SUNDIALS IN ANCIENT DOBROGEA

DOINA IONESCU[*],
ELENI ROVITHIS-LIVANIOU[**]

Abstract. The paper presents three sundials, of Greek and Roman origin, discovered on the Romanian territory of Dobrogea that is unique there. We refer to the historical context when these pieces appeared, and give their description and principle of construction. Finally, a very general discussion concerning time and its measurement is made.

Keywords: Sundials, ancient Greek colonies in Dobrogea.

1. INTRODUCTION

In our epoch it is rather difficult, and especially for the younger who can know the time having a glance at their mobile phones, to imagine, or understand that this was neither easy, nor accurate, or even not possible in some cases. Even so, the conception of the *idea of time* was indubitably one of the biggest steps ancient people did; both the meaning of time, and its measurement. The latter were based on astronomical remarks they made. And as is known from the sun's daily motion in the sky, from moon's movement around Earth, and from the sun's apparent annual motion around Earth, the *day*, the *month* and the *year* were defined.

Ancient people either observing the sun during its daily apparent motion in the sky or the stars' «movements» during night, could estimate the time, and arrange their actions and works. For example most of the actions of ancient Greeks were based on astronomical observations as for instance *Ἡσίοδος*, Hesiod, refers, (*Ἡσίοδος*, *Ἔργα καὶ Ἡμέραι*, Hesiod *Works and Days*). Primitive people noticed the light/dark, or the sun's/stars' alteration, and deified them, especially the sun. And it is not accidental that in almost all ancient cultures sun was worshiped, from the Babylonians, Egyptians, Greeks, Chinese, Aztecs or Incas. For example ancient Greeks deified sun firstly with *God Sun*, *θεός Ἥλιος*, who imagined as having rays around his head, (Fig.1), moving in the sky from East to West in his chariot carried by horses, (Figs. 1 & 2).

Today we know that sun's daily motion from East to West is apparently due to the Earth's rotation around its axis from West to East. And although we also know that its observed movement during a year around Earth is not real, and it is similarly due to Earth's movement, it is nice to see how the ancient imagined the god Sun to move among the months and the Zodiac signs during the year, (Fig. 3).

[*] BA Bucharest University, Romania. Assistant Researcher, Astronomical Institute of the Romanian Academy, Str. Cuțitul de Argint 5, Sector 4, București, Romania (E-mail: doinaionescu36@clicknet.ro).

[**] PhD, Ass. Prof., Athens University, Athens, Greece (E-mail: elivan@phys.uoa.gr).

Fig. 1, left. *Coin from Κρανάη, Kranae* [1], *Laconia, Peloponnesus, grape cluster & crayfish below & KPAN.*
Fig. 1, right. *Stater of (460–400) BC from Kyzikos* [2], *Mysia, Asia Minor. Naked Helios kneeling right and holding 2 horses prancing left and right, tuna down.*

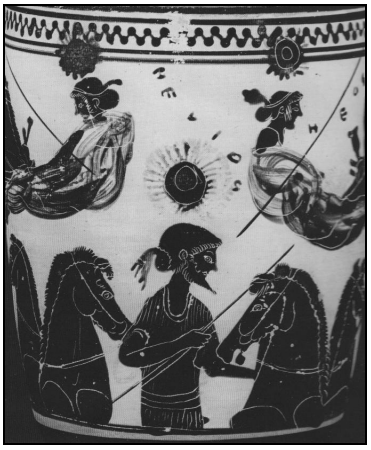

Fig. 2. *God Sun holding the horses of his chariot with the solar disk above his head. Moreover, Νύξ, i.e. the Night, and Ἠώς, i.e. the Down, are moving in their chariots (Black painted, white background, λήκυθος, lecythus, of (500–475) BC, Metropolitan Museum of New York, USA).*

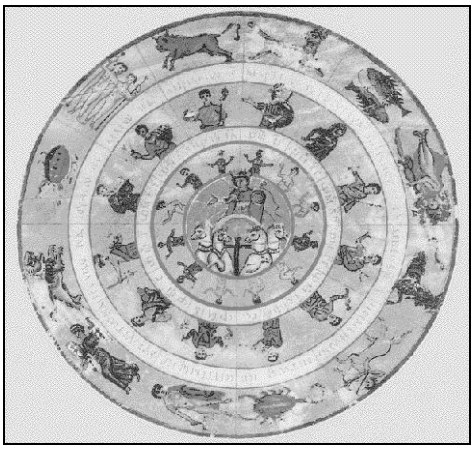

Fig. 3. *In the centre god Sun in his chariot, and in homocentric rings: the Ὧραι, Hours; the Μῆνες, Months and the Ζώδια, Zodiac Signs (Vatican Biblioteque, code Greek n. 1291 and leaf 9α).*

Coming back to time, and especially in its measurement, we know that ancients used various devices for timekeeping, as are the *water* or *sand* clock – known as clepsydra–, and the sundials. The latter is the subject of the present paper, and especially the sundials found at ancient Dobrogea in Romania. Thus, starting from what a sundial is, we continue with some information concerning the Dobrogea area and the description of the sundials discovered there, and we finish with a general discussion.

2. SUNDIALS

Sundials are devices based on Sun's daily motion to measure the local solar time, and especially the hours of a day in the place in which they are installed. Their construction is simple enough as it is based on the simplest astronomical instrument, i.e. *gnomon*, *γνώμων*.

As is known gnomons, either in their simplest form of a thin vertical rob ending to a sharp edge, or in the form of obelisks, were known as early as 3500 BC. But their use as sundials started around 1500 BC by the Egyptian and Babylonian astronomers. Then, it passed to ancient Greeks as Ἡρόδοτος, *Herodotus*, refers: «*Πόλον μὲν γὰρ καὶ γνώμονα καὶ τὰ δυώδεκα μέρεα τῆς ἡμέρης παρὰ Βαβυλωνίων ἔμαθον οἱ Ἕλληνες*», (Ἡρόδοτος, Ἱστορία Β΄, *Εὐτέρπη*, 109). That is: «*The Greeks took from the Babylonians the use of pole, and the gnomon, as well as the division of the day in twelve parts*», (Herodotus, History B΄, 109). And, according to Διογένης Λαέρτιος, *Diogenis Lae*rtios, Ἀναξίμανδρος, *Anaximander* [3], introduced the gnomon and sundials to Greece, and he found the accurate times *of equinoxes and solstices*, (Diogenes Laertios, Βοοκ Β).

On the other hand, the Greeks, using their knowledge in geometry improved and constructed various types of sundials, meaning that the umbra reception surface could be plane, spherical, cylindrical, or conical.

Although gnomon is the simplest astronomical instrument, it is very important as one can find with it for the place in which it has been established, the following:

- the North-South direction;
- the times of the equinoxes and solstices, i.e. the duration of the tropic year;
- the ecliptic's obliquity;
- the geographic latitude of a place;
- the Sun's declination, and
- the real solar time.

3. THE PRINCIPLE AND CONSTRUCTION OF A SUNDIAL

Sundials principle, as already referred, is based on the gnomon and its shadow during the day; and as is known, at noon gnomon has the shortest shadow.

In order to establish a sundial on a place what is needed is the knowledge of the *North-South* direction. Then, the perpendicular, *East-West* direction is known, too. The latter being the path that Sun's follow during its daily motion. Thus, if you have a mathematically properly dawn surface, (Fig. 4), with a thin pillar that plays the role of gnomon, its shadow can *show* you the local solar time.

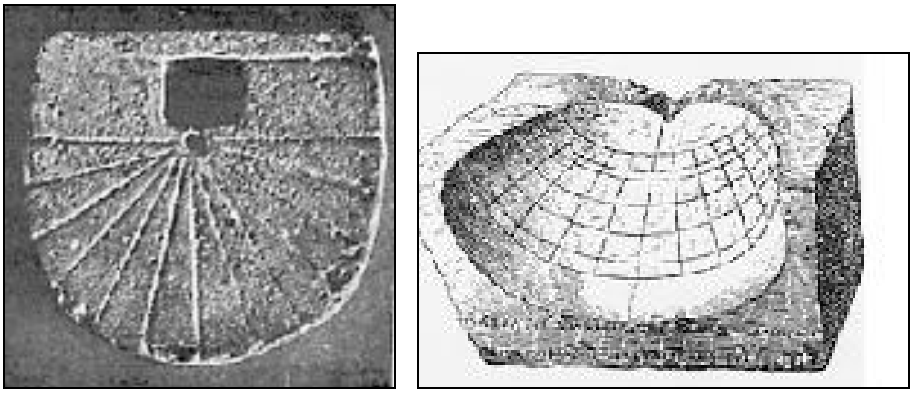

Fig. 4, left. *Horizontal Egyptian sundial, (Metropolitan Museum of Art).*
Fig. 4, right. *Sundial of scaphoid type constructed by Themistagoras* [4] *and Apollonius* [5], *offered it to King Ptolemy* [6], *(Louvre Museum, France).*

The construction of a sundial did not require very special knowledge. However, it necessitated a whole year of observation of the sun movement and a gnomon's shadow, to find the *times of the equinoxes and solstices* and the *ecliptic obliquity*. Besides, the knowledge of the *latitude* of the place in which the sundial will be placed is necessary to be known. Furthermore, sundials have two major drawbacks; namely: 1) they can be used only during the day, and if the sun is shining, and 2) they can be used only for the place where they were traced, or in another with the same latitude.

Knowing the obliquity of the ecliptic and the *κλίμα*, *clima*, i.e. the geographic latitude of a place, one can always *build* scientifically a sundial. And as the Sun appears to move around a mean position during the year, some diagrams of its altitude, known as *diagrams of analemma*, had to be made to show its position on various dates during the year. The word *analemma* comes from the Greek word *ἀνάλημμα*, which according to Suda [7], (*Λεξικόν Σουΐδα*, Dictionary Suida, 2002), means the *high* or the *pop*, *support*, i.e. *ἀνάλημμα*, is the pedestal of a sundial, or the sun's altitude on the sky.

In the 3rd century BC there were already tables of latitudes and treatises of *analemma*; while for sundials with a spherical reception surface, and the stile pointed horizontally into the sphere centre, complete *analemma* were calculated by Vitruvius [8]. Today, and after the introduction of the mean sun [9], *analemma* gives the declination of the sun, according to Equation of time [10]. The latter shows how much the *true sun* is ahead or behind the *mean sun*.

Taken over by the Romans, sundials are no longer objects of scientific interest. Their construction became a real industry that employed the tables of the astronomers and mathematicians, the *analemma* traced by the architects in keeping with the model already established and the constructors' talent. As Roman life depended on the hour, sundials abound all over the empire, in the forum, at the circus, in thermos, and in private villas. The Romans took over these instruments for measuring the temporary hour without adding anything or bringing anything new.

4. ANCIENT DOBROGEA

Dobrogea is a land in present day Romania lying between the last few miles of the river Danube and the shore of the Black Sea, where the river flows through three canals. It was inhabited from the Iron Age by Thracian tribes.

In the first centuries BC it was colonized by Greeks. The settlement of the Greeks on the coasts of the Black Sea is a phenomenon that is part of the huge emigration process known as the Greek colonization. Then, a part of the Greek world sailed towards other worlds, i.e. in between the 11th–6th centuries BC. On the coasts of the Black Sea, which they called «*Εὔξεινος Πόντος*», «*Pontus Euxinus*», (i.e. they gave to this *Πόντος* = *Sea* a name exactly opposite of its characteristics, which was really very difficult to sail), the Greeks set up important colonies for commercial and military purposes. Worth mentioning are *Τυράς*, *Tyras* and *Ὀλβία*, *Olbia*, (nowadays on the territory of Ukraine), as well as *Διονυσόπολις*, *Dionysopolis*, *Ὀδησσός*, *Odessa*, Μεσημβρία, *Mesembria* and *Ἀπολλωνία*, *Apollonia* (on the present territory of Bulgaria). On the territory of Romania there were three Greek colonies, *Ἴστρια*, *Histria*, *Τόμις*, *Tomis* and Καλλάτις, *Callatis*, whose remnants have survived until the present day.

Histria, or *Ἴστρος*, *Histrus*, is an ancient Greek colony, the oldest town ever recorded on the present territory of Romania. Nowadays, its ruins are to be found on the administrative territory of the Istria village, in Constanţa county. Histria was set up around 657 BC according to the historian Eusebius of Caesarea [11], or in 630 BC according to Σκύμνος, *Scymnus of Chios*[12], by Greeks from another Greek colony, *Μίλητος*, *Milletus*, at the West coast of Asia Minor in the Aegean Sea. It was intended to be a harbour to the Black Sea, to facilitate the trade with Getae. The Greek geographer and historian *Στράβων*[13], *Strabon*, wrote that Histria was placed «*at a distance of 500 stadiums from the sacred mouth of Istrus*», (*Στράβων*, *Γεωγραφικά*, Strabo, *Geographica*). Actually, the settlement was fixed on the shore of the present lagune Sinoe, previously an open golf, at a relatively small distance from the southermost cannal of the Danube (the present cannal St. George). This was due on the one hand by conditions favourable for fishing, and on the other by the easy access by water to the Get-Dacian inland nearby. Its best period was in the 6th–5th centuries, until the Hellenistic epoch. Towards the end of the 3rd century BC it began to decay because of the sand blocking the port and the degradation of the relationships with the Get-Dacian

natives. Around 30 AD Histria became a Roman town, and it was destroyed in the 3rd century AD either by an earth-quake, or by a Gothic invasion.

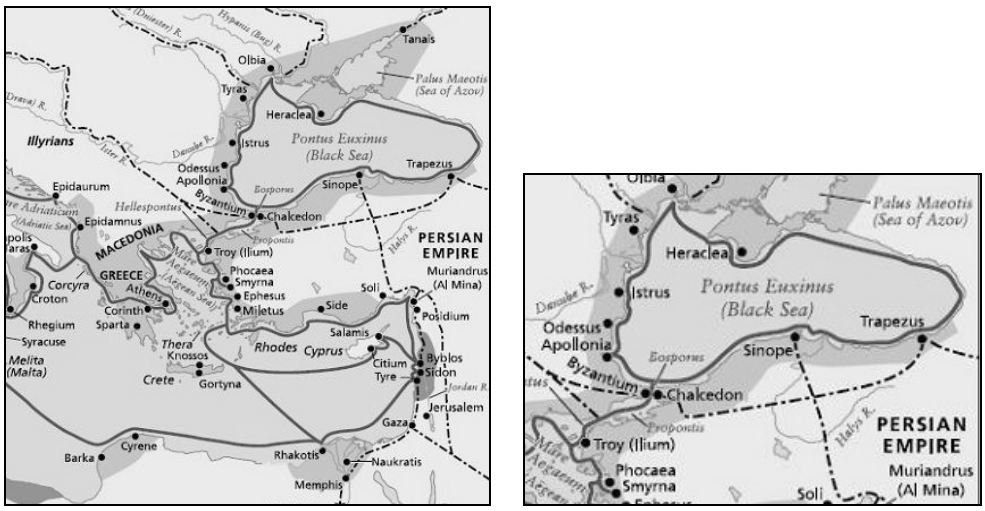

Fig. 5, left. *The ancient Greece and some of the ancient Greek colonies.*
Fig. 5, right. *The ancient Greek colonies at Euxinus Pontus.*

The Millesian Greeks also set up the town of Tomis (at present called Constanţa), according to some. This took place probably at the beginning of the 6th century BC on a promontory (peninsula), situated nearby the present town harbour Constanţa. On the other hand, according to *Ἀπολλόδωρος*, *Apollodorus*, the city was founded by the king of *Αἶα*, *Aea*, *Αἰήτης*, *Aeetes*. Indeed, he refers: «*Αἰήτης δὲ ἐπιγνοὺς τὰ τῇ Μηδείᾳ τετολμημένα ὥρμισε τὴν ναῦ διώκειν˙ ἰδοῦσα δὲ αὐτὸν πλησίον ὄντα Μήδεια τὸν ἀδελφὸν φονεύει καὶ μελίσασα κατὰ τοῦ βυθοῦ ῥίπτει˙ συναθροίζων δὲ Αἰήτης τὰ τοῦ παιδὸς μέλη τῆς διώξεως ὑστέρησε˙ διόπερ ὑποστρέψας, καὶ τὰ σωθέντα τοῦ παιδὸς μέλη* θάψας, *τὸν τόπον προσηγόρευσε Τόμους. Πολλοὺς δὲ τῶν Κόλχων ἐπὶ τὴν ζήτησιν τῆς Ἀργοῦς ἐξέπεμψεν...*», (*Ἀπολλόδωρος*, *Βίβλος Α΄*, IX.24; Apollodorus, *Book A΄*, IX.24). It is, thus, believed that the name Tomis comes from the Greek word *τομή = cutting*, because at this place Aeetes buried the pieces of the body of his son, when his daughter *Μήδεια*, *Medea*, going away with *Ἰάσων*, *Jason*, and the *golden fleece* cut it in pieces and thrown it to the sea.

There are some historical data on the town of Tomis from Demetrius of Callatis [14], as well as from the Roman poet *Ovidius*[15], who was exiled there between (9–17) AD, at the order of the Roman Emperor *Octavian Augustus*. At Tomis, the archaeological researches have dug up Ionic engravings and other proofs about Ionic cults, the foremost of which was that of *Ἀπόλλων*, *Apollo*. It underwent a special development after the 2nd century BC and played an important role in the Roman epoch when it became the capital of the Roman province of Scythia Minor. It was destroyed by the Avars and the Bulgarians at 680 AD, but it

continued to be inhabited even after that. Tomis was a harbour-town by excellence, intended only for the small trade brought about the traffic of the ships through its harbour. For a long time it lagged behind Histria and its youngest neighbour Callatis.

Callatis (at present the town Mangalia, in Constantza county) was set up somewhat later, namely by the end of the 6th century BC by some Dorian Greek colonists, who came from Ἡράκλεια τοῦ Πόντου, *Heraclea Pontica*, (today Eregli, on the Turkish coast of the Black Sea). The historian Pseudo-Skymnos [16] set its foundation date by referring to the reign of the king Amyntas of Macedonia, (approximately between 546–498 BC). Other data about it come from the geographer Demetrius, who lived a part of his life in this town. This colony was set up on the place of a previous Get village called Acervetis or Cerbatis, on a fertile land situated in the neighbourhood of the sea and of a lake with sweet water, the present Lake Mangalia.

All these Greek colonies were originally intended to exploit the riches on the shores of the Danube. The colonies maintained intense commercial relations with the large Greek to the South such as Milletus, Rhodes, Samos, Clazomene, Corinth and Athens. During the *Ἑλληνιστική ἐποχή*, Hellenistic epoch, i.e. from 4th to 1st centuries BC, these towns registered a high economic, as well as social-political development according to the archeological researches. In that period were raised strong walls of defense to the inland, as well as harbor devices, temples, public and civil edifices, monuments. Between 71–72 BC these Greek colonies were conquered by the armies of the Roman Empire. In 55 BC the land of Dobrogea, together with all the Greek colonies there, were conquered by the armies of the Get king Burebista. They became part of his empire until the year 44 BC, when Burebista died and his empire was destroyed. After that date the colonies re-entered Roman occupation. In the 7th century AD all these colonies in Dobroges were destroyed by the tribes of Avars and Slaves and their populations began to fled away, or to settle on other nearby territories.

Especially in the Greek and Roman periods, the cities of Istria, Tomis and Callatis had a prosperous cultural life. They possessed both sports institutions in the so-called *γυμνάσια*, gymnasiums, where the word is coming from the Greek *γυμνός* = naked, because they were undressed; and cultural-artistic ones the so-called *Μουσεῖα*, Museums, where the word comes from the Greek *Μούσαι*, which were secondary deities, protectors of science and fine arts. Generally speaking *Μουσεῖα* had the meaning of Universities. Science, as well as mathematics and astronomy, flourished especially in the Hellenistic period, during the 4th century BC, as attested also by the solar marble clocks discovered on the archaeological sites opened at Istria and Tomis, as well as in other parts of Dobrogea.

5. THE SUNDIALS IN DOBROGEA

Archaeological researches made in Romania, at Grădiștea Muncelului, on the site of the old capital of the Dacian state, Sarmizegetusa, have led to the discovery

of several sacred precincts, where the architecture of the constructions indicates a large connection – yet unexplained – with the celestial phenomena and the calendar. It seems that the Dacians practiced astronomy and created a quite precise solar calendar, which they used especially in agriculture. Advanced concerns with the calendar were found also at Istria, as well as at the other Greek colonies on the shore of the Black Sea. At Histria, as well as in the village of Cumpăna, (also in Dobrogea), were found marble sundials dating from the 4th–3rd centuries BC.

A. At Istria, a fragment from a sundial was dug up in 1950. It was discovered in a sacred zone of the fortress, where it had been used as filling material for late constructions. According to the archaeological researches it dates from the 4th century BC or the 3rd century BC at the latest, so from the Hellenistic period. The piece is made from white marble with mauve lines and has the shape of a part from a concavity cloven in a straight prismatic block. The concavity is perfectly spherical and seems to be worked with a great precision. The sphere radius is of 157 mm. Two convergent lines cross the block upwards from the bottom and must have met in a superior point beyond the clove. Two horizontal parallels cross these lines from right to left. All lines are circle arches, very finely dug. The dimensions of all the segments created by the lines are given in Figure 7.

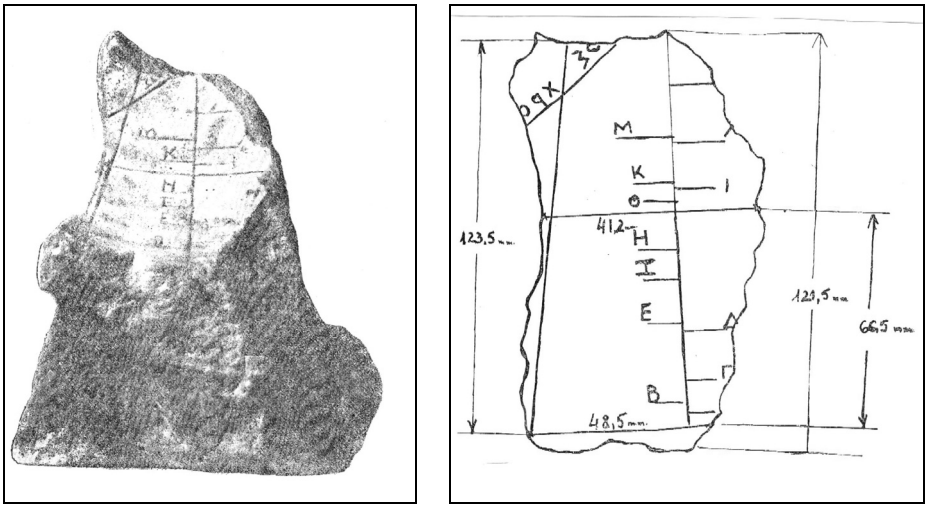

Fig. 6, left. *Sundial block in mauve marble at Histria.*
Fig. 6, right. *Graph of the sundial at Histria.*

The cleavage opening does not overpass 0.8 mm. The left convergent line is cut obliquely, in the upper part by a curvature segment on which are dug five Greek capital letters, written in reverse, as if reflected in a mirror. On the right convergent line are traced horizontally small lines, six to the right and seven to the left. Except for the first and last ones to the right, the other ones are marked with

Greek capital letters, perfectly readable from the bottom up. It is but natural to suppose that the first line was marked with A and the last one with N, while the second displayed B up to M (Fig. 6, right). At present this solar clock is to be found in the storeroom of the National Museum of Archaeology. However, it is displayed only at exhibitions or other special occasions.

B. The second piece of solar clock presented here was discovered also in Dobrogea, in the Cumpăna Village, approx. 12 km South-West from the town of Constantza, in 1960. It is displayed at the Archaeological Museum of Constanța.

The piece is generally well preserved. It represents a sculptural ensemble made up of the frame of a sundial fixed between the horns of an ox. The clock surface is a part from a straight circular cylinder, with a radius of 160 mm. On it are dug eleven hour convergent lines and two transverse parallel curves, (they indicate the equinoxes and the solstices).

Fig. 7. *Roman sundial at Cumpăna Village.*

The entire ensemble is carefully worked, from white marble with mauve spots. The tracing is approximate In view of the oxen shape, the piece is dated in the 2nd century AD, i.e. it dates from the Roman occupation period.

C. The third clock is to be found also in the storeroom of the National Museum of Antiquities in Bucharest. The date and circumstances of its discovery are not known. It consists of a portion from a sphere resting, with its opening up, on a man's head. The hands that support it laterally manage to suggest the complete image of the ensemble: a man – probably *Τιτάν Ἄτλας* [17], *Titan Atlas*– and above his head there are hands supporting the clock over all its length. Both the support and the back enflaming show that the instrument was caught in a construction. The material from which the piece was built is soft sediment lime, of a yellow colour, a rock that is found in Dobrogea. The craftsman that made it was not a great drawing master. There is no symmetry of the whole and there is also a great lack of proportion between the head and the hands. The same lack of artistry is observed in the tracing of the lines whose width reaches up to 5 mm. The clock proper, whose average width is of 35 mm, is part of a sphere with radium of approx. 170 mm. These are average data, because a hole in the bottom part changes the curvature ray. On the spherical

surface are traced two parallel half circles (the curvatures of the winter solstice and of the equinox) that has the centre on an imaginary horizontal right line situated in the meridian plane; it starts from a rectangular hole in which the stile was fixed. The half circles are crisscrossed by eleven curves (hourly) that divide the surface in twelve hours (Fig. 8). Judging by the work manner, the piece dates from the end of the 3rd century BC probably from the Hellenistic period.

6. DISCUSSION AND CONCLUSIONS

From what we have shown so far, we can draw the conclusion that in the colonies set up by the ancient Greeks in Dobrogea was a remarkable scientific activity that included astronomy and mathematics, especially between the 4 and 3rd centuries BC. This activity continued also in the following period of Roman domination. The solar clocks discovered there prove the high level of scientific knowledge of the people that built these colonies, especially the Greeks, as is known that the Romans did not make any improvement to the sundials.

Time is called *Χρόνος* in Greek, and is said that its name came from the god *Κρόνος*, i.e. god *Saturn*, which is the personalising of time. Later, time personalised by Hercules was joined to necessity. The latter, as *Ἀδράστεια*, *Adrasteia*, represents the laws. Thus, the coupling of *Χρόνος* and *Ἀδράστεια* shows that the whole world's evolution in time is based on some powerful universal laws.

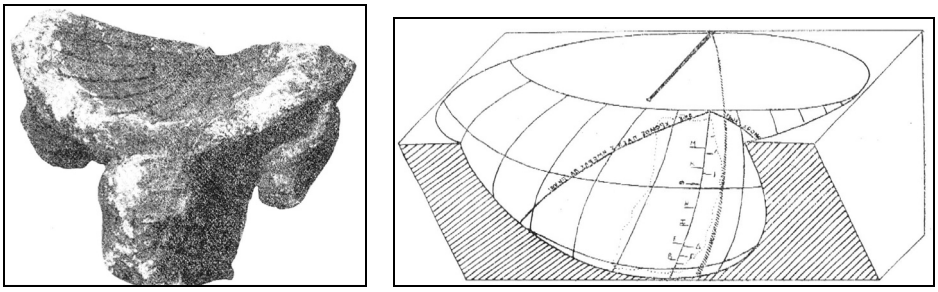

Fig. 8. *Sundial including pieces similar to the head and hands of Titan Atlas.*

As concerns the use of gnomon and sundials, the whole procedure was known and called by the Greeks *σκιαθηρία = shadow hunting* from the Greek words *σκιά = shadow* and *θηρεύω = hunt*. And it is remarkable that 3 or 4 centuries ago the *clima* or the *shadows* were the main themes of many scientists and books. See for instance *Χρύσανθος Νοταρᾶς* [18], *Chrysanthos Notaras*, book, (1716, 2010), who following tradition gives Tables of the climata according to the *oldest*, to *Hipparchus*, and to the *newer* division. Besides, he refers that some soldiers were astonished and frighten when they show their shadows to be in different direction than that they had in their own country).

Furthermore, it is worthwhile to add that shadow hunting and the sun's movement is referred in the Bible; namely: in *Ἡσαΐας*, *Isaiah* (Chapter ΛΗ΄ i.e. 38, §8), as well as in *Βασιλειῶν Δ΄*, *Kings Δ΄*, (Chapter Κ΄, §9–11). Both of them are referred to the same fact, i.e. the therapy of Ezekiel and the miracle of the sun's shadow movement ***backwards*** in the sundial. Indeed in the first is referred: «*Ἰδού ἐγὼ στρέψω τὴν σκιὰν τῶν ἀναβαθμῶν, οὓς κατέβη ὁ ἥλιος, τοὺς δέκα ἀναβαθμούς τοῦ οἴκου τοῦ πατρός σου, ἀποστρέψω τὸν ἥλιον τοὺς δέκα ἀναβαθμούς, καὶ ἀνέβη ὁ ἥλιος τοὺς δέκα ἀναβαθμούς οὓς κατέβη ἡ σκιά*». This means: «*I'll turn back by 10 degrees the sun's shadow (in the sundial) that exists in your father's house. I'll turn back the sun by 10 degrees, and indeed the sun moved upward by 10 degrees, the 10 degrees that its shadow had previously moved backwards*».

Sundials have two major disadvantages, as was already referred, i.e. that they can be used only:

- during the day, and if the sun is shining, and
- for the place where they were traced, or in another with the same latitude.

Even so, they were used until the development of the mechanical clocks, (middle of the 17th century), and they were even used to check the latter's' good operation. As concerns the disadvantage of the place, it is referred that *Θεοδόσιος ἀπὸ τὴν Βιθυνία*, *Theodosius of Bithynia* [19] had invented a universal sundial, i.e. a sundial that was made to be used «*πρὸς πᾶν κλίμα*», meaning «*for every latitude*», i.e. *anywhere on Earth*», (Virtuvius, «*De Architectura*», Book IX, Chapter 8.1).

On the other hand, one of the biggest step people made was the conception of the *idea of time* as well as its measurement. Simultaneously, *time* is a huge subject that can't be neither described, nor exhausted in a simple paper. Especially as many scientists from all kind of sciences, have been concerned with it. From ancient philosophers like Plato, Aristotle etc, the Saints of the Church, like Saint Basil the Great in his work (*Ἑξαήμερο*, *Six Day*), Saint Gregory, Saint Augustine and others, till the more recent philosophers like Kant, Descartes and many others. Some of these ideas are very briefly given in Appendix of a paper by Rovithis-Livaniou & Antonopoulou (2009). Moreover, time is considered as a continuously running quantity. For instance, in ancient Greek philosophy as well as in some others, there is the meaning of the eternal and endless time. And as *time* is a huge subject it is better to consider *it* only from the point of view of modern astrophysics. According to the most modern physicists **there was no time before the *Big Bang***. Indeed, according to Hawking, time is without meaning before the *Big Bang*. Time begins together with the *Big Bang* and it is impossible to be defined earlier. Generally speaking all changes of our surrounded space, considered as movements or variations of the matter, are made «*within time*», and this is how the space and time are related in the four dimensions model of Einstein.

Finally, it is worthwhile to mention that sundials are constructed even today and one can see them in various cities of the world. But today they are used for decoration purposes, as time is measuring with great accuracy, actually the greatest then every other element.

ANNEX I

[1] **Κρανάη, Kranae:** A small island in front of the city of *Γύθειον*, *Gytheion* at Laconia, Peloponnesus. Paris and beautiful Helen stayed there when Paris had stolen her from Sparta.

[2] **Κύζικος, Kyzikos:** Island and homonymous city at Propontis, Mysia, Asia Minor that was connected with the opposite land with two bridges. The city had two closed harbours and more than 200 naval stations. City's position was very important and it was colony of the Milecians, while the area belonged to Fryges in the past. Some supposed that the city was established by the hero Kyzikos, where from city name is came. Later Kyzikos was subdued to the Lydian's and then to Perses, while it became free when the later were won by the Greeks. The city became part of the kingdom of Seleucid's and remains preserved its freedom till emperor Tiberius times, when it became province of the Roman Empire. Kyzikos was famous for its electron staters which were in use till Alexander the great times.

[3] **Ἀναξίμανδρος, Anaximander:** (611–546 BC), Greek philosopher, mathematician, physician and astronomer from Miletus. He constructed a sundial and put it in Sparta, Lacedemona, in Peloponnesus, and he measured the *ecliptic obliquity* and found it to be 24°. Moreover, he made the first celestial sphere and the first map of the Earth.

[4] **Θεμισταγόρας, Themistagoras:** Ancient Greek astronomer and mechanic. He was known as *Themistagoras the Alexandrian*, because either he was born or lived in Alexandria, Egypt. He was famous constructer of sundial, one of which, (Fig. 4, right), was offered by the well known mathematician and astronomer *Ἀπολλώνιος*, Apollonius, to the king *Πτολεμαῖος*, Ptolemy, («*τῷ Βασιλεῖ Πτολεμαίῳ*», as it was written in Greek).

[5] **Ἀπολλώνιος, Apollonius:** Born in Alexandria, Egypt, about 270 BC. He was librarian, and epic poet, who in his youth wrote an epic poem named «*Ἀργοναυτικά*», «*Agronautics*», i.e. about the Argonauts and the Golden Fleece. But, as his epic work was hardly criticised he disappointed left his country and moved to the island of Rhodes, from which he is known as Ἀπολλώνιος ὁ Ρόδιος. Later, he revised and improved his epic poem «*Ἀργοναυτικά*», and is known as one of the best poets of his epoch.

[6] **Πτολεμαῖος, Ptolemy:** We are referred to Πτολεμαῖος Γ΄, (284–221) BC, known as *Εὐεργέτης*, i.e. *Benefactor*. He was son of Πτολεμαῖος Β΄, and Βερενίκης Α΄, Berenices Α΄, and was king of Egypt from 246 till 222. He was married to Berenices Β΄ of Kyreneia from whom the constellation *Comma Berenices* was named.

[7] **Suda:** An encyclopaedic Byzantine lexicon, i.e. dictionary, written in Greek in the 10th century with 30,000 entries. It was formally attributed to an author called Suidas, (see reference Λεξικό Σουΐδα), by the archbishop of Thessalonica Εὐστάθιος, Eustathios. Today, various suggestions have been made to explain where from the name Suda comes.

[8] **Vitruvius** (Marcus Vitruvius Pollio – born c. 80–70 BC, died after c. 15 BC): Roman writer, architect and engineer, active in the 1st century BC. He is best known as the author of the multi-volume work *De Arhitectura* («*On Architecture*»).

[9] **Mean sun:** An intelligible point that moves with constant velocity on the Equator. And, as the apparent movement of the (real) sun is on the Ecliptic and is made without constant velocity, naturally either the mean or the real sun is ahead. The result of this is the Equation of time.

[10] **Equation of time, E:** The difference of the *mean solar time*, **M**, from the *true* or *real solar time*, **A**, i.e. **E=A–M**. Equation of time varies during the year from **+16** *min* to **–14** *min*.

[11] **Eusebius of Caesarea** (263–339): Roman historian, exegete and Christian polemicist. He became the Bishop of Caesarea in Palestine about the year 314. He was a scholar of the Biblical canon. He wrote *Demonstrations of the Gospel*, *Preparations for the Gospel*, and *On Discrepancies between the Gospels*, studies of the Biblical text. As «*Father of Church History*» he produced the *Ecclesiastical History*, *On the Life of Pamphilus*, the *Chronicle* and *On the Martyrs*.

[12] **Σκύμνος, Scymnus of Chios** (fl. c. 185 BC): Greek geographer. He was said to have been the author of a *περιήγησις*, *periegesis*, i.e. a tour in prose. An anonymous verse periegesis first published at Augsburg in 1600, originally ascribed to Marcianus of Heraclea, was long thought to be the lost work of Scymnus, but this was shown not to be the case.

[13] **Στράβων, Strabo** (64/63 BC – 23 AD): Greek geographer and historian. His work «*Geographica*» has been a trustworthy source for archaeology.

[14] **Demetrios of Callatis** (3rd–2nd centuries BC): a native of Callatis, historian and geographer, the author of a «*Geographia*» made up of 20 books about Europe and Asia.

[15] **Ovidius, Publius Ovidius Naso:** 20 March 43BC –17/18 AD. Known as Ovid in the English speaking world, he was a Roman poet. He is best known as the author of three major collections of poetry: the *Heroides, Amores* and *Ars Amatoria*, and the *Metamorphoses*, a mythological poem written in εξάμετρο, *hexamater*. He is also well known for the *Fasti*, about the Roman calendar, and the *Tristia* and *Epistulae ex Ponto,* two collections of poems written in exile on the Black Sea. Ovid was also the author of several smaller pieces, as well as of a lost tragedy, Medea. His poetry, much imitated during Late Antiquity and the Middle Ages, greatly influenced European art and literature and remains as one of the most important sources of classical mythology.

[16] **Pseudo-Scymnus** is the name given by Augustus Meineke to the unknown author of a work on geography written in Classical Greek, *The Circumnavigation of the Earth*. An anonymous verse *περιήγησις*, *periegesis* first published at Augusburg in 1600. It was originally ascribed to Marcianus of Heraclea, then to Scymnus of Chios, until this was disproven by Meineke (edition, 1846). It is dedicated to a King Nicomedes most likely Nicomedes IV of Bithynia. Its composition was placed around 90 BC. A geographical summary in iambic verse, it has some

worthwhile material on the coasts of Spain, Liguria, the Euxinus Pontus, data on various Greek colonies, as well as information about the ancient people.

[17] **Ἄτλας, Atlas:** According to the Greek Mythology he was the primordial Titan who held up the celestial sphere. He was the son of Titan Iapetus and the Nymph *Klymene*, *Κλυμένη*. Atlas participated in the fight between the giants – the first generation of monstrous divinities who were very violent – and the Olympians. He was defeated by the latter ones and was punished by Zeus to carry the celestial vault of heaven forever on his shoulders.

[18] **Νοταρᾶς Χρύσανθος, Notaras Chryssanthos** (1665?–1731): Patriarch of Jerusalem, 1707–1731. His origin was famous Notaras family from Constantinople, and he was born in a small town at Peloponnesus, Greece. He got excellent education at various European centres where he studied from Theology to Geography and Astronomy. Considered as one of the most educated persons of his epoch, and published the first universal map in the Greek language. He organized both the elementary and the higher education not only in some places of Greece as well as in Jerusalem, but at Iași and Bucharest, too.

[19] **Θεοδόσιος ἀπὸ τὴν Βιθυνία, Theodosius of Bithynia:** (160–100 BC), Greek astronomer and mathematician born at Tripolis of Bithynia, where from its name comes. He wrote three books title: «*Sphaerics*», «*On Habitations*», and «*On Days and Nights*».

REFERENCES

1. Ἀπολλόδωρος: «*Βιβλιοθήκη*», Αρχαία Ελληνική Γραμματεία «ΟΙ ΕΛΛΗΝΕΣ», Εκδόσεις ΚΑΚΤΟΣ, Αθήνα 1984, (Apollodorus: «Bibliotheque», Ancient Greek Literature «THE GREEKS», KAKTOS Ed., Athens 1984).
2. Ἡσίοδος: «*Ἔργα καί Ἡμέραι*», ΤΑ ΑΠΑΝΤΑ ΤΩΝ ΑΡΧΑΙΩΝ ΕΛΛΗΝΩΝ ΣΥΓΓΡΑΦΕΩΝ, Ἀρχαῖον Κείμενον – Μετάφρασις – Σημειώσεις Π.Γ. Λεκατσά, Ἐπιστημονική Ἑταιρεία τῶν Ἑλληνικῶν Γραμμάτων, ΠΑΠΥΡΟΣ, Ἀθῆναι 1975; Hesiod: «*Works and Days*», Ancient Text – Translation – Notes P.G. Lekatsa, Scientific Society of Greek Writtings, PAPYRUS, Athens, 1975.
3. Ἡρόδοτος: «*Ἱστορία*», ΤΑ ΑΠΑΝΤΑ ΤΩΝ ΑΡΧΑΙΩΝ ΕΛΛΗΝΩΝ ΣΥΓΓΡΑΦΕΩΝ, Ἀρχαῖον Κείμενον – Μετάφρασις – Σημειώσεις, Ἐπιστημονική Ἑταιρεία τῶν Ἑλληνικῶν Γραμμάτων, ΠΑΠΥΡΟΣ, Ἀθῆναι 1975; Herodotus, «History», WHOLE OF ANCIENT GREEKS AUTHORS, Ancient Text – Translation – Notes, Scientific Society of Greek Writtings, PAPYROS, Athens 1975.
4. Horatiu Crisan Ion: *Civilizația geto-dacilor* (*The civilization of the Get-Dacians*), vol.1, 2, Ed. Dacică, București, 2008.
5. Ionescu-Carligel Const.: "*Cadrane solare grecesti si romane in Dobrogea*" («*Greek and Roman solar clocks*»), in *Pontice* review, No.2, 1969.
6. Notaras Chysanthos: «*Εισαγωγή εις τα Γεωγραφικά και Σφαιρικά*», Notaras Chryssanthos "*Introduction to Geographical and Spherical"*, first edition Paris 1716 and new edition ΣΥΛΛΟΓΟΣ ΠΡΟΣ ΔΙΑΔΟΣΙΝ ΩΦΕΛΙΜΩΝ ΒΙΒΛΙΩΝ Athens 2010, (in Greek language).
7. Rovithis-Livaniou H. & Antonopoulou E.: "*Cosmology and Genesis*", in TRANSDISCIPLINARITY IN SCIENCE AND RELIGION, (Weislogel E., Nikolescu B. & Stavinschi M., Eds.), No. 5, p. 53, 2009).
8. Λεξικό Σουΐδα: ΘΥΡΑΘΕΝ ΕΚΔΟΣΕΙΣ, Θεσσαλονίκη 2002, (Dictionary Suida: ΘΥΡΑΘΕΝ EDITION, Thessalonika 2002).
9. Vitruvius: "*Ten Books on Architecture*", The Project Gutenberg eBooks on Ten Books on Architecture.
10. Vulpe Radu: *Vechi focare de civilizatie: Istria, Tomis, Callatis* (*Ancient centres of civilisation: Histria, Tomis, Callatis*), 1966, Ed. Științifică și Enciclopedia, București, 1966.