the top, and retains many of its features intact, including mouldings, and an entablature supported on console brackets (see Boardman et al., 1967; Fletcher, 2001).

The entrance of the Temple of Apollo at Delphi is aligned due northeast, and points towards the two Faidriades cliffs (see Figures 2 and 4). Due to the proximity of the Temple to the Faidriades, the angular altitude of the skyline (AAS) of the Faidriades from the Temple of Apollo varies between 23° and 35°, depending on whether one was viewing from the back or the front entrance of the Temple, with a corrected azimuth of 56 ± 2°, which is well beyond the azimuth of the rising Sun (Figure 2). The Delphi landscape is bounded by mountains, and the rocky Faidriades in front of the Temple are in close proximity, thus, the AAS is important for the rise of stars and constellations at particular dates and times. This northeastern orientation does not appear to be random but relates to the three adjacent constellations of Lyra, Cygnus and Delphinus, which rise over the Faidriades in that order. The first two constellations always appear in front of the Temple at the exact azimuth that points to the intersection of Hyampia and Nafplia, while Delphinus is a little further to the east (see Figures 2, 4 and 5).

The path across the sky of these constellations is always the same: they appear at a northeastern azimuth of ~56º and disappear at a northwestern azimuth of 310º, corresponding to declinations of $\delta = 40^{o}$- 41^{o} and 24^{o}- 28^{o} for these two orientations, respectively.

The combination of the appearance of these constellations at sunrise and their positions in the Delphic sky created the impression that they ‘left’ and ‘returned’ with the God Apollo (who was related to them).

4 THE ORIGIN OF CONSTELLATIONS IN BRIEF

Regarding the origin of the constellations and their stars—and their uses—they were developed between Old Babylonian times and the Seleucid period. The Babylonian constellations were largely developed and consolidated during the latter half of the second millennium BC (Rogers, 1998a; 1998b).

However, there is no firm evidence that the Greeks ‘borrowed’ constellations directly from Mesopotamia. During the Hellenistic Period it is possible that Berossus, the Phoenicians and Egyptians, and other Chaldean contemporaries made the Babylonian night sky familiar to the Greeks. It also is likely that there were ‘competitive’ schemes of Greek celestial astronomy until the wide adoption of the scheme developed by the Greek astronomer Eudoxus of Cnidus (see Lasserre, 1966) and diffused through his written works on the constellations in the fourth

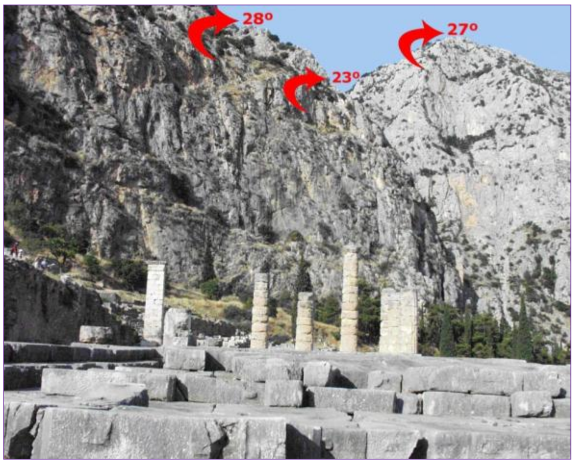

Figure 4: A view of the Faidriades from the rear of the Temple of Apollo, showing associated AAS values (photograph by IL).

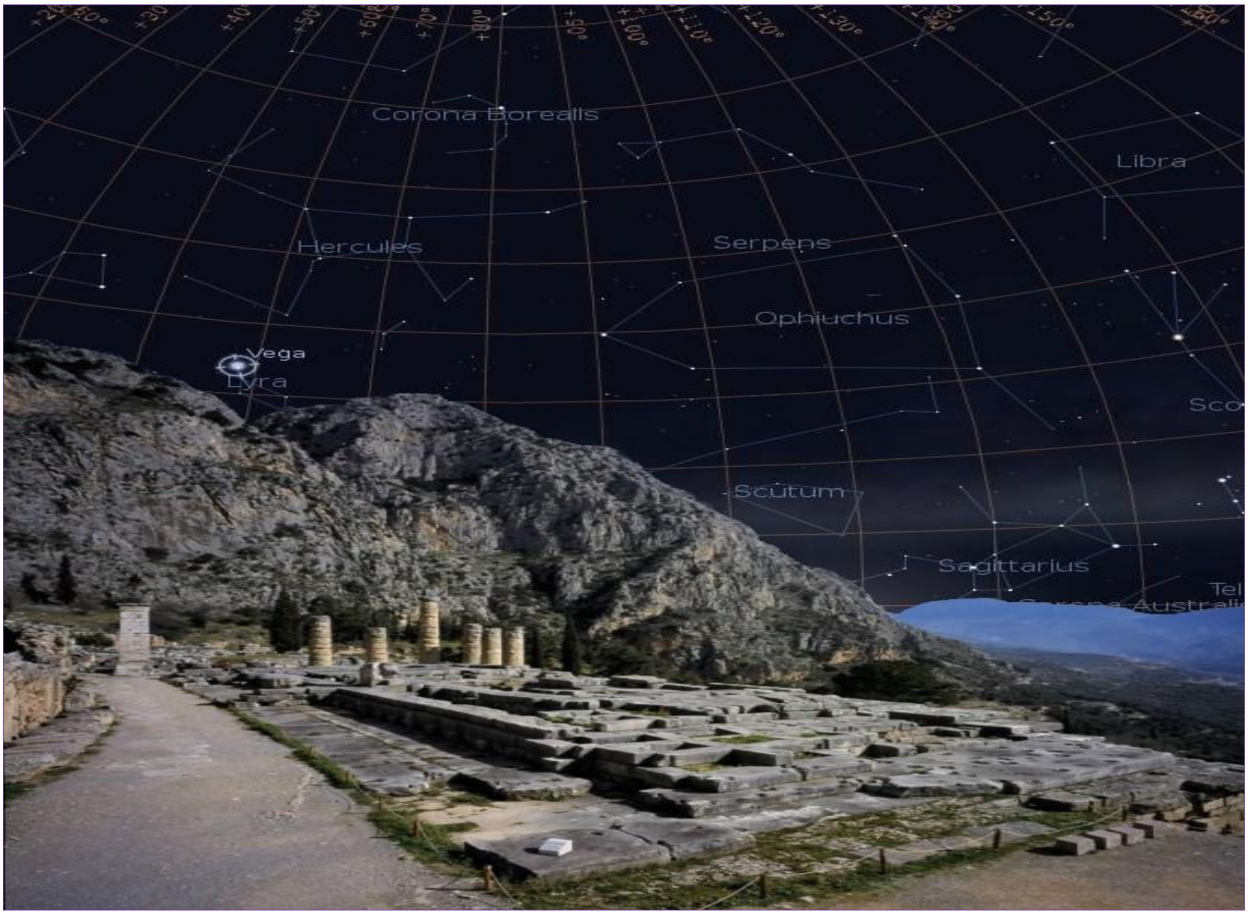

Figure 5: The heliacal rising of Vega above the Faidriades in the northeastern Delphi sky at dawn on 21 December 480 BC.

Figure 6: Star configurations in the constellations of Lyra, Cygnus and Delphinus (left), and corresponding images (right).

century BC, and through the Greek poet Aratus of Soli in the third century BC. This was the ultimate success of the *Sphaera Graecanica* as we have it today (i.e. its complete acceptance by the Greek world and later the Roman world). Eudoxus (see Schaefer, 2004) catalogued the stars in the Greek sky and delineated the various constellations in his works *Enoptron* and *Phaenomena*, and Aratus (Mair and Mair, 1921) later turned the contents of these two works into a poem concerning the constellations in his *Phenomena (*315-318). The *Phaenomena* became hugely popular in the Graeco-Roman world. Without this popularisation by Aratus, the works of Eudoxus may never have exerted the lasting influence they achieved. The final consolidation of the Greek constellations was based on the work of Hipparchus of Rhodes and the writings of Ptolemy.

The constellations of Cygnus and Lyra were originally listed by the Greek astronomer Ptolemy in the second century A.D., and earlier in a parapegma by Euctemon as recorded by Geminus (see Hannah, 2001; cf. Evans, 1998) where Cygnus was referred to as 'Ornis': 'The Bird [Ornis] begins setting at nighfall.' (see Hannah, 2001: 145). Due to precession, around 12,000 BC α Lyrae (Vega) was the pole star.

Crediting the Minoans of Crete—as some like to do—as the 'makers' of the classical constellations and offering explanations based on the destruction of Minoan civilization and the later ineptitude of the Greeks as observers is plausible. There is no evidence that the classical Greek scheme of constellations existed anywhere prior to its development in Greece circa 500 BC. There is no compelling reason to believe that the constellations were specifically established, at a particular time and place, as a reference system. The scheme proposed by Ovenden (1966) and the work carried out by Blomberg and Henriksson (1996; 1999; see, also, Henriksson and Blomberg, 2011; cf. Rogers 1998b) apparently does not try to identify the Greek constellations known prior to Eudoxus (i.e. the earlier Greek constellations of Homer and Hesiod).

Moreover, there is a lot of speculation regarding 'the birds' and the mythological birds that were orbiting the North Celestial Pole in Palaeolithic times (e.g. see Rappengluck, 1999; 2006; 2009).

It has been suggested that in certain Egyptian tombs which contain paintings of a woman and a swan these possibly depict the goddess Nut and the Milky Way and the constellation Cygnus, but this is only speculation (Belmonte, pers. comm., 2012). However, although of interest, these types of arguments are highly speculative and entirely deductive, and depend on *a priori* assumptions.

Nevertheless, a rational view is that knowledge based on (archaeo-)astronomical observations of star configurations was transmitted from generation to generation on a local and a regional scale, through cultural interactions that occurred between the Aegean area and the southeast Mediterranean from the end of the third millennium BC (e.g. see Betancourt, 1998; Branigan, 1973; Dicks, 1970; Wachsmann, 1998).

Lyra is a very conspicuous constellation (see Figure 6), with Vega at apparent visual magnitude 0.03 and other stars between magnitudes 3 and 5. Vega is the first conspicuous star in this constellation to rise above the Faidriades, even though the constellation covers an area of 2º × 7º. The brightest star in Cygnus is Deneb, which has an apparent visual magnitude of 1.25, while other stars in the constellation are between 2 and 4; meanwhile, its cross-like figure extends ~17º from Deneb, and the wings span ~23º. Finally, following Cygnus is the small and rather inconspicuous constellation of Delphinus, with its distinctive parallelogram shape that extends ~2º × 5º and contains stars of the 4th magnitude.

5 LYRA, CYGNUS, DELPHINUS AND APOLLO

The constellations of Lyra and Cygnus were most important to Apollo. The Greek word for swan is *κυκνος* (*kuknōs*), and the Latin word is *Cygnus*. Swans carried the souls of sacrificial kings to Hyperborea (Graves, 1955: § 161.4), while to be 'swan-like' was to greet one's death with a song of exceptional beauty, as in *Phaedo*, 84D-85B, a famous passage by Plato (Wagner, 1870; Wilson, 2007), where Socrates hopes his own prophecy will match that of swans: "... who, though they also sing in earlier times, sing especially well when on the point of death, because they are about to go off to the god whose servant they are." Their god, of course, was Apollo, who was famous for his association with singing swans and their distant northern retreat in the land of the Hyperboreans. Indeed, after Phaethon's death, his friend Cygnus was metamorphosed into a swan, whose lamenting death song is of proverbial beauty. Apollo was the son of Zeus and Leto (who took the form of a quail when she conceived him). He was born on the island of Delos (see Figure 1) on a seventh day, the Sun's day. On the day of his birth, swans came from the golden stream of Pactolus, and flew seven times around Delos, uttering songs of joy. The swan was a recurring motif in Greek and Roman mythology, generally as a bird associated with the Sun. Each Greek tribe had its own favourite myths, and additional stories constantly were being imported into Greek religion from foreign sources.

The swan also was the bird of the Muses. It was sacred to Apollo and to Aphrodite. Aeschylus, a Greek playwright, mentioned swan maidens. Several depictions of the swan and Apollo are on Greek vases and coins (e.g. see Head, 1893: *Pontus* Pl.28.5).

Similarly, Lyra (Greek *Λύρα*) was the beloved musical instrument of Apollo, the God of Music. Apollo was a gifted musician, who delighted the Gods with his lyre performances. He also was a master archer and a fleet-footed athlete, credited with being the first victor in the Olympic Games. He also is said to have taught humans the art of healing.

Ancient sculptors showed Apollo as a beautiful youth with flowing hair tied in a knot above his forehead, wearing a laurel wreath, holding his lyre or a bow. One of the most famous statues is the 'Apollo Belvedere', a Roman copy of a Greek bronze original, now kept in the Vatican Museum, in Rome, Italy. Also, painted on a circa 480 BC kylix (a shallow, stemmed, two-handled drinking bowl) in the Delphi Museum (No 8140), is a seated Apollo who pours the libation from a bowl, with a raven to his left.

Apollo also had a special relationship with dolphins, and he appointed Cretan sailors as the Delphi sanctuary's first priests. Having seen a Cretan ship sailing from Knossos in Crete to Pylos in the Peloponnese (see Figure 1), he turned himself into a dolphin and guided the ship into the Crisaean Gulf (the Phocian section of the northern coast of the Gulf of Corinth). From Crisa, the Cretan sailors came to Parnassus, led by Apollo. Having become priests of Apollo, they called the city Delphi, for the God, who appeared to them in the shape of a dolphin and told them:

> I sprang upon the ship in the form of a dolphin, pray to me as Apollo Delphinius; also the altar itself shall be called Delphinius ... (Richardson, 2010: 493; cf. Chappell, 2006).

Each year the constellations of Lyra and Cygnus travel to Hyperborea and so are only visible in much of the Greek world in summer, but in the north of Greece they are circumpolar and therefore can be seen all year long.

6 THE POSITIONS OF LYRA AND CYGNUS IN THE SKY, AND IMPORTANT DATES

To the Greeks, the dates upon which Lyra and Cygnus were located at certain positions in the sky just before sunrise or at sunset were particularly important. Although the heliacal rising or setting normally refers to stars and Lyra and Cygnus are constellations with several stars occupying large areas of the sky, the rising, setting or zenith positions of their brightest stars served as visual sky markers in relation to the Temple of Delphi's orientation.

Moreover, it is interesting to note that the Sun also plays a key role in the orientation of the Temple, in that the rising Sun directly illuminates the rear (*opisthodomos*) of the Temple around the winter solstice and also during summer at a later morning hour (because the steep sides of Hyampia, behind the town of Arachova hide the Sun from view earlier—see Figure 7).

All orientations point to the *opisthodomos*, and the existence of openings (windows) at least on the southeastern side of the Temple is plausible, an architectural element known at least from the architectural remains of Greek and Egyptian temples of the same era, and possibly implied by inscriptions on the Stele of Prusias, which is located on the right at the entrance to the temple (see Section 7 below).

Regarding the celestial paths of Lyra and Cygnus, just 15 minutes after midnight at the time of the vernal equinox, Lyra appears above the intersection of Hyampia (the eastern cliff) and Nafplia, in front of the temple.

In order to complete the picture of Apollo who, according to a legend "… travels with his lyre on the chariot drawn by many Cygnus ..." (the Greek lyric poet, Alcaeus, from Lesbos Island (Figure 1) speaks of the swans bringing him back from the Hyperboreans to Delphi at the appointed time of his ephiphany—see Treu, 1952; Farnell, 2010), one should establish when Lyra and Cygnus appear in front the entrance to the Temple of Delphi. Due to the rocky surrounding landscape the most clear and obvious position to have viewed them was at the zenith, that is, when these constellations were directly above the temple at midnight.

The following interesting pattern unfolds from summer time onwards. During the summer solstice Lyra and Cygnus appear successively directly in front of the entrance of the Temple of Apollo at sunset (22 June, at 21.15 local time), with Delphinus there a little later, so that the bright stars in all three constellations one after another will predominate during the night as they traverse the celestial sphere along an 'ideal' circumpolar path that follows a circle above the temple. At 21.15 at sunset in summer Lyra and Cygnus are found in front of the Temple, and in the course of the summer nights these constellations will be seen at higher altitudes. On 01.05 Lyra reaches the zenith, directly above the temple, then two hours later (at 03.05) Cygnus is at the zenith. At the end of the night (at 05.42) the view of these two constellations is lost to the northwest of the Temple with the first rays of the Sun appearing behind the town of Arachova (rising on the right in Figure 8). The Sun first appears a few hours later, when it illuminates the rear of the temple. However, over a period of more than a thousand years, the constellations that predominated during the summer solstice have changed.

Then, during autumn (22 September, at 19.55 local time), Lyra, Cygnus and Delphinus are found at or near the zenith when the Sun sets, and they start their descent until they are lost sight of behind the Temple. From that date onwards they give the impression that they have 'departed' or 'gone', becoming visible for fewer and fewer hours after sunset, and always towards the northwest of the *opisthodomos*. In the early hours after midnight, and certainly well before the dawn, they are lost below the Temple's northwestern skyline. Yet although they have 'gone', the Sun continues to illuminate the statue of Apollo at the rear of the Temple. At sunset on the autumnal equinox the last rays of the summer Sun illuminate the *opisthodomos* and the statue of Apollo (see Figures 3 and 4b).

Towards the end of December (from 21 to 26 December, when Apollo has gone to Hyperborea) the most interesting phenomenon occurs: the constellations of Cygnus, Lyra and Delphinus are lost behind the Temple a few minutes after sunset, then are absent all night, only to reappear over the Faidriades and above the entrance of the Temple a few minutes before sunrise the next day (at 06.05 am). At this time Lyra is only visible for a few minutes until it is 'drowned' by the sunlight. So these constellations that are closely associated with Apollo have disappeared, or 'departed' (and they will only reappear, or 'return', when Apollo comes

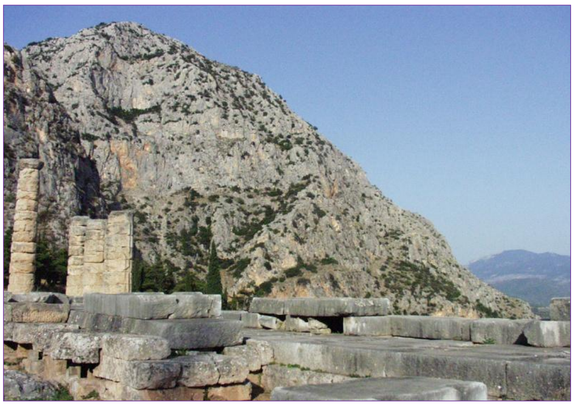

Figure 7: Hyampia seen from the rear of the Temple of Apollo. At the mid slope the sunrise appears during summer in the late morning (photograph by IL). (See, also, Figures 2 and 4).

back from the land of the Hyperboreans). Yet the rising Sun continues to shine on the back of the Temple, where the statue of Apollo is located, possibly to remind him of their absence. Nevertheless, as long as these constellations are visible for fewer and fewer hours each day from the entrance of the Temple, they never will rise high in the sky before they disappear from view.

Throughout the first millennium BC, Lyra and Cygnus were at the zenith in Delphi at some time before sunrise during the third week of March (see Figure 8), and from 18 to 21 March these constellations for the first time reached their highest positions in the sky, directly above the Temple, for a short time before sunrise. This is why the seventh day of Bysios always fell between early March and the middle of March. The variation in these days would have been used by the priests to determine exactly when Apollo would return, somewhat akin to the

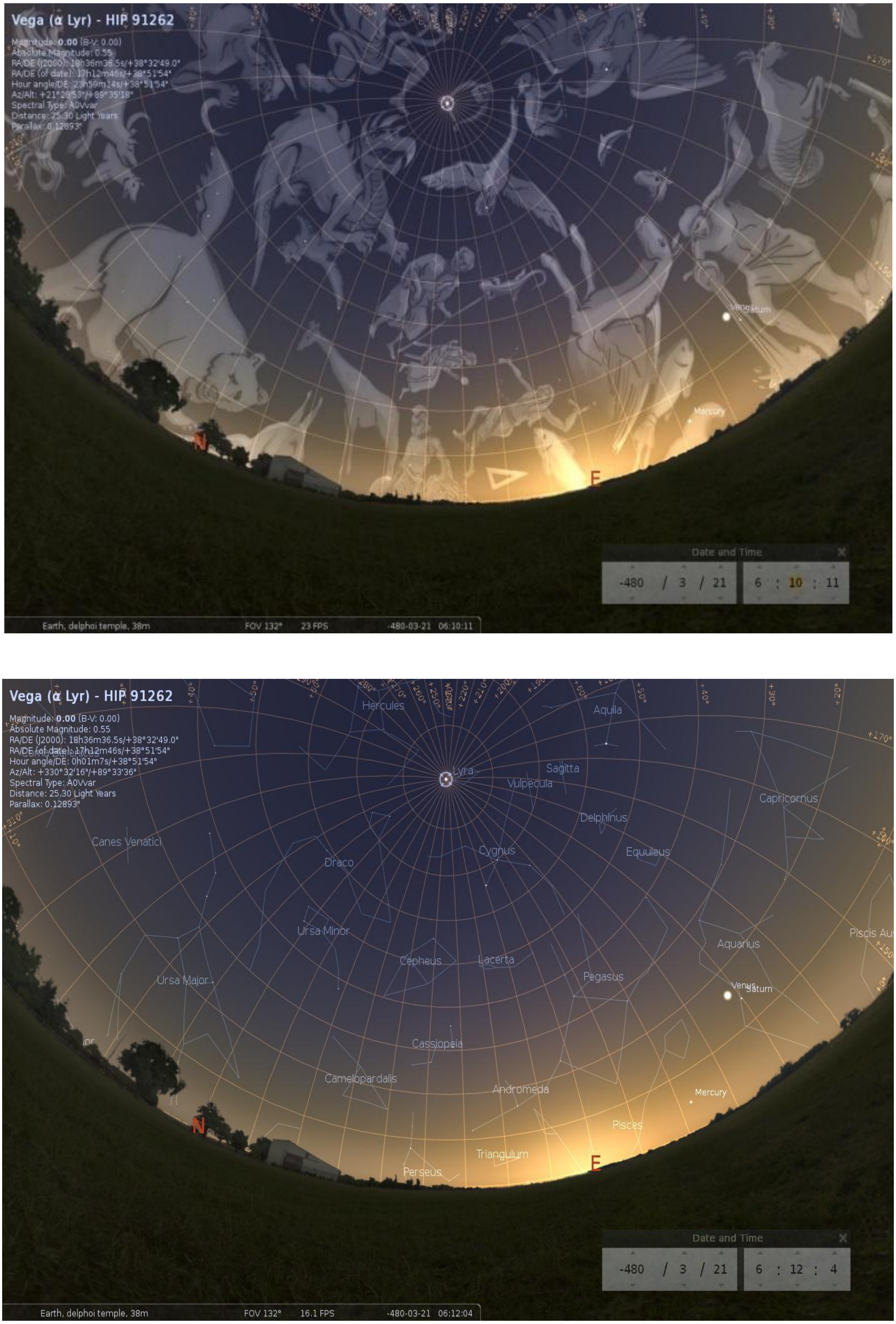

Figure 8: Lyra and Cygnus are at the zenith of Delphi a little before the sunrise during the third week of March on Julian date at 480 BC (the upper figure is in image form and lower figure shows the status of the sky at this time).

manner in which Christians choose the dates of Easter festivities each year.

Table 2 gives the times of the heliacal risings and settings of the brightest stars in Lyra and Cygnus for different dates between 1200 BC and AD 300, and their time differences in their appearances are negligible. At Delphi, the same orbital patterns remained during this long period, within a narrow range. For example, the heliacal rising of Vega on 21 December at 6.00 a.m. in 1200 BC was Az = 56º 25' and Alt = 22º 51', while the corresponding values for 480 BC were Az = 56º 06' and Alt = 21º 51', and for AD 300 Az = 57º 10' and Alt = 21º 03'.

From summer these constellations are visible for greater period of time each night. Thus, Lyra appears above the Faidriades before the dawn and Cygnus follows, so one could say that "The God gradually returns", but these two constellations will only reach the zenith during the first three weeks of March in the Julian calendar. The heliacal rising of Cygnus above the Faidriades occurs about a month later than Lyra.

Table 2: Heliacal rising and setting times for Vega (α Lyrae) and Deneb (α Cygnus) during the year and for 1200 BC to AD 300. During these heliacal risings the angular altitude of the skyline above Faidriades varied within ±0.5° and the respective azimuth within ±1°.

Year 480 BC

	March 21st	June 22nd	September 23rd	December 23rd
	Zenith at the Temple	*The Opisthodomos of the Temple*		*Faidriades Cliffs*
Vega rising	6.15 a.m.	5.35 a.m.	Not visible	7.15 a.m.
Deneb rising	6.10 a.m.	5.30 a.m.	Not visible	7.10 a.m.
		.	NB: Both constellations disappeared from the rear of the temple (= *opisthodomos*) during the night (Vega at 2.25 a.m. and Deneb at 4.25 a.m.), hours before sunrise.	
		Faidriades Cliffs	*Zenith at the Temple*	*The Opisthodomos of the Temple*
Vega setting	Not visible	21.10 p.m.	19.50 p.m.	18.00 p.m.
Deneb setting	Not visible	21.15 p.m.	19.55 p.m.	18.05 p.m.
	NB: Both constellations rise over the Faidrades during the night (Vega at 0.15 a.m. and Deneb at 2.15 a.m.), hours after sunset. Both are visible for only a few hours before sunrise (Vega from 0.15 a.m. to 6.15 a.m. and Deneb from 2.15 a.m. to 6.10 a.m.).	NB: Both are visible all night.	NB: Both are visible for a few hours after sunset (Vega from 19.50 p.m. to 2.25 a.m. and Deneb from 19.55 p.m. to 4.25 a.m.).	NB: Both are visible for a few minutes after sunset and again for a few minutes before sunrise, but they are not visible all night.

	January 15th	February 15th
	Faidriades Cliffs. At 52º altitude instead of 23º between Faidriades. Above the horizon seen from the front of the Temple, but not yet at the zenith as seen from the Temple.	*Faidriades Cliffs.* At 73º altitude instead of 23º between Faidriades. Above the horizon seen from the front of the Temple, but not yet at the zenith as seen from the Temple.
Vega rising	7.15 a.m.	7.05 a.m.
Deneb rising	7.10 a.m.	7.00 a.m.
	The Opisthodomos of the Temple	*Faidriades Cliffs* NB: Both constellations rise over the Faidrades during the night (Vega at 2.35 a.m. and Deneb at 4.35 a.m.), hours after sunset.
Vega setting	18.00 p.m.	Not visible
Deneb setting	18.05 p.m.	Not visible

Year 1200 BC

	March 21st	June 22nd	September 23rd	December 23rd
	Zenith at the Temple	*The Opisthodomos of the Temple.*		*Fedriades Cliffs*
Vega rising	6.25 a.m.	5.35 a.m.	Not visible	7.25 a.m.
Deneb rising	6.20 a.m.	5.30 a.m.	Not visible	7.20 a.m.
			NB: Both constellations dis-appear from the rear of the temple (the *Opisthodomos*) during the night (Vega at	

			2.35 a.m. and Deneb at 4.35 a.m.), hours before sunrise.	
		Faidriades Cliffs	*Zenith at the Temple*	*The Opisthodomos of the Temple*
Vega setting	Not visible	21.10 p.m.	20.00 p.m.	18.10 p.m.
Deneb setting	Not visible	21.15 p.m.	20.05 p.m.	18.15 p.m.
	NB: Both constellations rise over the Faidriades during the night (Vega at 0.25 a.m. and Deneb at 2.25 a.m.), hours after sunset. Both are visible for a few hours before sunrise (Vega from 0.25 a.m. to 6.25, a.m. and Deneb from 2.25 a.m. to 6.20 a.m.).	NB: Both are visible all night.	NB: Both are visible for a few hours after sunset (Vega from 20.00 p.m. to 2.35 a.m. and Deneb from 20.05 p.m. to 4.35 a.m.).	NB: Both are visible for a few minutes after sunset and again few minutes before sunrise, but they are not visible all night.

	January 15th	February 15th
	Faidriades Cliffs. At 54° altitude instead of 23° between Faidriades. Above the horizon seen from the front of the Temple, but not yet at the zenith as seen from the Temple.	*Faidriades Cliffs*. At 76° of altitude instead of 23° between Faidriades. Above the horizon seen from the front of the Temple, but not yet at the zenith as seen from the Temple.
Vega rising	7.25 a.m.	7.15 a.m.
Deneb rising	7.20 a.m.	7.10 a.m.
	The Opisthodomos of the Temple	NB: Both constellations rise over the Faidrades during the night (Vega at 2.45 a.m. and Deneb at 4.45 a.m.), hours after sunset.
Vega rising	18.10 p.m.	Not visible
Deneb rising	18.15 p.m.	Not visible

Year AD 300

	March 21st	June 22nd	September 23rd	December 23rd
	Zenith at the Temple	*The opisthodomos of the Temple*		*Faidriades Cliffs*
Vegas rising	6.05 a.m.	5.35 a.m.	Not visible	7.05 a.m.
Deneb rising	6.00 a.m.	5.30 a.m.	Not visible	7.00 a.m.
		.	NB: Both constellations disappear from the rear of the temple (*the opisthodomos*) during the night (Vega at 2.15 a.m. and Deneb at 4.25 a.m.), hours before the sunrise.	
		Faidriades Cliffs	*Zenith at the Temple*	*The opisthodomos of the Temple*
Vega setting	Not visible	21.10 p.m.	19.40 p.m.	17.50 p.m.
Deneb setting	Not visible	21.15 p.m.	19.45 p.m.	17.55 p.m.
	NB: Both constellations rise over the Faidrades during the night (Vega at 0.05 a.m. and Deneb at 2.05 a.m.), hours after sunset. Both are visible for a few hours before sunrise (from 0.05 a.m. to 6.05 a.m. for Vega and from 2.05 a.m.to 6.00 a.m. for Deneb).	NB: Both are visible all night.	NB: Both are visible for a few hours after sunset (Vega from 19.40 p.m. to 2.15 a.m., and Deneb from 19.45 p.m. to 4.15 a.m.).	NB: Both are visible for a few minutes after sunset and then again for a few minutes before sunrise, but they are not visible all night.

	January 15th	February 15th
	Faidriades Cliffs. At 49° altitude instead of 23° between Faidriades. Above the horizon seen from the front of the Temple, but not yet at the zenith as seen from the Temple.	*Faidriades Cliffs.* At 71° altitude instead of 23° between Faidriades. Above the horizon seen from the front of the Temple, but not yet at the zenith as see from the Temple.
Vega rising	7.05 a.m.	6.55 a.m.
Deneb rising	7.00 a.m.	6.50 a.m.
	The Opisthodomos of the Temple	NB: Both constellations rise over the Faidrades during the night (Vega at 2.25 a.m. Deneb at 4.25 a.m.), hours after the setting of the Sun.
Vega rising	17.50 p.m.	Not visible
Deneb rising	17.55 p.m.	Not visible

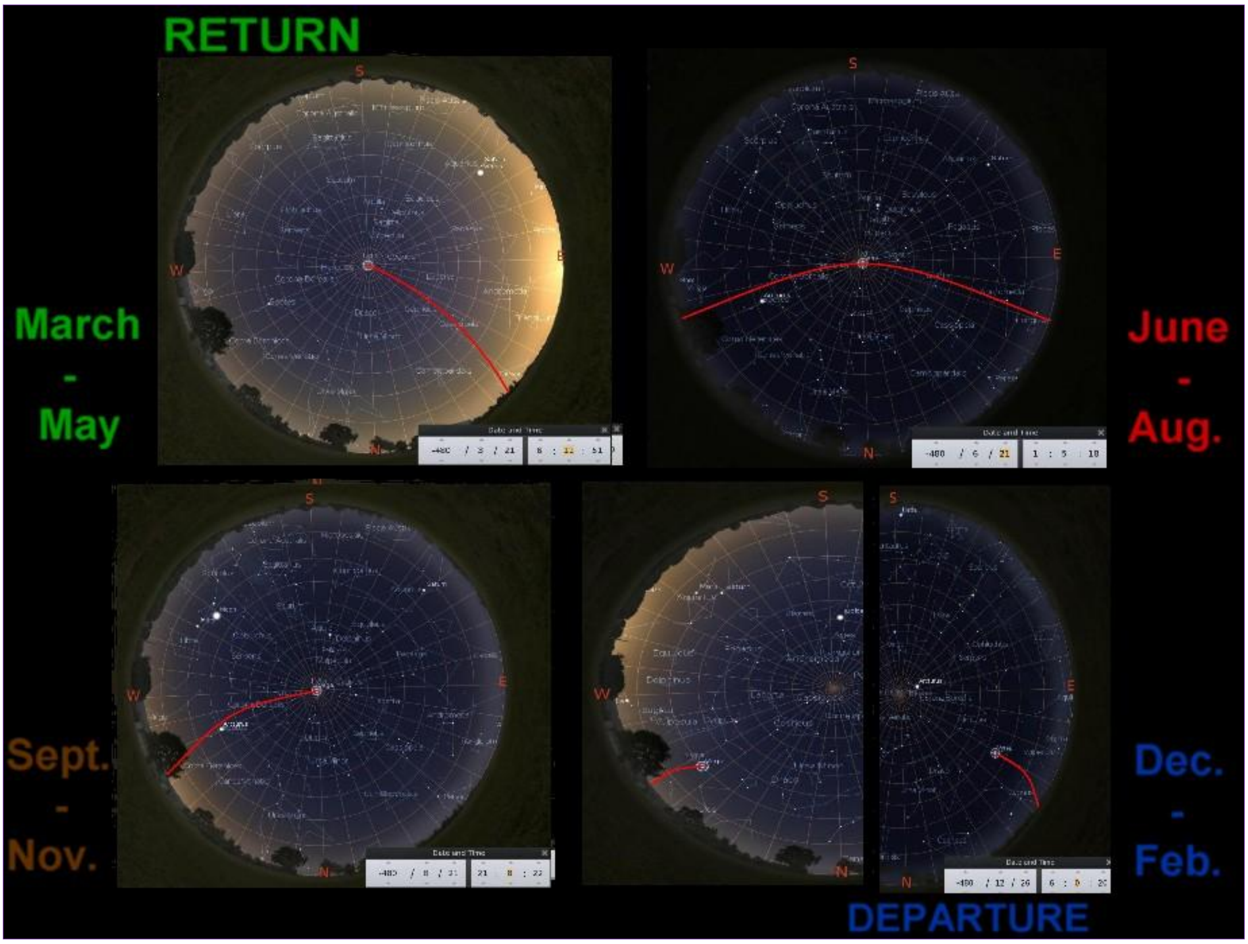

Figure 9: The transits of Lyra and Cygnus in the Delphic sky for the four seasons.

Figure 9 shows the appearance of Lyra and Cygnus in the Delphic sky for the four seasons of the year. Visibility was always going to be a significant factor, as due to weather conditions in the mountains during winter sometimes it would have been difficult—if not impossible—to observe those constellations. However, their absence from the zenith at Delphi in January, February and March may have signalled the interval when Apollo was supposedly in Hyperborea. Obviously, the difference in the AAS between a site on a flat landscape and one with a high rocky horizon, as at Delphi, meant that the heliacal rising of critical stars and constellations was delayed at the latter location. Thus in the case of both Athens in 480 BC and Pella (Macedonia) in 334 BC, with their flattish surrounds, Lyra appeared 0-5º above the horizon at dawn around 21 November, one month earlier than when it rose above the Faidriades in Delphi. Nevertheless, for all three cities Vega transited the zenith simultaneously at dawn on the same day (i.e. around the vernal equinox). In other parts of Greece, Lyra goes close to but does not actually reach the zenith. For example, from the Temple of Apollo in Rhodes (see Figure 1) which faces due east, Lyra has the same heliacal rising time, but the Sun overwhelms the event due to the Temple's orientation towards the Sun-god—poetically identified with Apollo—who was worshipped in Rhodes (Fontenrose, 1939).

An oracle that was known to have been given to the Athenians about 'wooden walls' (Bowden, 2005: 102) led to the Salamis naval battle on 22 September 480 BC, with the oracle given on the seventh day of the Delphic Boukatios or the Athenian Metageitnion (in July/ August).

Thus, this earlier heliacal rising of Lyra, followed successively by Cygnus and Delphinus, could mark the time for would-be visitors to depart for Delphi one month earlier, initially, during March, the seventh day of Bysios, and later on the seventh lunar day of each of the nine months. This is a much more plausible interpretation than the one suggested by Salt and Boutsikas (2005), as Vega (α Lyra) and even Deneb (α Cygnus) were much brighter stars than any in Delphinus, and these two constellations were more strongly associated with Apollo than Delphinus was.

The same star configurations seen above the Temple of Apollo at Delphi, bordered by the rocky Faidriades and with its open southern landscape, persisted throughout the period ~1000 BC to ~ AD 300, although there were some

Figure 10: The red-figure hydria related to Hyperborean Apollo (Museo Gregoriano Etrusco 16568, Vatican. Height is 58 cm).

minor changes at the beginning and end of this long interval due to precession of the equinoxes. The earlier date marks the establishment of the Delphic oracle (as mentioned by Homer in his Hymn to Apollo—see Chappell, 2006), and there is archaeological evidence that there even was a cult here in Mycenaean times (Nilsson, 1950), while the latter dates recalls the last recorded oracle, which was delivered to Roman Emperor Julian in AD 361. The Greek historian, Philostorgius, who was born in Cappadocia in about AD 364, mentions Julian and the Delphic oracle (see Walford, 2009).

The afore-mentioned appearance and disappearance of a particular prominent star or constellation recalls the Egyptian dating based on the Sothic cycle, that is, on the heliacal rise of Sirius. Each year for a period of seventy days Sirius was not visible due to sunlight, and its heliacal return was very important and was referred to as 'the coming of Sirius'. The first day of the new year was marked by the first day of the lunar month immediately after the annual reappearance of this star at dawn (Ingham, 1969; Parker, 1950: 13, 29, 30-32).

7 SUPPORTIVE DATA

Apollo's travel to Hyperborea is depicted on an Attic red-figure hydria (see Figure 10), that was painted by the 'painter of Berlin'.[8] The god Apollo playing his lyre is seated on an open-winged tripod that depicts Cygnus (the swan), and implies that his medium, the priestess Pythia, is giving oracles. He rides over the sea, which is denoted by fish and an octopus. Two dolphins leaping over the waves accompany him. The setting corresponds to the correct order of the constellations Lyra, Cygnus and Delphinus in the Greek night sky.

Another piece of evidence that supports the determination of festivities and oracular dates comes from a written source. To the right of the entrance to the Temple of Apollo at Delphi there is the restored Stele of Prusias (see Figure 11). On this there is an epigram written in ca. AD 120-130 on the calcitic surface, a dedication to the scientist Aristoklides from Tyane, a member of the Delphic amphictyonee,[9] that reads (*inter alia*, our English translation): "... offered/placed inside the door/window/niche, sacred objects …" This refers to sacred objects that were placed inside a door or niche or window, and which have since disappeared. Several interpretations have been given about this phrase and the meaning of the door/window/hole, the types of sacred objects (instruments?), and why they were placed there (for a dedication, for regular use, or for repairs?). The inscription suggests that both the place and the objects would have been well known to users of the Temple (see Courby, 1927: III: 4, 1; IV: 131-132, sect. 83; addenda au fase, I: 39). One working hypothesis would be that they were astronomical instruments that were used to observe the positions of the rising Sun, the Moon and the stars in connection with the departure and return of Apollo

Figure 11: A general view of the entrance to the Temple of Apollo at Delphi (left) with the restored Stele of Prusias to the right of the entrance. The central photograph shows another view of the Stele, and the right hand photograph is a close up of the epigraphy on the Stele (photographs by IL).

and the delivery of oracles by Pythia. Meanwhile, this inscription would also seem to indicate that a harmonious relationship existed between science and religion in Delphi at that time.

9 ON CALENDARS AND THE DETERMINATION OF THE SEVENTH DAY OF BYSIOS

Of all ancient calendar systems, the Greek calendar is one of the most confusing. The Greek calendar is much like ancient Greece itself: it shared a certain basic similarity from region to region, but each city-state kept its own version. All the Greek calendars were luni-solar and had the same basic features of other luni-solar calendars: twelve months, with a periodic intercalation of a thirteenth.

Therefore, in ancient Greece the lunar calendar consisted of twelve lunar months, which was shorter than the solar tropical year by about 11 days, which were added in the course of years with respect to the seasons (Hannah, 2005). In fact, there were 30 intercalary days in the third year, another 30 days in the fifth year and a further 30 days in the eighth year. In order to assess this correction, Salt and Boutsikas (2005: figures 2 and 3) illustrate the change of a lunar month in a century as a function of the Gregorian calendar and the insertion of the additional months during the eight years.

Keeping an exact calendar was important for scheduling festivals, but also for travel, for everyday work, and for agricultural and stock-breeding activities. Astronomical observations for pastoral movements and everyday needs were accumulated over the centuries, as textural (Hesiod, *Works & Days*—see West (1996); Homer, *Iliad and Odyssey*—see Fagles, 1996) and archaeoastronomical research has shown.

The proper day for a prophecy was a meticulous calculation that was carried out by learned priests and ancient philosophers. The month of Bysios (or Physios),[10] on average is February but could be any 30-day interval between January and mid-March (Lefevre, 1991). Bysios starts with a New Moon, but the beginning of a month is not easily pinpointed; thus, the month of Bysios and the seventh day, for giving oracles, cannot be identified and automatically associated with the Julian (or Gregorian) calendar.

The necessity to decide when people actually managed to sight the crescent Moon in Greece on the critical occasions was vital (much like the same problem that confronts those researching Islamic astronomy who have to identify specific dates). This would actually mean that the first day of the month was at least two days after the New Moon/conjunction, and if there was stormy weather even more. Indeed, this difficulty still plagues the Muslim world today—despite access to superior resources and (theoretically?) a more rigorous approach compared to the one followed by the ancient Greeks. Yet the ancient Greeks were perfectly capable of calculating the average lengths of months and thus a New Moon/conjunction (Pritchett, 2001). Lunar months average 29.53 days and that is why many Greeks had full months of 30 days followed by 'hollow' months of 29 days, because 2 × 29.53 = about 59 and 30 + 29 = 59 days.

The uncertainties that cause variation in the lunar month make determination impossible. An important factor relates to variations in the Moon's orbital velocity. Therefore there was some uncertainty about the determination of the beginning of Bysios (and the other nine vital days of the year), and flexibility is unavoidable in deciding when to insert an 'extra' (intercalary) month, based on subjective observations of seasonal drift. Hence, it is impossible to always pinpoint exact month-sequences in specific years (through not knowing whether or not an intercalary month had been inserted).[11] In addition, the occurrence of the New Moon has also been subjected to manipulation, and in fact some inscriptions found in Athens give two different dates, one using the 'civic calendar' and another using 'the goddess' (McCluskey, 2000: 18). References to local calendars would therefore not only carry religious and hence political connotations, but they also would be inherently chronologically unreliable.

In Greece the scientific application of current and traditional knowledge in the first millennium BC dealt with particular astronomical phenomena and calculations, while the three favourite constellations relating to Apollo were known. What was publicised in Athens (Figure 1) and other Greek cities was apparently much more than just a notice about the solstices. Rather, it looked very much like a combination of what we find in full-blown parapegmas—which not only recorded information about the solstices and equinoxes, but also provided indications of the weather which were allied to stellar phenomena, and the 19-year 'Metonic' cycle.

A parapegma keeps track of the solar year via various star movements, and thus it presumably provided the means to enable users of the Metonic cycle to keep track of the date of the solstice.[12] The Octaeteris (called by some the Enneateris when counting years inclusively) is, as Geminos (1898) tells us, an earlier intercalation scheme in years three, five and eight of an eight-year period that utterly failed to keep the months aligned with the seasons. According to Geminos (ibid.), it was replaced by the Metonic cycle, which in Athens was certainly being used by the fourth century BC. The traditional date of its discovery is 432 BC, but it was almost certainly not instituted until later. The Metonic cycle also was used by the Babylonians from around 500 BC. We have no evidence, however, that the Delphians or Athenians ever used the Octaeteris.

However, in Hellenistic times (i.e., by the second century BC), there is ample evidence that those at the Temple of Apollo in Delphi were employing the Metonic cycle, since its calendar was synchronized with several other Phokian calendars and the only reasonable way of doing this was if all of them were following the Metonic cycle. There is some evidence that by the second century BC Delphi and Athens normally intercalated in the same month, and if not the same month then certainly in the same year (Perlman, 1989; Rigsby, 2010). Thus, Bysios was probably normally coincident with the Athenian Anthesterion, and thus normally fell in February-March. But as mentioned above, the trick was to try and find out which historical lunar month Bysios corresponded to, and this is made difficult by not knowing in which year they intercalated and by what principles they did this. According to Hannah (2012, work in progress, pers. comm.), if the Delphic calendar was run according to a hypothetical 8-year cycle (for 421-431 BC), where years three, six and eight were intercalary years and all dates were Julian, Bysios could occupy the period between 25 January and 20 March, but would not be in March in years two (431/430 BC) and five (428/427 BC). Any conversion from the Julian to the Gregorian or Astronomical Calendar would involve a few days, or range between one and ten days for the first millennium BC. This is only a working hypothesis, and the experts regulating the Delphic calendar would have made their calendar corrections and adjustments based on the positions of certain critical constellations in the Delphic sky.

Moreover, turning to some historical issues, if instead of Physios (of nature) that Roux (1976) discusses we take 'pysios' for the Bysios month, as Plutarch (Sieveking, 1972) thinks is the right term, this could mean the month that men inquired about and heard from the God. In this month there used to be oracular activity (Sieveking, 1972: *Moralia* 292 E-F) on the seventh day, which they considered to be the birthday of Apollo, and they call this 'the day of many utterances', not because they baked cakes but because it was a day of many inquiries and utterances. Thus, only during Plutarch's time and from the fourth century BC were monthly oracles (αἱ κατὰ μῆνα μαντεῖαι) given to those who made inquiries, whereas in earlier times Pythia only gave responses once a year throughout this day, according to Callisthenes (see Hansen, 1998). The use of the term 'κατά' (= during) above actually suggests that oracles were given throughout the month, not just on a single day, and not during one single month of a year. Even more, it does not imply that in later times Delphic oracles were only given on the seven day of every month. We can only state that in earlier times the seventh of Bysios was the only day for giving oracles because it was considered to be Apollo's birthday.

Regarding constellations discussed here, the inclusion of the three constellations of Lyra, Cygnus and even Delphinus in a parapegma confirms that they were known to the Greeks from at least the fifth century BC (Hannah, 2002). Modern astronomical calculations agree with the records of the parapegma of Euctemon (e.g. see Schaefer, 1985; van der Waerden, 1984) that the helical rising of the aforementioned constellations occurs on what is now the third week of December.

Information regarding the analogous heliacal rising of star clusters (e.g. the Pleiades) and constellations (e.g. Bootes, Orion, etc.) is found in the works of Homer (Fagles, 1996: *Odyssey* 5.270) and Hesiod (West, 1996). The heliacal rising of Cygnus may also have been used to calculate the seventh day of Bysios for giving oracles following Apollo's return from Hyperborea. Indeed, the primary sources for pastoral-related astronomy are Hesiod's *Works and Days* and Homer's *Odyssey,* where both refer to the movement of the stars and the fauna of Greece, and assign to both the status of seasonal indicators. The astronomical sections in Hesiod and Homer include a variety of astronomical events, and have been the subject of analysis (e.g. see Aveni and Ammerman, 2001: 83-97; Papamarinopoulos et al., 2012; Theodossiou et al., 2011; West, 1996: 376-381). The most commonly-cited astronomical phenomenon relating to heliacal rising is in the *Works and Days*, where the time for harvesting and sailing is signalled by the dawn rising of certain stars and constellations (e.g. see West, 1996: 383-387, 571-573, 597-600).

Lyra and Cygnus are the most obvious heliacal rising markers, separated by one month, but the relatively inconspicuous constellation of Delphinus would appear only to an experienced observer with excellent eyesight watching on a clear night. Difficulties owing to weather conditions that are most evident during February and March would also hamper observations of this little constellation. Therefore, it is more plausible that the heliacal rising, not at sunrise but in the northeast, of the constellations Lyra and Cygnus, were used in the Delphic calendar to determine the three months of Apollo's absence in Hyperborea. As a first magnitude star, Vega also had the advantage that its appearance warned of the imminent heliacal rising of the constellation of Lyra.

For the officials, knowledge of the length of the solar year would have been important, so that religious festivals centring on agricultural events, such as sowing and harvesting, could be held at the appropriate seasonal times. In Delphi an additional factor was important in defining the calendar, and this was the decrease in vapours emanating from the subterranean chasm during the winter months, which had to be precisely determined every year.

At any rate, visitors from the outlying areas beyond Delphi (and Athens) who wanted to attend festivals or other activities on the *noumenia* (new month) had to rely, firstly, on getting information on the crescent Moon from calendars, and secondly, on finding out when the constellations of Lyra and Cygnus rose in their skies. This way they could time their arrival at Delphi in advance of the day when oracles would be given, even if this particular day was not precisely known to them beforehand.

10 THE DELPHIC CALENDAR

Regarding the ancient Greek calendars (see Fontenrose, 1974: 383; Hannah, 2005; Mikalson, 1975: 9; Trumpy, 1997: 212) and systems of measuring time and the duration of years, months and seasons we have the references given by ancient writers like Censorinus, Geminus and Herodotus (see Hannah, 2005; Heath, 2004;). It is Geminus who speaks clearly of a soli-lunar calendar:

> The ancients had before them the problem of reckoning the months by the moon, but the years by the sun. For the legal and oracular prescription that sacrifices should be offered after the manner of their forefathers was interpreted by all Greeks as meaning that they should keep the years in agreement with the sun and the days and months with the moon. Now reckoning the years according to the sun means performing the same sacrifices to the gods at the same seasons in the year, that is to say, performing the spring sacrifice always in the spring, the summer sacrifice in the summer and similarly offering the same sacrifices from year to year at the other definite periods of the year when they fell due, for they apprehended that this was welcome and pleasing to the gods. The object in view, then could not be secured in other way than by contriving that the solstices and equinoxes should occur in the same months from year to year. Reckoning the days according to the moon means contriving that the names of the days of the month shall follow the phases of the moon. (Manitius, 1898: c.8,6-9, p.102.8-26).

The dealing with months, years and cycles in ancient Greece towards a solar calendar or a calendar in accordance with saving the phenomena, has produced a striving involving the Sun and the Moon's phases, and several critical reviews have been produced. The development involved 'hollow' and 'full' months, and it can be assumed that the intercalation (the *trieteris*) occurred every third year as Geminus says that "… the ancients made the months 30 days each, and added the intercalary months in alternate years …" (Manitius, 1898: c.8.26), while Censorinus called it the *trieteris* because the intercalation took place every third year (Maude, 1900: Chapter 18.2). According to Censorinus, the *pentaeteris*, or four years, was the next change, but Geminus says nothing about this.

Meanwhile, the *trieteris* system did not follow the Sun's path with accuracy: "… days and months did not agree with the moon nor the years keep pace with the sun …" (Manitius, 1898: c.8. 34-5), so the final long-term solution was to create cycles of eight years. The *Oktaëteris* (where the sacrifices always were offered to the Gods in the same seasons of the year, by introducing the intercalary months in the third, fifth and eighth years) is thought to have been known in earlier times, and certainly well before the eighth century BC (Ginzel, 1911; Heath, 2004: 289-290). Then, the 16-year and 160-years cycles (Manitius, 1898: 8), Meton's 19-year cycle (Oldfather, 1933: xii, 36) and Callippus' cycle of 76 years all were discussed by Geminus too (Manitius, 1898), and there also was Hipparchus' cycle of 304 years where the mean lunar month is 29 days 12h 44m 2.5s (Heath, 2004, 297).[13]

In Delphi we have noticed how the architecture of the Temple of Apollo was oriented so as to allow observation of the stars, and especially those constellations that were related to the myth of Apollo riding his 'swan-chariot' while playing the lyre. It is shown below that from the 8-year period, 484 to 477 BC, it was necessary to add a whole month to the New Moon Calendar every three years in order to achieve a Moon-based calendar that followed as closely as possible the annual seasons. This could be done by observing the position of certain constellations relative to the Temple of Apollo on the days of the equinoxes and the solstices.

Indeed, we have a calendar that always started with the first New Moon after the summer solstice, as long as an intercalary month was added every third year. Translating this to Delphic festivities, it means that the New Year begins with the intercalary month that starts the night when Apollo with his lyre and his swans shines the whole night long over his temple, i.e. on the summer solstice.

When should this intercalary month be added? Here we have two possibilities. The first scenario would be to add this extra month after the eighth month of the calendar (i.e. after Bysios, the sacred month of Apollo's birthday). This extra month always ends around the day when Lyra reaches the highest point in the heavens at sunrise, on 21 March. In this scenario, the occurrence of a very early month of Bysios (around January) would give the clue to add an extra month that year, that always would come to an end around the date when Lyra reaches the zenith at sunrise (using a luni-solar-stellar calendar). This is illustrated in Table 3.

A second, and perhaps more plausible scenario, would be to add the extra month before Bysios (see Table 4). Here again, if the sacred month of Bysios was very early (in January), an extra month would be added beforehand so that the celebration of Apollo's birthday always happened around middle of February, when the constellations of Lyra, Cygnus and Delphinus were prominent in the night sky in front of the Temple—the famous pattern of the "… God re-

Table 3: 484 BC to 477 BC First scenario: Adding an intercalary month after Bysios every third year (column in red). Dates calculated with SkyMap Pro11.

DELPHIC CALENDAR MONTHS	YEAR 484 BC	YEAR 483 BC	YEAR 482 BC	YEAR 481 BC	YEAR 480 BC	YEAR 479 BC	YEAR 478 BC	YEAR 477 BC
1. Apellaios	20/07	09/07	28/06	16/07	05/07	25/06	14/07	03/07
2. Bucatios	19/08	08/08	28/07	15/08	04/08	24/07	12/08	01/08
3. Boathoos	17/09	06/09	27/08	03/09	02/09	23/08	11/09	30/08
4. Heraios	16/10	06/10	25/09	13/10	02/10	21/09	10/10	29/09
5. Daidaphoros	15/11	05/11	25/10	12/11	01/11	21/10	09/11	28/10
6. Poitropios	14/12	04/12	24/11	12/12	01/12	20/11	08/12	27/11
7. Amalios	13/01	03/01	23/12	10/01	30/12	19/12	07/01	26/12
8. Bysios	11/02	01/02	22/01	09/02	29/01	18/01	06/02	25/01
Intercalary			20/02			17/02		
9. Theoxenios	13/03	02/03	20/03	10/03	28/02	19/03	07/03	24/02
10. Endispoitropios	11/04	01/04	19/04	08/04	29/03	17/04	05/04	25/03
11. Heracleios	11/05	03/04	18/05	08/05	27/04	16/05	05/05	24/04
12. Ilaios	10/06	30/05	16/06	06/06	27/05	15/06	03/06	24/05

Table 4: 484 BC to 477 BC Second scenario (more plausible). Adding an intercalary month before Bysios every third year (column in red).

DELPHIC CALENDAR MONTHS	YEAR 484 BC	YEAR 483 BC	YEAR 482 BC	YEAR 481 BC	YEAR 480 BC	YEAR 479 BC	YEAR 478 BC	YEAR 477 BC
1. Apelaios	20/07	09/07	28/06	16/07	05/07	25/06	14/07	03/07
2. Bucatios	19/08	08/08	28/07	15/08	04/08	24/07	12/08	01/08
3. Boathoos	17/09	06/09	27/08	03/09	02/09	23/08	11/09	30/08
4. Heraios	16/10	06/10	25/09	13/10	02/10	21/09	10/10	29/09
5. Daidaphoros	15/11	05/11	25/10	12/11	01/11	21/10	09/11	28/10
6. Poitropios	14/12	04/12	24/11	12/12	01/12	20/11	08/12	27/11
7. Amalios	13/01	03/01	23/12	10/01	30/12	19/12	07/01	26/12
Intercalary			22/01			18/01		
8. Bysios	11/02	01/02	20/02	09/02	29/01	17/02	06/02	25/01
9. Theoxenios	13/03	02/03	20/03	10/03	28/02	19/03	07/03	24/02
10. Endispiotropios	11/04	01/04	19/04	08/04	29/03	17/04	05/04	25/03
11. Heracleios	11/05	03/04	18/05	08/05	27/04	16/05	05/05	24/04
12. Ilaios	10/06	30/05	16/06	06/06	27/05	15/06	03/06	24/05

Table 5: Moon calendar year from 432 BC to 425 BC with an intercalary lunar month (column in red) every third year before Bysios (2nd scenario).

DELPHIC CALENDAR MONTHS	YEAR 432 BC	YEAR 431 BC	YEAR 430 BC	YEAR 429 BC	YEAR 428 BC	YEAR 427 BC	YEAR 426 BC	YEAR 425 BC
1. Apellaios	15/07	05/07	23/07	11/07	30/06	19/07	09/07	28/06
2. Bucatios	14/08	03/08	22/08	10/08	30/07	18/08	07/08	27/07
3. Boathoos	12/09	02/09	21/09	09/09	29/08	16/09	06/09	25/08
4. Heraios	11/10	01/10	20/10	08/10	27/09	16/10	05/10	24/09
5. Daidaphoros	10/11	31/10	19/11	07/11	27/10	15/11	04/11	23/10
6. Poitropios	09/12	29/11	18/12	07/12	26/11	15/12	04/12	22/11
7. Amalios	08/01	28/12	17/01	05/01	26/12	14/01	03/01	22/12
Intercalary		27/01			24/01			20/01
8. Bysios	06/02	25/02	15/02	04/02	23/02	12/02	01/02	19/02
9. Theoxenios	08/03	27/03	15/03	05/03	24/03	14/03	02/03	21/03
10. Endispoitropios	07/04	25/04	14/04	03/04	22/04	12/04	01/04	19/04
11. Heracleios	06/05	25/05	13/05	03/05	22/05	11/05	30/04	19/05
12. Ilaios	05/06	24/06	12/06	01/06	20/06	10/06	29/05	17/06

turning with his lyre in a chariot pulled by swans …" (e.g. see Figure 10). Checking the same pattern 50 years later, during the period 432-425 BC (Table 5), shows a calendar that repeats the same stellar configurations. We get a calendar with twelve months by adding an intercalary month every third year.

Observation of the constellations of Lyra and Cygnus from the Temple of Apollo at Delphi allowed the creation of a lunar-heliacal calendar that ran according to the Moon's phases yet managed to respect heliacal risings and accommodate seasonal phenomena ('saving the phenomena'), which were important, and at the same time was tuned harmoniously to changes in localized natural phenomena, like the flow of gaseous vapors and spring waters.

Therefore, even over a long interval of fifty years this system does not lack accuracy, and maybe only in the very long term would adjustments need to be made. The Temple of Apollo at Delphi certainly had astronomers who were capable of measuring and correcting for it, using their observations of the Moon, the Sun and certain stars. Based in this system they were in a position to give an approximate day when it was appropriate to consult the oracle, or at least show how it could be calculated for the next half millennium.

11 CONCLUSION

The landscape of the Temple of Apollo at Delphi had special astronomical associations. Observations of the constellations of Lyra and Cygnus as they crossed the Delphic sky, along with their sunrise and sunset positions, signified the departure and the return of Apollo from the land of the Hyperboreans. The progressive disappearance of these two constellations in December marked his departure, and their presence at the zenith, directly above the Temple in March, signalled his return and that the time for the delivery of oracles had arrived once more.

The positions in the night sky of Apollo's favorite constellations were fixed by the equinoxes and solstices, so the Temple functioned as a seasonal solar observatory. The seventh day of Bysios, when oracles originally were offered, could be identified when Lyra and Cygnus had risen over the Faidriades and were at the zenith at midnight, which occurred in February or March. Lyra, followed by Cygnus, only was at the zenith when the first rays of sunlight appeared on the vernal equinox or near this date. On other months of the year these constellations crossed the zenith either after midnight (e.g. during summer) or a little later (in autumn), but never at sunrise.

We can summarize the departure and return of Apollo as follows:

1. The only months when the constellations of Lyra and Cygnus were visible for a very short time (weather permitting) and they never reached the zenith was December to March, and during these three winter months Apollo was away, in the land of the Hyperboreans.

2. We propose that he returned to the Temple around the time of the vernal equinox, when Lyra and Cygnus for the first time reached the zenith at sunrise.

3. The absence of Apollo may also have been related to the diminution of vapours in the Temple.

4. Despite the controversy surrounding the ancient Greek calendars, our research using available textural evidence and computed Julian dates shows that the ancient Delphian astronomers sought to maintain a seasonal calendar which reflected the celestial movements of the constellations of Lyra and Cygnus, and they did this by adding an intercalary month every third year, immediately before the start of the eighth lunar month.

Although the exact dates shift, depending on precisely when the intercalary months were introduced, our calculations show that the seventh day of Bysios occurred between the later part of February and 21 March. The configuration of Lyra, Cygnus and Delphinus with Apollo shown here on the red-figure hydria in Figure 10 is consistent with the written sources. The priestess, Pythia, gave oracles on days that were determined by astronomical observations, following the long-established Greek astronomical tradition that is well recorded in ancient texts, in mythology and in art. The Delphic calendar was a luni-solar-stellar one, and apart from its primary ritual functions the Temple of Apollo at Delphi also served as a type of solar observatory.

12 NOTES

1. According to Wikipedia,

   > In Greek mythology the Hyperboreans … were a mythical people who lived far to the north of Thrace. The Greeks thought that Boreas, the North Wind, lived in Thrace, and that therefore Hyperborea was an unspecified region in the northern lands that lay beyond the north wind. Their land, called Hyperborea or Hyperboria – "beyond the Boreas" – was perfect, with the sun shining twenty-four hours a day, which to modern ears suggests a possible location within the Arctic Circle."

   See, also, Bowra, 2000: 401; Macaulay, 1890: Book IV, Chapters 32-36; Mair and Mair, 1921: Hymn to Apollo, Hymn 4 to Delos 275 ff; Oldfather, 1933: Book II, 47-48; Rackham, 1952: 4. 88 ff; West, 1824: 224; etc.
2. The priestess Pythia served as a medium for the God Apollo, who was believed to take over her body and voice during her prophetic trances. The high priest Plutarch described the supposed relationship between Apollo, Pythia, and the natural forces by picturing Apollo as a musician, Pythia as his musical instrument, and the pneuma (spirit), or vapour, as the plectrum or tool which he used to draw sounds from the instrument.
3. In this regard, Flacelier (1938) notes that the value in money for the consultation was eleven times more for a city than for a citizen.
4. Callisthenes was a nephew and pupil of Aristotle whose *Hellenika* started with the King's peace of 386, and covered the 30-year period down until the destruction of Delphi in 356 BC. So Callisthenes must have written his narrative after 356 BC and probably before 335 BC, when he left with Alexander on his expedition to Asia—where he died in about 328.
5. This is one of three ways that subsurface gases can reach the surface of the Earth. The other two are: through porous overburden, or due to artificial opening of a gas-bearing reservoir (e.g. through drilling).
6. This equation is exact only for an ideal gas, and ignores various intermolecular effects. However, it is a good approximation for most gases that are under moderate pressure and temperature.
7. The software used in this paper to simulate the ancient sky at particular dates and declinations were: a) SkyMap Pro Version 11 (SkyMap Pro v11.0.6), Copyright 1992-2005 C.A. Marriott, www.Sky-map.com, b) Stellarium 0.10.6.1, Copyright 2000-2010, Stellarium developers, Free software Foundation, inc., c) Voyager 4.5.7 Carina software, and d) home-made software (Stars & Sundays) to get declinations of stars and days of sunrise (Liritzis and Vassiliou, 2002). Exemplary images were derived from Stellarium that before 1582 automatically gives Julian dates. These were used in conjunction with Google Earth.
8. This is the conventional name given to an Attic Greek vase-painter who is widely recognised as a rival to the 'Kleophrades Painter', one of the most talented vase-painters of the early 5th century BC. (see Beazley, 1964). There is an outstanding collection of their vases in the Museum of Berlin.
9. An 'amphictyony' is a league of neighbouring ancient Greek states sharing a common religious centre or shrine, especially the one at Delphi. An 'amphictyonee' is a member of this league.
10. From Physis = nature, the blossomed season, the spring, or Pysios and verb "to ask for and get informed", as Plutarch preferred (Sieveking, 1972: Moralia 9, 292 E-F; see also Roux, 1976: 71-72; Parke, 1943).
11. For dates of New Moons see: http://eclipse.gsfc.nasa.gov/phase/phasecat.html, which uses proleptic Julian dates extrapolated backwards.
12. For modern constellation equivalents see Hannah (2001: 76-9, 145, 147), and for star charts illustrating each entry, see star charts from ancient excerpts in Diels and Rehm (1904: 104).
13. These astronomical concepts also found other practical applications. For example, Philochorus explains that the original division of the Athenian people into 4 filae, 12 factions and 360 kinships corresponded to the seasons, months and days of the year (see Bekkeri, 1854: 239).

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