Atlantis: a Grain of Truth Behind the Fiction?

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Abstract: The legend of Atlantis was almost certainly invented by Plato to promote the political ideal of his masterwork *The Republic*, while praising the heroism of his own ancestors. This paper suggests that, in assembling the story, Plato might have reworked the myth of the foundation of Egypt, attributed to divine invaders bringing agriculture and unknown technologies to the country. The key issue explored is the curious coincidence between the period of the alleged foundation of Egypt (according to traditional Egyptian sources) and some remarkable events that characterized the end of the Ice Age. Indeed, besides the sudden increase in temperature and the consequent rise in sea level, the period was also marked by the birth of agriculture and the appearance of totally new technologies in diverse Middle Eastern locations. The memory of these events would have been handed down through the myth of the foundation of Egypt and, through this, to Greek culture, enabling Plato to exaggerate the antiquity of his noble ancestors while embellishing the characteristics of the invaders. Such occasional technological leaps may also have occurred elsewhere in the world, for instance on the deltas of the Indus or the Yangtze, driven by the same change in climate that affected the whole planet. Although today there is no archaeological evidence of such events besides in the Middle East, the article suggests that the possible discovery of obsidian in a submerged site would be a strong indication of a local technological leap. To this end it examines, amongst suspected Mediterranean sites, some flooded islands in the Strait of Sicily, which, lying on the route to Pantelleria, may retain traces of ancient obsidian exploitation.

Keywords: Atlantis; Obsidian; Pantelleria; Strait of Sicily; Plato

1. Introduction

The myth of Atlantis stems from two late Dialogues of Plato (*Timaeus* and *Critias*)[1] [1], in which the philosopher wrote of a powerful Mediterranean empire that had conquered Egypt about nine thousand years earlier, before being defeated by the primordial Athenians and then destroyed by a cataclysm. The two dialogues praise the perfect social structure of the original Athenian polis (mirroring that described in Plato's masterwork, *The Republic*) and the heroism of the founding fathers of Athens (from whom the aristocrat Plato descended), giving the immediate feeling that the philosopher forged the legend of Atlantis to support his political ideal and celebrate his ancestors.[2]

Inventing stories to sustain a thesis has always been a common practice among writers. And since the more the legends are believed, the more they support the author's assumptions, various techniques have been developed to substantiate the forgery. The trick of modifying true stories (or stories believed to be true) by inserting one's own inventions in them is widespread and boasts

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[1] The Platonic text analysed in this article is the translation by W. R. M. Lamb [1].

[2] Plato was the son of Ariston (whose pedigree stretched back to the first kings of Athens and, through them, to the god Poseidon) and Perictione (belonging to another prominent family, related through Critias to Solon, the legislator) [2].

illustrious examples. Both the *Aeneid* and the *Orlando Furioso*, to name just two classical cases, modified popular legends to glorify the ancestry of their commissioners.[3]

Scholars' scepticism about the possible existence of Atlantis is therefore well justified. The present article takes for granted the 'invention' of the legend, but attempts to analyse whether it might contain references to actual events, even though artfully retouched. The working hypothesis is that Plato inserted the propaganda elements (the social structure of the ideal polis and his ancestors' heroism) in a narrative of episodes believed to be real by his countrymen (the recipients of his message), to render them more credible.

Plato's fellow citizens had the sense of an obscure grand past, witnessed by the mysterious cyclopean walls still visible on the acropolis, although they were not sure about how far it dated back. What they seemed to know more accurately was the age of Egypt: according to Herodotus, the human kingdom of Egypt (which followed the divine one) began 341 generations before his visit to Thebes (Book II, 142-144) [3]. With a generation gap of 25 years this meant about 8500 years earlier (plus the duration of the divine realm).

The Egyptians, at the time considered the oldest people in the world,[4] themselves provided further support to the myth of a vanished ancient civilization. Their chronologies reported that their first pharaohs had been gods [5] (p.18) who came from the West, a polite way of saying that their kingdom had begun when foreign conquerors with 'magical powers' (i.e. unseen technologies) arrived in the area, bringing agriculture and new knowledge.

The whole story could therefore result in a syncretism blending mythological legends and impressive natural phenomena, to be placed in a period well-suited to the beliefs of the time. For example, it could have mixed the myth of a flood hitting a primordial society which had grown so powerful and wicked as to deserve divine punishment (rather common among ancient cultures, including Greece) with the shocking experience of the earthquake cum tsunami that erased the city of Helike in the Gulf of Corinth in 373 BC. (Paus. 7.24.12) [6].[5]

In short, in Plato's times, legends regarding lost civilizations and the time of the 'divine' birth of Egypt were somewhat widespread among literate Athenians. The thesis supported in the present article is that Atlantis was the name given by Plato to the land where the god-founders of Egypt originated. To this extent, note that according to the likely independent view of Diodorus of Sicily[6], the Atlanteans were an extremely refined and pious people because the gods had been born among them: their first king had been Uranus, a god who taught them agriculture [7] (Book III, 56, 3). For the sake of completeness, Appendix A summarizes Plato's and Diodorus' references to the geographical position of Atlantis, although their credibility is questionable.

Identifying Atlantis with the land of Egypt's founders would solve the problem of the passing down of the myth to Plato's days (through their traditional mythology), while coercing the epoch of the episode. Let us focus on the date set by Plato for the purported flourishing of Atlantis (coherent with Herodotus' estimate and with the antiquity that Egyptians traditionally attributed to themselves): it would correspond roughly to 11,500 years ago (9500 BC), a period of substantial climatic upheaval and archaeological novelties.

This is the key problem with the story: this was the end of the Ice Age, a time before agriculture when humans were still engaged in hunting and gathering, and therefore an unlikely time for an 'advanced' human society like the one described by Plato. What do we know about this crucial

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[3] Virgil's *Aeneid* attributes the origin of the gens Julia (the family of Caesar and Augustus) to Aeneas of Troy. In Ariosto's *Orlando Furioso*, a poem dealing with the Carolingian cycle, Bradamante and Ruggero are supposed to be the founders of the Este family.

[4] Egyptians themselves estimated their own antiquity to be even older than that claimed by Herodotus [4].

[5] Even the demise of Santorini could have contributed to inspire the story (supposing that Plato knew about it).

[6] Although Diodorus probably knew the Platonic Dialogues, he does not seem to have drawn from them. His main source about Atlantis, quoted by Diodorus himself, was Dionysius, almost certainly Scytobrachion, a mythographer of Mytilene who lived and taught in Alexandria in the second century BC.

period, the end of the Ice Age? Are there any environmental factors which could help us explain elements of the myth of Atlantis, in particular its destruction by flooding and earthquake/volcanic eruption?

2. The end of the Ice Age

The Earth's climate has not always been the same. For example, in the last half a million years there have been four ice ages interrupted by four much shorter interglacial periods [8]. The last ice age began more than one hundred thousand years ago and peaked around twenty thousand years ago, whereupon the temperature began to rise [9]. During this transitional phase, seafaring spread throughout the Mediterranean and became rather sophisticated. Seventeen thousand years ago this enabled the colonization of Sardinia [10] and the development of the practice of deep-sea fishing [11]. But thirteen thousand years ago, at the beginning of the Younger Dryas[7] a quantum leap in Mediterranean navigation occurred, with the colonization of Cyprus (Fig. 1), which involved crossing forty nautical miles [13], and with the establishment of 'regular' sea routes for shipping obsidian from the island of Melos to Argolis in mainland Greece [14].

Figure 1. Location of some early technological breakthroughs (map from d-maps.com) [15].

In the same period, although apparently still hunters/gatherers, humans were able to coordinate themselves to build and decorate with bas-reliefs a large stone temple at Göbekli Tepe in Turkey [16]. A little further south (Fig. 1), in the western tip of the Fertile Crescent, communities began to select grains to grow [17], heralding the beginnings of agriculture. In fact, although wild cereals had already been part of the human diet since the Last Glacial Maximum [18], prior to thirteen thousand years ago when the first domestic species appeared, we cannot state if they were planted or spontaneous. Just a little further south, between current Lebanon and the Sinai, in the arc of time between the two Meltwater Pulses (MWP) 1a and 1b,[8] another group of humans became sedentary for the first time. In fact, the first stone houses appeared in Natufian villages [19], containing tools and ornaments never seen before [20].

In practice, from the Aegean Sea to the Sinai, various revolutionary innovations, both marine and terrestrial, altered the life of humans shortly after MWP 1a. They were probably detached from

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[7] The Younger Dryas was a period of intense cold that interrupted the trend of general warming at the end of the Ice Age for about 1300 years [12].

[8] Between 14,500 and 11,500 years ago. The Meltwater Pulses (MWPs) were sudden warming episodes that caused swift ice melting on the poles and therefore an equally rapid rise in sea level. During the last deglaciation phase there were two important MWPs, classified as MWP 1a and MWP 1b.

one another, reinforcing the suspicion that these lifestyle changes were due to the abrupt climate change: the average temperature suddenly rose to today's level, summers became hotter and precipitations varied in intensity and frequency.[9] Longer summers and calmer seas extended the navigation season, allowing the refinement of maritime techniques. Perhaps in southern Turkey the wild grain no longer grew spontaneously and it was necessary to irrigate the soil or to select the lands to grow it. Certainly, the ingenuity to exploit local resources was not lacking a little further south, where, for the first time, a people (the Natufian) was able to become sedentary.

Worldwide, such a warm climate had not been seen for fifty thousand years [21]. Necessity is the mother of many inventions, thus the hypothesis that the innovations mentioned above were independent responses to altered climatic conditions is plausible; but why have their traces been found only in the Middle East? Where are the signs of human ingenuity in the rest of the world? After all, climate warming affected the whole planet.

The answer to this question could lie in a side effect of the higher temperatures: the rise in the sea level. During the transition from glacial to interglacial, many coastal areas were flooded by the sea and had to be abandoned, sharing the same fate as many flat islands which rapidly became part of the seafloor. In other words, the human tendency to live along the shoreline had an obvious consequence for the location of archaeological sites: it is likely that many areas inhabited before the onset of the interglacial period lie on the seafloors that constituted the coast of the time [22], providing a good explanation for the lack of findings to date.

The flourishing of navigation and the density distribution of the Natufian huts over time (much higher during the warm period than in the subsequent cold one, according to Munro [23]) suggest that changes were more probably an adaptation to the warm Bølling-Allerød period rather than to the cold Younger Dryas. In other words, it is likely that it was the arrival of heat that caused the revolution in human habits and not the onset of the subsequent cold period. But can we really state these climatic changes occurred with such precision?

The ratio between two oxygen isotopes (O^{18}/O^{16}) in the skeleton of foraminifera, organisms stratified on the ocean bottom, is correlated to the size of the glaciers up to five million years ago [24]. The succession of ice ages revealed by foraminifera is confirmed by the measurements of O^{18}/O^{16} trapped in the Antarctic ice [8] for the last 800,000 years, and, in the Arctic ice [25] for the past 120,000. Obviously, the details increase as we approach the present day, thus the temperature trend in the last twenty thousand years is known quite precisely. There is also a broad agreement between the Antarctic and the Arctic data, confirming that the largest climatic events regarded the whole planet [26].

The change in average temperature between glacial and interglacial periods (which could reach 10 °C) was not the sole difference between the two climatic periods. The water accumulated in the continental glaciers was obviously missing from the oceans, which were emptier and thus shallower: at the glacial maximum the sea level was 120 metres lower than today (Fig. 2). As a result, the coastline was different from today's: several seafloors were emerged and fit for living. Since the territorial occupation followed the drift in the shoreline, the sea level rise also had repercussions for those living further inland. In short, since the last ice age, climate change has probably caused conflicts, migrations and aggregations among human populations.

At the Last Glacial Maximum (around twenty thousand years ago) northern Europe was almost uninhabitable [27], while the Mediterranean basin had a relatively temperate climate (see fig. 5). The North-Western Sahara, however, was as dry as today, apart from the coastal strip from Morocco to Tunisia, which enjoyed the Mediterranean climate [28].

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[9] Bølling-Allerød is the name of the warm period that followed MWP 1a and lasted about fifteen hundred years. In Europe, many forests became populated, having turned into favourable hunting grounds.
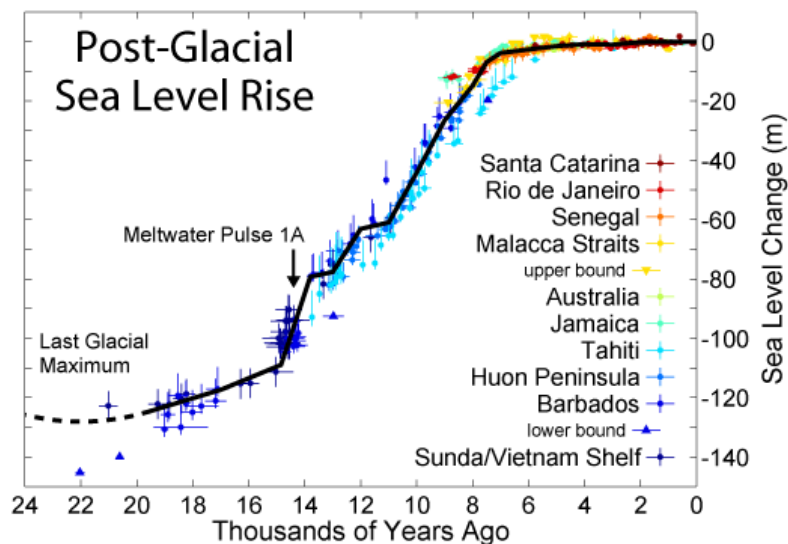
Figure 2. Sea level rise from the Last Glacial Maximum to today, based on data from K. M. Fleming (2000) [29], K. Fleming et al. (1998) [30], and Milne, Long, and Bassett (2005) [31] (image created by Robert A. Rohde / Global Warming Art).

Eighteen thousand years ago, the temperature began to rise and, in the following ten thousand years, the melting of glaciers raised the sea level by about 120 metres, up to the current value [24]. The rise in sea level was not uniform, but characterized by sudden increases, including the two episodes already mentioned: MWP 1a and 1b. Fairbanks [32] recorded extensive evidence of the two pulses in Barbados. Their ^{14}C timing was corrected a year later by E. Bard et al. [33] with U-Th measurements (Fig. 3). The two Meltwater Pulses were later confirmed in China by Wang et al. [34] using data from the Hulu cave.
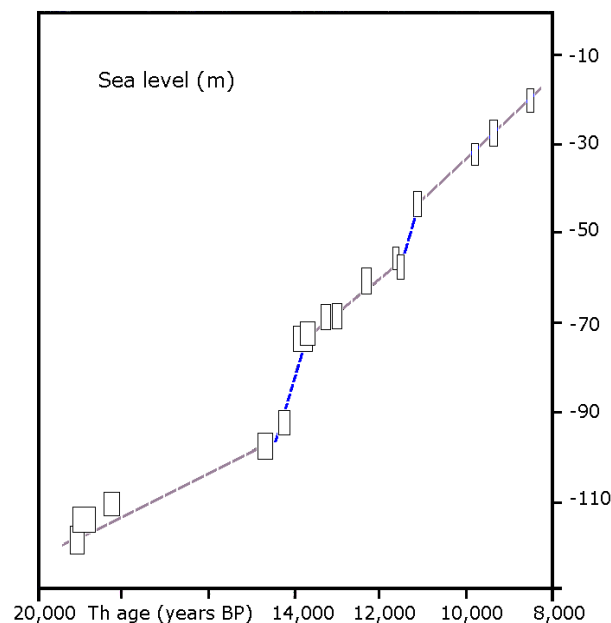
Figure 3. MWP 1a and 1b (in blue). Sea level in function of the ^{230}Th age, inferred from Barbados coral reefs. The U-Th age errors are quoted at 2σ level (from E. Bard, Hamelin, and Fairbanks 1990) [35].

According to these observations, during MWP 1a (around 14,300 years ago), the sea level rose from −95 to −75 metres, while during the later MWP 1b (about 11,500 years ago) it rose from about −60 to about −45 metres compared to the present value. Liu and Milliman [36], who reviewed the Caribbean data of Fairbanks [32] and E. Bard, Hamelin, and Fairbanks [35], stated that the MWPs

were fast phenomena, happening in less than two hundred years. Even faster according to Steffensen et al. [37], who later examined the Greenland ice and claimed that the Pulses had lasted between three and ten years.

MWP 1a is often considered the indicator of the end of the Ice Age, because in the following Bølling-Allerød period temperatures were much higher and similar to current ones. However, thirteen thousand years ago, the cold climate suddenly returned and temperatures became glacial again for about thirteen hundred years, in the period known as the Younger Dryas [12]. The Younger Dryas ended abruptly too with MWP 1b, which marked the beginning of the Holocene, the period we currently live in (Fig. 4).
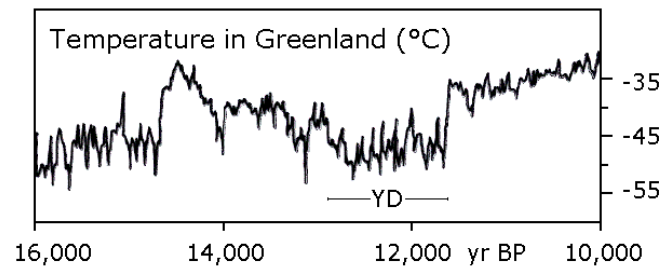
Figure 4. The temperature in Greenland during the 'thaw'. Note the sudden increase at the end of the Younger Dryas, in correspondence with MWP 1-b (from Alley 2000) [12].

Fig. 5 summarizes the climatic conditions of the Mediterranean basin prior to fifteen thousand years ago. The coastline, calculated by the National Geophysical Data Center [38] for the glacial maximum, was still roughly valid, giving an idea of which territories were most suitable for inhabitation. It is likely that among them were several emerged seafloors [22].

Figure 5. The climate of the Mediterranean basin before MWP 1a (modified map from GLOBE 1999) [38].

In the northern hemisphere, common sense suggests that the preference went to the more fertile southern plains populated by herbivores to hunt, and to coastal areas. Just before MWP 1a the Sahara became suddenly moist [39] and forests filled the Atlas Mountains, while prairies and savannahs covered the Western Sahara [28]. The former desert became populated by gazelles, elephants and lions [40] and humans followed soon after. This wet period, known as the African Humid Period (AHP), ended about six thousand years ago [41], much later than the onset of the Holocene.

The shoreline depicted in fig. 5 was valid before MWP 1a, that is, until the sea level was at least 90 metres lower than today. Then the sea level rose quickly and people had to move away. While they still could, they simply moved more inland, but when the sea submerged inhabited islands, they had to leave them.

The flooding that marked the end of the Ice Age did not come alone but was accompanied by terrible volcanic eruptions. It was not bad luck, but the result of the dynamics of continental plates: when the ice deposited on a plate melts, the reduced weight on the plate generates instability. Because of these tensions, along the plate boundaries the layer of the Earth's crust can deform to the point that it cracks, allowing the underlying magma to find a passage towards the surface and generate new volcanoes. For their part, volcanic eruptions themselves cause climatic variations. Usually they disperse ash in the stratosphere, increasing the reflection of sunlight and causing cooling, although sometimes they can also emit large amounts of methane or CO_2, thereby increasing the greenhouse effect.

The cause and effect relation between climate and eruptions is rather complicated, but it is well known that the planet's climate changes have always been accompanied by an increase in volcanic activity. This correlation was observed during the Quaternary [42, 43], and has been confirmed in the central Mediterranean [44]. It is no coincidence that the beginning of the Holocene was accompanied, 11,300 years ago, by a terrible eruption, witnessed by the largest peak of SO_4 (Fig. 6) recorded in Greenland during the last twenty thousand years [45].

In fact, it is the explosive activity that is related to climatic changes, as shown by Zielinski et al. [45] by examining the data of the last hundred thousand years. For example, in the Mediterranean basin only, in coincidence with the highest variations in sea level, the number of large explosive eruptions tripled, reaching the frequency of three per millennium [46].
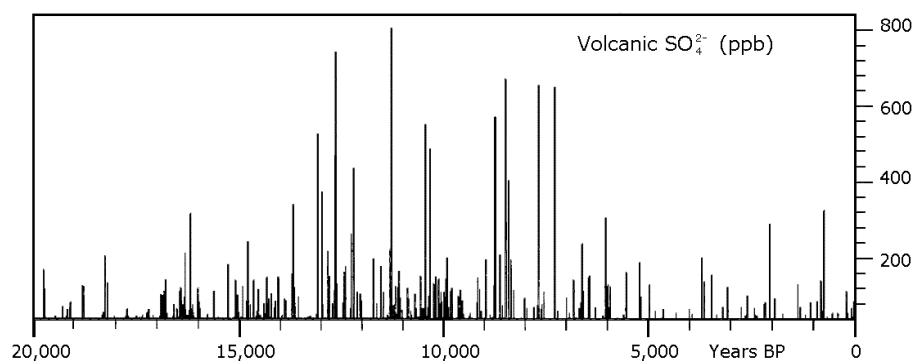
Figure 6. Volcanic SO_4 > 40 ppb in the past 20,000 yr (from Zielinski et al. 1996) [45]; data from the Greenland Ice Sheet Project 2 analysed through an empirical orthogonal function decomposition method (Mayewski et al. 1994) [47]. Note the high density of episodes between fifteen and eight thousand years ago.

On the whole, the geological and climatic disasters of the end of the Ice Age may well justify not only the flourishing of innovations that occurred then in the Middle East, but also the birth of the collective memory of that catastrophic period. Plausibly, similar cultural leaps could have happened elsewhere in geographically similar regions of the world and gone unnoticed just because their submerged sites have not been searched.

In this broad contest, the myth of gods bringing agriculture and new technologies to nascent Egypt could simply relate to the arrival of an 'early' Neolithic people in the region (perhaps displaced by one of the cataclysms that afflicted the epoch). The memory of the event, passed down through the Egyptian tradition, could have made up the core of Plato's legend. Obviously, accepting such a chronology would imply that many aspects of the fanciful Atlantis civilization must be the sheer fruit of the philosopher's fantasy.

3. In search of Atlantis

3.1. Is a site off the coast of Egypt a potential candidate for Atlantis?

The peoples who conceived the innovations of the end of the Ice Age were roughly grouped near the eastern tip of the Fertile Crescent, thus a most likely candidate to bring civilization to Egypt should first be sought among them (the Natufians, for example).

There could have been some sort of communication among them, but it is possible that they developed their new habits independently, driven essentially by comparable climatic change happening in geographically similar regions. In any case, an even more local solution could be envisaged for bringing civilization to Egypt: somebody occupying the ancient Nile delta, which was then rather larger than today. Anyone living there (perhaps aware of Near Eastern inventions) would have been driven southbound by the subsequent sea level rise and pushed to occupy the land of today's Egypt.

In fact, in Egypt the tide of the ancient technological inventions actually flowed from north to south [48]. Kuper and Kröpelin [48] catalogued hundreds of radiocarbon-dated Egyptian sites and grouped them geographically. Their physical distribution shows a striking correlation between the onset of the desertification and the gathering of the tribes along the Nile, which resulted in the birth of the pre-dynastic Egyptian kingdoms. In short, their location provides a climatic cause for the formation of the primeval 'kingdoms' along the course of the river. However, it cannot say much about the initial settlements in the delta and on the coast, because of lack of data on those areas.

On the other hand, the overall geographical pattern of the findings is evident: over time: new technologies spread from north to south, implying that the source of these innovations was in the delta or on the coast. Unfortunately, in these two regions the number of finds becomes increasingly rare stretching back in time: there are no finds at all from before eight thousand years ago.

This absence can be explained by recalling, firstly, that the ancient coastline is today offshore (sites should be searched for underwater, which has not been done yet) and noting two other aspects:

a) The structure of today's Nile delta is not the same as eleven thousand years ago: many branches of the river have changed position.

b) Usually in the Nile delta, archaeologists avoid excavating layers deeper than those corresponding to about 7,000 years ago, because they get flooded almost immediately. Although in principle it is technically possible to dry these, the cost and effort required, combined with the abundance of finds in the higher layers, often persuade searchers to stick with the younger and more accessible layers.

In practice, the absence of older sites along today's coast and in the Nile delta should not be ascribed to the lack of ancient occupation, but, more probably, to the insufficient search for sites [4]. In other words, although along the course of the river the archaeological timeline of the pre-dynastic kingdoms is not in question, the geographical distribution of the dated finds suggests that the coast and the Nile delta should have been inhabited much earlier.

3.2. Other suitable places

Although the Natufians or an unknown people living in the Nile delta are the most verisimilar candidates to impersonate the gods who brought civilization to Egypt, the climatic changes that occurred between fifteen and eleven thousand years ago regarded the entire northern hemisphere. More than ten thousand years ago, along three of the largest Asian rivers (the Yangtze, Indus and Tigris-Euphrates), agriculture emerged independently [49, 50, 17]. Some time later, the same floodplains hosted the oldest human civilizations. It is enticing to imagine that along the corresponding coastlines (today submerged) a precursor phase could have taken place during the deglaciation process.

In other words, eleven thousand five hundred years ago, there might have been several "Atlantises" (some modern authors proposing them in diverse distant locations may actually be

right), although none of them could have actually been related to Egypt, a possibility that instead was within reach for peoples living closer.

Indeed, although less likely, it cannot be ruled out that some of the innovative practices recorded in the Middle East twelve thousand years ago were replicated somewhere else along the Mediterranean coast, driven by similar geographic and climatic conditions. To this extent, the seabed lying south of the 38th parallel (see fig. 7) are the most indicated.
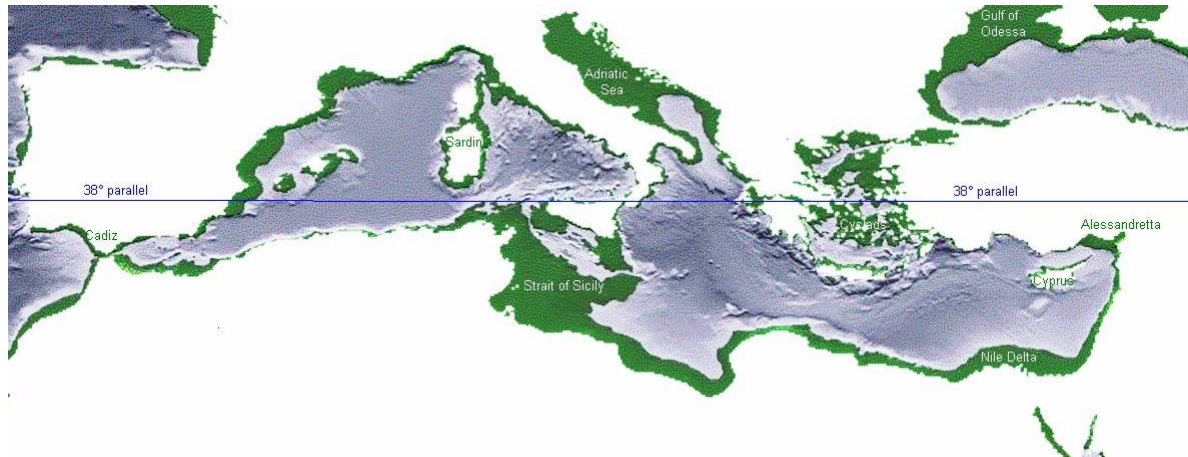
Figure 7. The Mediterranean seafloors emerged during the Last Glacial Maximum (in green).

Many authors have already pointed to some of these regions as possible sites for Atlantis, supporting their choices with ingenuous arguments. It is likely that future underwater archaeological discoveries on the Mediterranean seabed will reinforce some of these hypotheses, re-engaging interest in the Platonic myth. To enumerate the suggested locations is beyond the scope of this article, but the interested reader may find most of them in the Proceedings of two dedicated Conferences [51] in which they are unfolded quite exhaustively.

Nevertheless, among the possible candidates is a region where the hypothesis can be tested in a rather straightforward way, thanks to the presence of an obsidian source: the seabed of the Strait of Sicily. To this extent, two lucky accidents seem promising for the investigation:

a) The seabed of the Strait of Sicily is geologically rather quiet: it is almost possible to reconstruct the past shape of most of its coastline, taking into account only the eustatic factor (meaning that the isobath surfacing at a given sea level drop corresponds to the shoreline of the matching time) [4].

b) The island of Pantelleria, one of the four obsidian sources in the central-western Mediterranean, is one of the islets that dot the region.
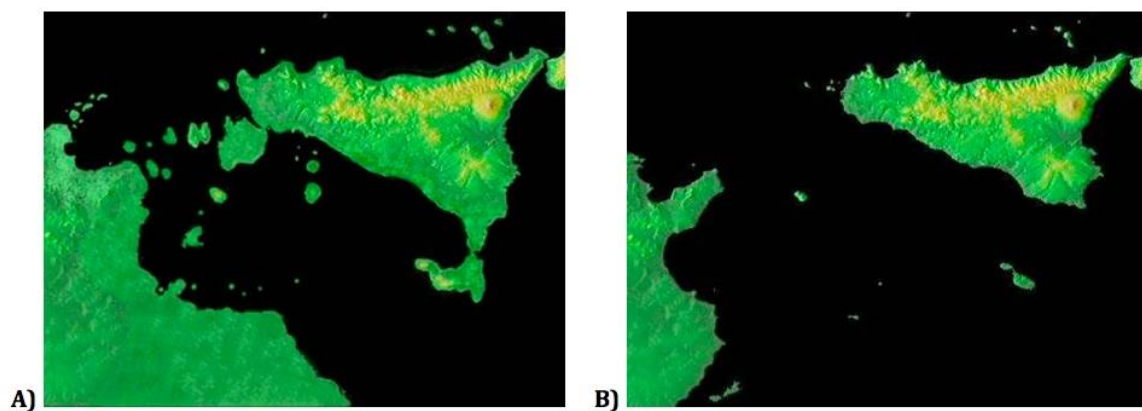
Figure 8. A) The Strait of Sicily at the time of MWP 1a (Rapisarda 2008) [52]; B) The Strait of Sicily today.

Which isobath (or sea level) should indicate the shores of twelve thousand years ago? E. Bard, Hamelin, and Fairbanks [33] estimated that before MWP 1b the oceans' level was about sixty metres below today's. Lambeck et al. [53], through a geological model developed for Italy, later concluded

that the same level was also valid for the Mediterranean Sea.[10] Still, Lambeck, like Ferranti et al. [55], considered likely a marked subsidence of the southern border of Sicily, a factor that would add about a dozen metres to the eustatic value of the seabed near the southern coast of Sicily (leading the value of the isobath to choose there to around −70 metres).

Taken with a grain of salt, Fig. 8 A) depicts a profile not very different from what might have been the Strait of Sicily during the Younger Dryas, showing an intriguing feature which would remain even if slightly different sea levels were selected. This feature is the presence of an archipelago, which would have permitted navigation between Tunisia and Sicily with land always in sight. An archipelago that a ten or twenty-metre rise in sea level would have modified, but not entirely submerged.

Occupying the maritime link between two continents would have been an advantage in a period that saw navigation progress rapidly. As we saw, in the Aegean Sea regular routes were being established to supply Melos obsidian to the mainland and, in the middle of the Strait of Sicily, there was an obsidian source in Pantelleria. It is unlikely that those living in the proximity would not have noticed it.

Between fourteen and eleven thousand years ago the region underwent significant changes. In the south western corner of Sicily, the large shallow seabed named Avventura bank (Fig. 9) was a peninsula (Fig. 8 A) before MWP 1a and later a group of islands. In front of it, Tunisia stretched into the sea with a large floodplain that included the island of Lampedusa. Portions of these plains survived the sea level rise of MWP 1a and experienced the warming of the Bølling-Allerød period.
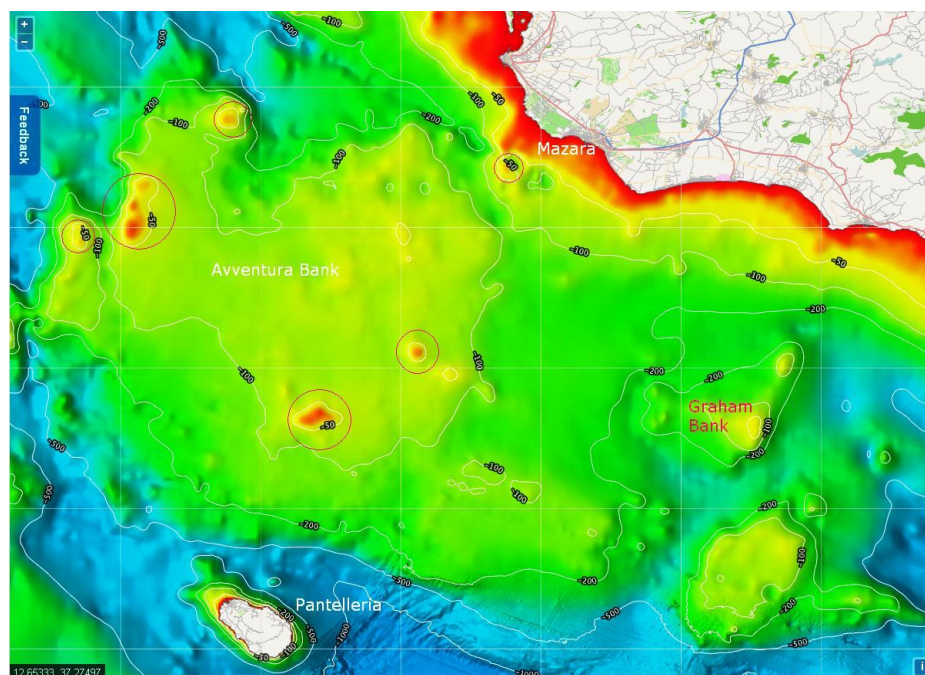
Figure 9. The bathymetry of Avventura and Graham banks. In the red circles, six seafloors which were islands at the end of the Younger Dryas and had to face the upheaval of MWP 1b (map from EMODnet 2015) [56].

A few millennia later, at the end of the Younger Dryas (when the sea level was about fifty metres lower than today) the geographical situation had changed considerably (Fig. 10): most of the Avventura bank had been submerged, but an archipelago was still there to ensure a safe route to Pantelleria's obsidian. If the region was inhabited it is likely that its most convenient spots were too, like the island closing a small southbound gulf near Mazara, or some of the islets on the route to Pantelleria.

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[10] Recently, Lambeck et al. (2014) [54], summarizing a large number of measurements carried out in the Indian and Pacific Oceans, confirmed that the sea level variation due to eustatic factor, with respect to twelve thousand years ago, should be about sixty metres.

The Avventura bank is partly surrounded by volcanoes, whose coastline history is too complex to reconstruct, since they have been subject to their own geological movements. It is interesting to note one of them: Graham bank, a submarine volcano located about thirty miles south of Sciacca. Most of the time it was entirely submerged, but during its occasional eruptions it may have managed to emerge (to become Graham Island or Isola Ferdinandea as happened in 1831).
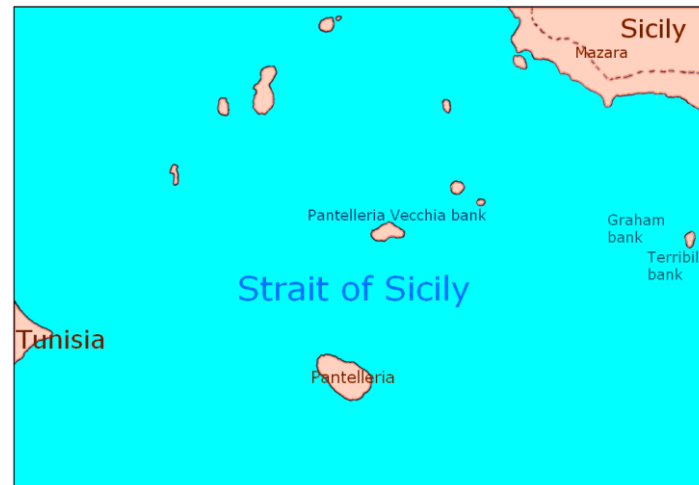
Figure 10. Map of the Strait of Sicily obtained from the −50 m isobath provided by EMODnet [56]. The dotted line indicates the present Sicilian shoreline; note the small island closing a small gulf near Mazara and the larger one (Pantelleria Vecchia) on the route from there to Pantelleria.

Graham bank (Fig. 9) is one of the summit cones of a much larger submarine volcanic building, named Empedocles, located at 37° 10' N, 12° 43' E (of which the Terribile bank is another cone, for the moment quiet, see Fig. 10). In fact, the Strait of Sicily is dotted with volcanoes, submarine and otherwise (Pantelleria and Linosa are the two emerged examples). Needless to say, an explosive eruption from any of them, possibly accompanied by an earthquake and a tsunami, would have been a dramatic way to end human occupation in the region.

4. Obsidian as a possible clue in the central Mediterranean basin

To check whether the Strait of Sicily was really inhabited at the end of the Younger Dryas, obsidian could prove straightforward: given its uniqueness, finding some on a submerged seabed would demonstrate the seabed's occupation at the time of its emersion.

Obsidian is a volcanic glass formed by the sudden cooling of lava rich in silicon. The possibility to chip it and create sharp edges, its hardness and its shine made it a material suitable for crafting tools, weapons and jewellery, turning it in one of the most wanted assets of the prehistoric age. Its macroscopic characteristics (colour, homogeneity, hardness) and its chemical composition [57] are typical of each specific lava flow, making it possible to establish the geographical origin of obsidian artefacts found in sites far from their source.

Few volcanoes produce obsidian, because the conditions for its formation are rather uncommon. Since 1970 it has been known that only four islands (Sardinia, Palmarola, Lipari and Pantelleria) provided all the obsidian found in the western Mediterranean [58].

Although the first use of obsidian dates back to one hundred thousand years ago in the Horn of Africa [59], in the Mediterranean basin its utilization is normally associated with Neolithic culture. In the Western Mediterranean, the accepted chronology states that its systematic exploitation began about eight thousand years ago [60]. In Sicily the use of obsidian is associated with the spread of Neolithic culture and agriculture in the region [61], a thesis also corroborated by recent excavations [62, 63], which confirmed the absence of obsidian in Palaeo/Mesolithic layers. The Neolithic association is also assumed valid on the other side of the Strait: the date of 8000 BP for the first use of obsidian is, for example, confirmed in Tunisia, by preliminary research undertaken by Mulazzani et al. [64].

This general depiction seems not to leave much hope of finding pre-Neolithic specimens in the region. However, looking more closely, some odd details emerge. Naturally, the distance from the two Sicilian sources determined their geographic penetration. The island was basically divided into two market basins: the north-eastern one served by Lipari and the south-western by Pantelleria, but the supply changed with time. In some sites situated along the hypothetical border dividing the basins, both islands provided the obsidian: in the village of Mandria di Serra del Palco (Caltanissetta), which was continuously inhabited during prehistory, the percentage of Pantellerian material fell progressively during the Neolithic period in comparison to that from Lipari [65]. A similar replacement of supply source happened in Cava dell'Uzzo (Trapani) [66] and at Skorba (Malta) (p. 67) [67].

The timeline of the diffusion and the change in supply appear somewhat peculiar. Although the mineral had been always available in Pantelleria but not in Lipari (Lipari's oldest flow dates back to eight or nine thousand years ago [68]), it seems that nobody collected it before the Lipari eruption advertised the precious material. It is therefore to be understood why many ran initially to Pantelleria to collect it, although the version from Lipari, glassier and shinier, was always the favourite. As a matter of fact, later Lipari progressively became the only source for most sites.

A linear explanation could be that the exploitation actually started before the Neolithic era. This idea was initially suggested about twenty years ago by the discovery of some artefacts in Mesolithic layers (unfortunately in the presence of disturbed stratigraphy) and of a Liparian blade, found at Perriere Sottano (Catania) and dated 9500 BP cal. [69]. It gained some strength when two other obsidian blades, dated between 9500 and 9800 BP cal., were later discovered at Favignana (Trapani) [70]. But it was the recent discovery of a pre-Neolithic processing site near Punta Tracino (Pantelleria) at an underwater depth of about twenty metres [71] which showed that the hypothesis is not entirely far-fetched.

The hope of finding obsidian processing residues on a submerged seabed is helped by another peculiarity of Pantelleria. The island shows no traces of human settlements at the time of its Neolithic exploitation and the remains of its lithic industry are far more modest than those of Lipari (p. 73) [66], which instead became inhabited and acquired importance essentially due to its obsidian industries. Quite paradoxically, the first known traces of stable communities in Pantelleria date back to five thousand years ago, when collection of obsidian from the island was already very scant.

The absence of settlements contemporary to the obsidian exploitation period is usually explained by the intense agricultural terracing experienced by Pantelleria over the centuries, which would have erased the traces of the ancient sites (although it is yet to be understood why the terracing process did not erase more recent remains). However, the particularity of the island, barely cultivable and lacking beaches or a safe port, could itself justify the absence of stable settlements and the choice of a collection method that did not require operations on site. If so, the first recorded inhabitants may have only settled when the obsidian gatherers ceased to raid the island. If this is the context, the pre-Neolithic processing site on the seafloor of Punta Tracino could indicate a former occupation of its shores (now submerged) followed by an early Neolithic abandonment of the island, perhaps due to the vanishing of the archipelago that facilitated navigation to the mainland.

Figure 11. Schematic map of the eruptions pre and post green tuff, from Rapisarda [72], based on the Pantelleria geological map of Orsi [73]. The flow of green tuff is shown in turquoise, while magenta indicates the surface affected by all successive lava flows. The areas in blue are the coastal zones where the layers prior to green tuff are accessible because the sea erosion that created the cliffs tore the cover.

To illustrate a possible way of gathering obsidian without landing on the island it is helpful to summarize its orographic characteristics. Pantelleria's geological history is marked by the Green Tuff eruption that almost completely covered it about forty-five thousand years ago [74]. Five obsidian flows have been identified: three almost horizontal layers at Balata dei Turchi and two deposits at Bagno dell'Acqua and Gelkhamar [75]. The Gelkhamar source looks similar to the lava flows of the island of Lipari, NE of Sicily; the deposit at Bagno dell'Acqua is fragmented and scarce; but the conformation of the three lava flows at Balata dei Turchi is rather peculiar, although consistent with the orography of the southern part of the island [72]. Because of the limited slopes and the absence of pronounced valleys, the southern part of the island is characterized by lava flows that extend almost uniformly around the volcanic cone. The obsidian flows most exploited for the manufacture of prehistoric objects were the southern ones, from Salto la Vecchia to Balata dei Turchi (Fig. 11). This prevalence, well known among the Sicilians finds [60], has been confirmed in Tunisia too [64].

The landslide at Cala delle Pietre Nere (Scauri), which dragged obsidian blocks from the above vein into the sea, suggests a practical method of collecting the mineral from the southern flows: skirting the shore with a boat and picking up what you need (Fig. 12). This does not require docking on the island - dangerous almost everywhere - or climbing the cliffs (even more hazardous). The method favours the collection of the raw material as it is, leaving the refining process for later, on the way back or once returned home. Such a collection method could easily explain the deficiency of industries for processing the mineral on the island.

Figure 12. Cala delle Pietre Nere, near Scauri (enlarged detail on the photo to the right). In the cliff (about 150 metres high) the obsidian flows are clearly visible, inserted between layers of yellowish pumice. The landslide, containing large blocks of obsidian, is partially emerged and partially submerged. In these conditions, the collection of material from the sea does not require landing on the island (rather difficult everywhere) but simply approaching the landslide with a boat and helping oneself.

If the obsidian was not treated locally due to the difficulties docking on the island, it might have been processed on a handy site along the route home. If exploitation was already active during the Younger Dryas, the islets that then emerged along the route to Sicily (Pantelleria Vecchia bank, for example) could have been a convenient place to do this job (Fig. 10). The remnants of an obsidian industry, if found there, would constitute irrefutable proof of human presence at the end of the Younger Dryas. Given that, as mentioned, a rather similar discovery has recently been made on the seafloor of Pantelleria [71], the same kind of research at some selected spots on the Avventura bank at -20 and -40 should not be unthinkable.

5. Discussion

The climatic upheavals and the technological revolutions that occurred eleven thousand five hundred years ago in some areas of the Mediterranean basin, combined with the timing of the alleged destruction of Plato's Atlantis, raise the possibility that the legend may have drawn inspiration from these events, passed down through Egyptian mythology. The changes in climate concerned the whole northern hemisphere and several Mediterranean areas, including the Nile delta, could have hosted an early Neolithic society sharing some of the innovations recorded in the Middle East, whose traces would have been later erased by the rise in sea level.

Thanks to its geographical position, the archipelago that then lay in the Strait of Sicily experienced the same climatic change endured by the Middle East. The traces of an early occupation of the region are admittedly weak, consisting of the recent discoveries of an underwater pre-Neolithic processing site at Pantelleria and a few obsidian blades scattered in Sicily. Nevertheless, they support the possibility of finding similar traces (for example the remnants of an obsidian industry) on the seafloors that were emerged twelve thousand years ago, a discovery that would prove beyond doubt that the Strait was inhabited at the end of the Younger Dryas.

Obviously, such a discovery would not demonstrate that such proto-Neolithic settlement actually inspired the myth of Atlantis, but it would show that the Strait of Sicily was inhabited much earlier than is believed today, which would represent a considerable archaeological result in itself. All in all, there may have been more than one "Atlantis" in the Mediterranean and beyond: although historically their existence may never be proved, from a geological and environmental perspective, their presence is a strong possibility. Such prehistoric Atlantises could never have been as advanced as the one described by Plato, but could well have contained the seeds that inspired the myth.

Conflicts of Interest: The author declares no conflict of interest.

Appendix A

Both Plato and Diodorus gave geographical indications regarding the location of Atlantis.

Since Plato's indications were not relevant to his propaganda issues, one could imagine that the geographical details of the dialogues maintained some unmodified elements of the original Egyptian myth. Questionable as this is, a summary of Plato's main clues is reported below.

Nine thousand years before the visit of Solon to Sais (Tim. III 23.e; Crit. III 108.e), the Atlantic Sea[11] was navigable (Crit. III 109.a) and, in front of the Pillars of Hercules (Tim. III 24.e), was an island larger than Libya and Asia combined. This island was close to other islands and, by 'hopping' between them, one could reach the continent that enclosed the vast ocean. The 'capital' of this empire was a small island which ruled over the entire archipelago. On the continent, Atlantis ruled Europe up to Thyrrenia and Libya (Africa) from the Pillars to the Egyptian border (Tim. III 25.b). The main island of the archipelago had a large plain, three thousand stadia (approximately, 550 km) long and two thousand stadia (350 km) wide,[12] surrounded by northern mountains and by a southern channel that ended in the open sea (Crit. X 118.b), with rivers, lakes, mountains and marshes, two harvests per year (Crit. X 118.e), elephants (Crit. VI 114.e) and exotic fruits (Crit. VI 115.b). Its first king was Atlas (Crit. VI 114.b), who ran the country perfectly, following commendable political principles, second only to those of Athens. But when Atlantis wanted to conquer Egypt and Athens, the heroic Athenians resisted and defeated it, freeing Egypt, which in the meantime had been subjugated, as well. A little later, a violent earthquake and a flood destroyed Atlantis in a day and a night, leaving an impenetrable swamp in place of the island (Tim. III 26.d); Athens also perished in the cataclysm.

Diodorus too provided some geographical hints about Atlantis. According to him many generations before the Trojan War, the refined Atlanteans were subjugated by the Libyan Amazons (Book III, 54, 1). In fact, long before the Amazons of classical tradition (who lived along the river Thermodon, on the southern coast of the Black Sea – author's note), Libya was inhabited by other Amazons originating from an island on Lake Tritonis[13] (Book III, 53, 4), from which they dominated the surrounding region (Figure A1).[14]

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[11] Plato uses the term Atlantic Sea indistinguishably for an enclosed sea near the island-capital (no longer delimited in Plato's times due to the sinking of the islands that used to surround it and no longer navigable due to the presence of marshes and shallow waters) and for a large open sea, surrounded by the continent dominated by Atlantis.

[12] The dimensions of the plain of Atlantis are not those of a continent, in contradiction of the statement "Libya and Asia combined", whose size Plato was certainly aware of. To this extent one point should be clear: twelve thousand years ago (or even at the glacial maximum) in no part of the world was there an emerged seabed the size of a continent. The bottom of the Atlantic Ocean is thousands of metres deep and no portion of it ever emerged following a drop in sea level of just 120 metres. From a geological point of view, twelve thousand years is a pittance, ten thousand times shorter than the movements of continental plates. Those invoking the continental drift demand movements occurring over tens or hundreds of millions of years, not thousands of years: days when humans simply did not exist.

[13] Identifiable with the vast Saharan depression south of the Atlas Mountains, which was actually a lake several thousand years ago.

[14] The source, quoted by Diodorus, is Dionysius, almost certainly Scytobrachion, a Mytilene mythographer who lived and taught in Alexandria in the second century BC.
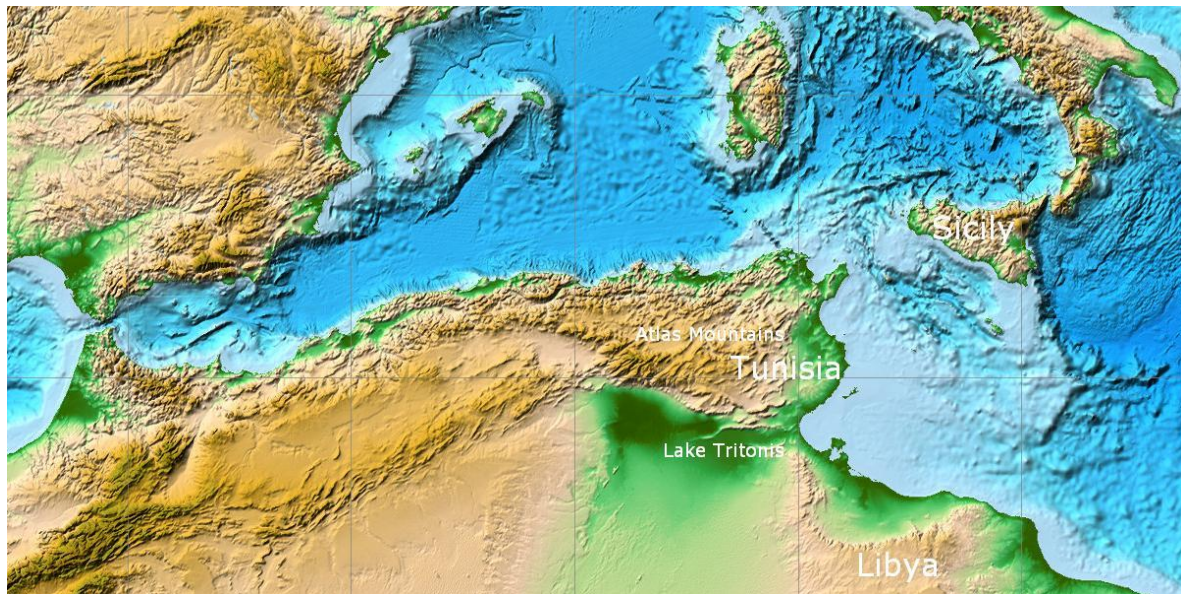
Figure A1. The locations the Atlanteans, according to Diodorus. Map from NOAA site.[15]

The Atlanteans surrendered en masse to the Amazon queen Myrina when Cernê, the only city of theirs that had tried to resist, was completely destroyed (Book III, 54, 5). According to Diodorus, the Atlanteans, who had many cities and lived in a fertile region on the coast (Book III, 56, 2), were an extremely refined and pious people, because the gods had been born among them. Their first king had been Uranus, a god who had elevated them from their bestial state and taught them agriculture (Book III, 56, 3).

Uranus had several wives, including Titea, later called Gaea, who bore him eighteen children: the Titans. One of these, Hyperion, succeeded his father and, on his death, the kingdom was divided between his brother Kronos and his nephew Atlas (son of another brother, Iapetus). Atlas took the coastal and the mountainous regions, giving his name not only to the mountains, but also to the inhabitants of the whole kingdom (Book III, 60, 1). According to the Cretans, Kronos reigned over Sicily, Libya and Italy (Book III, 60, 3).

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[15] http://maps.ngdc.noaa.gov/viewers/wcs-client/

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