The Prosymna Globe:
a new interpretation

This article aims at suggesting a new interpretation of the signs and symbols plotted on the southern part of the Prosymna Globe and especially on the "fishbone-shaped" quadrant. It also aims at explaining how to plot the quadrants using a regular compass.

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Introduction

The *Prosymna Globe* was discovered in 1939 by the American archaeologist Carl Blegen while excavating the ruins of the ancient Greek city of Prosymna (near Corinth, on the Peloponnese peninsula in Greece) and it is currently kept in the Archaeological Museum of Nauplion. To date, archaeologists have uncovered only two spherical sundials from ancient times: *the Prosymna Globe* and *the Matelica Globe*, the latter discovered in 1985 in Matelica, a small town near Macerata, Italy.
Reference [1] is a detailed introduction to said two artefacts. References [2], [3] and [4] are more specialised studies carried out on the Prosymna Globe, while References [5], [6], [7], [8], [9] and [10] are dedicated to the Matelica Globe.
The *Prosymna Globe* consists of three solar quadrants:
The **1st** quadrant faces south, features a *fishbone* shape and a solar calendar.
The **2nd** quadrant faces south, features *curved lines* and a solar calendar.
The **3rd** quadrant faces north, features *drop-shaped* circles and a solar calendar.

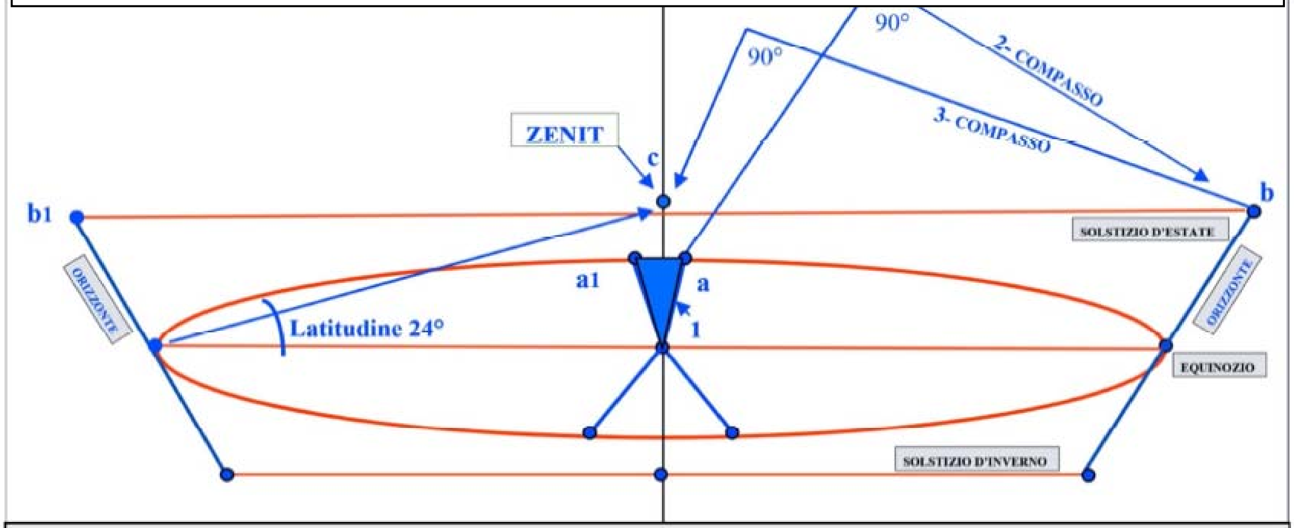
Orlando Zorzenon reproduced the three quadrants on a fiberglass globe using a regular compass and a tailor's measuring tape. It is presumed that the manufacturer of the Prosymna Globe used similar techniques to mark the circular arcs on the spherical sundial. According to archaeologists and epigraphists *the Prosymna Globe* probably dates to the III century B.C..
Our goal was to identify the various construction stages that resulted in the three solar quadrants. We also wished to determine whether the latitude of the town of Prosymna actually corresponded to the latitude of the three quadrants engraved on the globe.
We started reproducing the quadrants of the original globe (ø 53 cm) on a fiberglass sphere (ø 60 cm). This allowed us to suppose that the *Prosymna Globe* was not designed for use in the town of Prosymna, but in two other places, far from Greece.
The three solar quadrants of *the Prosymna Globe* differ in the way they have been built. In order to test the correct functioning of the quadrants, we decided to build a second copy of the globe, this time according to the latitude of the town we live in: Aiello del Friuli (Udine). We noticed that when exposing the globe to sunlight, the three quadrants were functional only after modifying the above mentioned **1st** *fishbone* quadrant. This article, indeed, will focus mainly on the fishbone quadrant as few studies have been performed to date, and also because it will reveal a little of the story of this extraordinary sundial.

The 1st south-facing quadrant, named *fishbone*

The first south-facing quadrant, also named *fishbone,* is easily discerned as it is carved into the lower area of the globe, over the horizon line.
Our first question was: "How could a quadrant possibly function, being placed in such a low area of the globe and diverging so much in form from the other two?" The answer seemed to be quite

simple: if the lines of the quadrant were the lines of the terminator at Equinoxes and Solstices, exactly as in the 2nd quadrant, named “curved lines”, then it couldn't!
But if it couldn't function, then why was it engraved there?
Orlando Zorzenon had an intuition: rotating the copy of the Prosymna Globe and placing the quadrant at the right latitude, everything made sense. The fishbone quadrant became functional when facing south.
At the beginning we built the quadrant (on the equinoctial line of the new latitude, rather than on the horizon) according to the latitude of Prosymna (37° 42’), but it looked very different from the original one. So we decided to draw the quadrant of the sample globe according to a more southern latitude, 35.7°, but also this time the Hour Lines looked wrong. This is when we decided to learn the correct latitude building the quadrant in reverse. So first of all we copied the triangle of the meridian of the original *Prosymna Globe* on our sample globe. Using a regular compass (see Picture 1, relevant to Stage **1**) in four steps we plotted the horizon line first and then the Zenith line. Once we had the Zenith point on the globe, we calculated the angle between the Zenith line and the Equinoctial line, thus obtaining the latitude.

1st SOUTH-FACING *FISHBONE* QUADRANT DRAWN ON A FLAT SURFACE



1) Reproduction of the triangle on the upper quadrant of the Prosymna Globe.
1b) Plot, both above and below the intermediate (equinoctial) circle, two smaller circles corresponding to the Solstices and +/- 23.5° distant from it.
2) Compass (90°) pointed on **a** to determine **b** (Horizon) on the line of the south-east solar calendar
3) Compass (90°) pointed on **b** to determine **c** (Zenith). The angle formed by **C** with the Equinoctial line tell us the quadrant's latitude: **24°** for the **1st** quadrant of the Prosymna Globe

To our surprise, the latitude angle was **24°**!
This latitude told us the origin of the spherical sundial, which is far from Prosymna and Greece. The **24th** parallel, indeed, crosses Ancient Egypt and present-day Saudi Arabia passing through the city of Medina!
While marking all the Hour Lines on our sample globe we encountered a probable gross design flaw in the spacing of the twelve hours on the Prosymna Globe. As a result, the inclination of the Hour Lines is incorrect.

The hypothetical error probably lies in the designer’s choice to indicate the 6 lines marking the morning and afternoon hours on the Solstice lines starting from the sunrise and sunset points, instead of starting from the meridian line till the point marking the Sixth Hour. In the next few pages we will explain in more detail the construction stages of the spherical sundial using just a compass and a tailor's measuring tape. (Pictures 2, 3 and 4 in Appendix - Stages **2, 3** and **4**)

The 2nd south-facing *curved lines* quadrant

We similarly reproduced the second quadrant featuring *curved lines*, re-calculating the matching Se volete che sia più letterale, allora “little hles”
between the Calendar Lines, the Hour curves engraved on the solar calendar and the small depressions marking the hours and encircling the globe from east to west. This allowed us to determine that the right latitude is **33°**. Again, the spherical sundial was meant to function not in Prosymna or Greece, but in places at this latitude such as Damascus or Baghdad.
Recreating the quadrant on our fiberglass globe, we noticed also an imperfection in the seventh (VII) hour marking of the original globe: the Hour line drawn at the Winter solstice is slightly off the correct position. Indeed, it is likely that the designer pointed the compass in the wrong place, mistaking the eighth hour (VIII) on the Equinoctial line for the ninth hour (IX) on the very close Summer solstice line. The technique used to make the 2nd quadrant featuring *curved lines* is very similar to that used for the Mantelica Globe and already described in detail by Andrea Carusi and Danilo Baldini (who discovered the artefact, see [5] and [6]). For this reason further description here is not necessary.

The 3rd north-facing *drop-shapes* quadrant

The **3rd** north-facing quadrant is linked to the **2nd** south-facing quadrant as both have been calculated starting from the positions of the Sun on the Solstices and the Equinoxes at different hours. Therefore it is not possible to build the third quadrant without the second. The compass should always be set at 90°, which is the angle from the Pole to the Equinoctial line of the **2nd** quadrant. To further investigate this issue, read Fantoni’s work on plotting methods, References [1].
Please note that the straight lines on the quadrant are nothing more than connections, linking together the hour points at different times of the year (Solstices and Equinoxes) on the two quadrants. Therefore they have no time relevance at all. We could call this quadrant *the Seasonal quadrant*.

Conclusions and considerations

These analyses carried out on the *Prosymna Globe* tell us a very interesting story. Indeed, according to the different latitudes of the sundial's quadrants, we can surmise that the **1st** *fishbone* quadrant was intended for use in a location at a latitude of 24°, that is, in Northern Egypt, Medina or in a place in the middle of the Arabian peninsula.
Then, for reasons unknown to us, the globe was probably taken to a location at a latitude of 33°, such as Damascus, Baghdad or another place on the 33rd parallel.
As a consequence, we can presume that two more quadrants were added to it. They were built according to different construction methods compared to the first quadrant, probably according to the techniques used in those places at the time. It is possible that two or even three centuries may have passed between the construction of the first quadrant and the last two.
We can also suppose that the designer who built the **2nd** and the **3rd** quadrants, decided not to erase the first one. Therefore he had to rotate the globe on the Southern meridian and to engrave the new sundials where the surface of the globe was untouched. Finally, we can presume that the designer made a hole in the lower part of the globe to fix the new support of the sundial.
We also believe that the sundial was probably moved from this unknown place on the 33rd parallel, perhaps as a spoil of war (like the sundial that the Romans brought to Rome from Syracuse and placed in the Roman Forum, where it told the wrong time for centuries) or perhaps, being a valuable instrument, it was sold to a merchant who took it to Greece to be finally discovered amid the ruins of that ancient city, 2000 years later.

Today the spherical sundial is kept in the Archaeological Museum of Nauplion, not far from Prosymna.
As a result of the various tests carried out by Orlando Zorzenon, who faithfully followed the correct construction methods used in the past in order to reproduce the three quadrants, the authors of this article believe that there is no place in Greece where the *Prosymna Globe* can accurately mark solar time.
The spherical fiberglass sundial built according to the latitude of Aiello del Friuli (UD) shows us how the original globe was supposed to work. The three quadrants, faithfully reproduced as on the Prosymna Globe, never told the same time simultaneously. Only the 2nd quadrant, featuring *curved lines* and the 3rd quadrant, featuring *drop-shaped circles* tell the same time simultaneously. In order to read the right time on the 1st *fishbone* quadrant it is necessary to rotate the globe on the Southern meridian, bringing the quadrant to the right latitude (in this case, the latitude of Aiello del Friuli: 45° 52'). Therefore, when the first quadrant is functional, the second and the third aren't and vice versa.
For the occasion of the 16th Sundial Festival, taking place on 22 May 2016 in Aiello del Friuli, the Navarca Cultural Association – promoter of Aiello del Friuli, the Town of Sundials – has built a copy of the Mantelica Globe, twice the size of the original, and placed it in the Courtyard of Sundials, in the Friulian farming culture museum. The spherical sundial exhibited in Aiello features a 59 cm diameter (instead of 29.5 cm) and weighs 200 kg. The designers are: Professor Andrea Carusi from Rome, who performed the gnomonic calculations, Samuele Buset from Cervignano, who built the Corten steel support and Orlando Zorzenon, who built the globe. This valuable spherical sundial was inaugurated on 22 May, at 5 pm.
Last summer a second spherical stone sundial, inspired by the Prosymna Globe, was built and it will be inaugurated on occasion of the 2017 edition of the Sundial Festival, usually taking place the last weekend of May, in order to give all those interested in Gnomonics the chance to admire its perfect functioning and compare it to the other sundials exhibited in the courtyard, such as the Hemispheric, the Scaphen, the Inclined and the Vertical sundials and last, but not least, the spherical sundial featuring the same quadrant and calendar of the Mantelica Globe.

Aiello del Friuli, 21 March 2016

Orlando Zorzenon
Aurelio Pantanali

References

[1] G. Fantoni, "*Orologi Solari della Antica Grecia. I Globi di Prosymna e di Matelica*", 10th Italian Gnomonics Seminar, S. Benedetto del Tronto, 10/2000 pp. 95-116.

[2] K. Schaldach, O. Feustel, "*The Globe Dial of Prosymna*", BSS Bulletin Volume 25(iii) September 2013, pp. 6-12

[3] O. Feustel, "*The Mathematical Analysis of the Globe Sundial of Prosymna*", The Compendium Volume 20, Number 3, September 2013, pp. 4-16

[4] O. Feustel, "*Globe Sundial of Prosymna – The Enigma of its Ancient Construction is Solved*", The Compendium Volume 23, Number 3, September 2016, pp. 7-20

[5] D. Baldini "*Parliamo ancora del Globo di Matelica*". 2nd Italian Gnomonics Seminar, Monterubbiano, 04/1989 p. 6.

[6] A. Carusi - D. Baldini "*Il globo di Matelica*" in "l'Astronomia" No. 92 10/1989 pp. 30-38

(www.antiqui.it/archeoastronomia/globo.htm)

[7] F. Azzarita "*Il globo di Matelica*" 1st Italian Gnomonics Seminar, S. Elpidio a Mare 12/1987, pp. 3– 15

[8] A. Nicelli, "*Sul Globo di Matelica come gnomone di un orologio orizzontale*", 10th Iyalian Gnomonics Seminar, S. Benedetto del Tronto, 10/2000 pp. 183-191.

[9] A. Gunella "*La sfera di Matelica*" Gnomonica UAI No.4 09/1999 pp. 31 – 33.

[10] A. Nicelli "*Il modello matematico dei punti orari sul globo di Matelica*" Gnomonica UAI No..4 09/1999 pp. 35 – 39.

[10] Sharon L. Gibbs, "*Greek and Roman Sundials*", Yale University Press, 1976 pp. 27-30 and pp. 376-378.

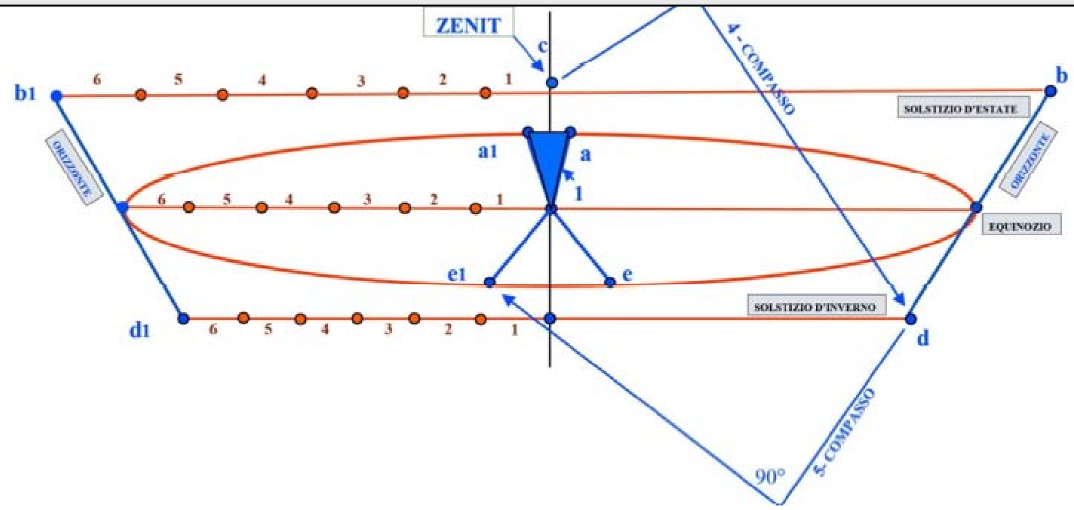
[ ] Searching the keywords "Sfera di Matelica" / "Matelica's Globe" on any search engine it is possible to find further articles and documents on this topic (the Italian ones are mainly written by Baldini and Carusi).

Appendix

Here follow some pictures explaining the methods recommended to plot the lines and also some instructions to correctly interpret the data resulting from the reading of the terminator on the globe.

STAGE 2: e1 (SUNRISE POINT ON WINTER SOLSTICE) and SUBDIVISION OF THE CALENDAR

1st SOUTH-FACING *FISHBONE* QUADRANT DRAWN ON A FLAT SURFACE



4) Compass (90°) pointed on **c** to determine **d** (Horizon) on the **Winter Solstice line.**

5) Compass (90°) pointed on **d** to determine **e1** on the **Winter Solstice line** of the quadrant. (Sunrise on Winter solstice)

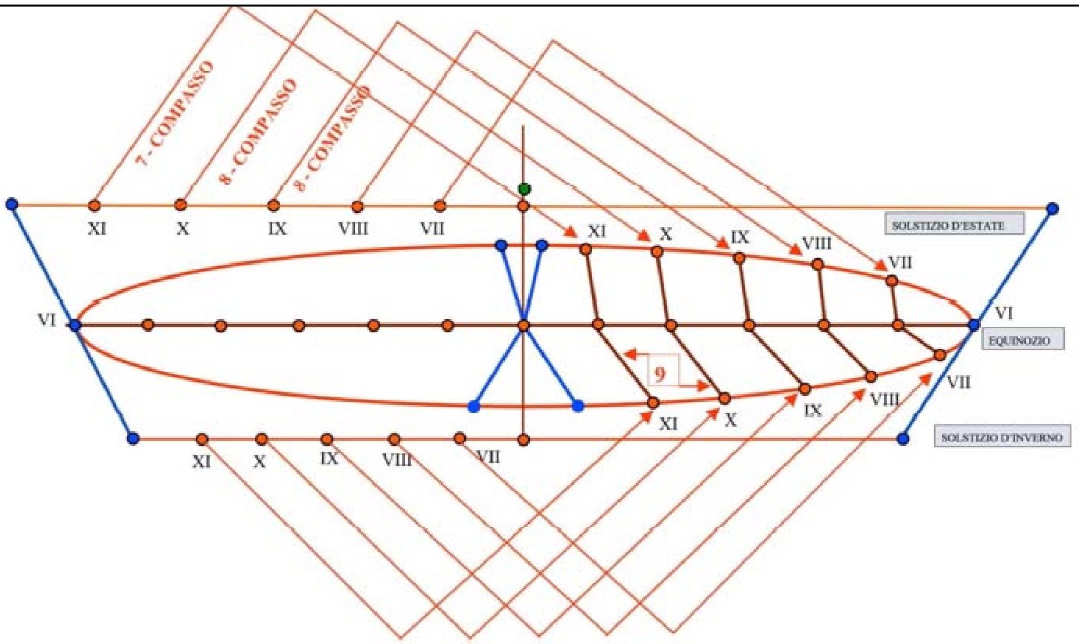
6) Subdivision of the Solstice lines into 6+6 equal sectors (Hours) and of the equinoctial line in 12 equal sectors (Equinoctial Hours)

View from the east - View from the south
1b- Pole
1a- Horizon
Summer solstice
Equinox

Vista da Est - Vista da Sud
1b-Polo
1a-Orizzonte
Solstizio d'Estate
Equinozio
Solstizio d'Inverno

STAGE 3: PLOTTING OF THE HOUR LINES

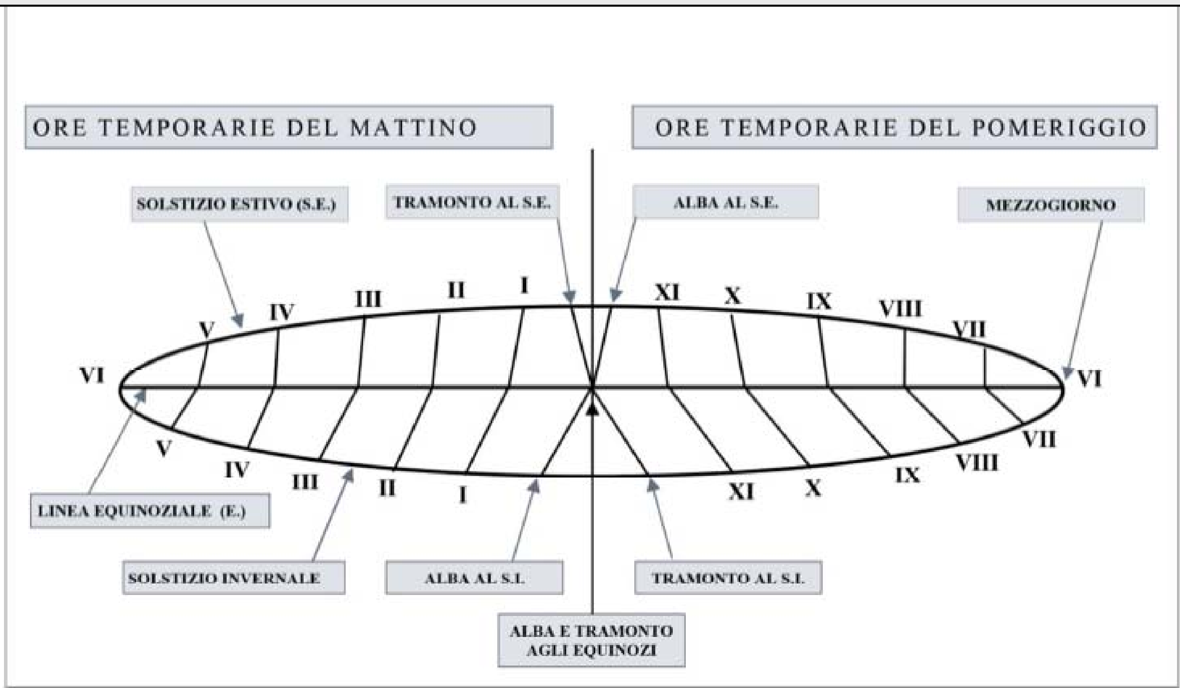
1st SOUTH-FACING *FISHBONE* QUADRANT DRAWN ON A FLAT SURFACE



7) Compass (90°) pointed on the sixth sector of the left solar calendar to determine the eleventh (XI) hour.
8) Compass (90°) pointed on all the other hour subdivisions of the S.S. to indicate them on the quadrant of the great circle of the Summer solstice.
8) The same procedure as above to draw the Hour points on the great circle of the W.S.
9) The Hour points are connected with lines. The same procedure is used to complete the morning quadrant.

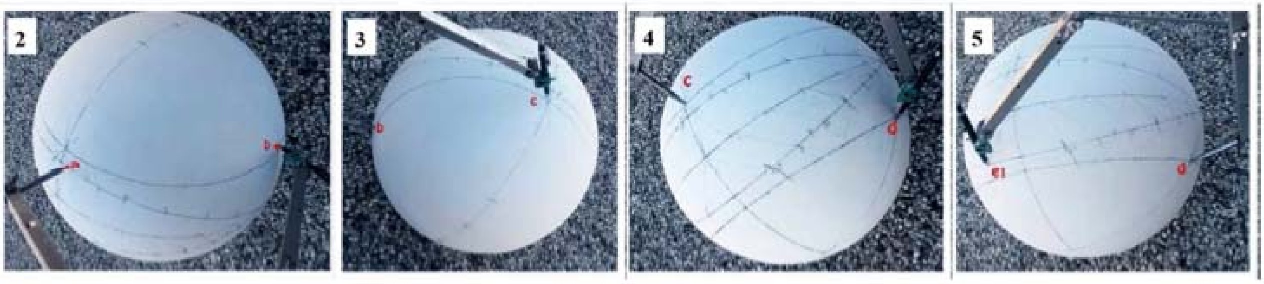
TAGE 4: THE SOLAR QUADRANT

1st SOUTH-FACING *FISHBONE* QUADRANT DRAWN ON A FLAT SURFACE

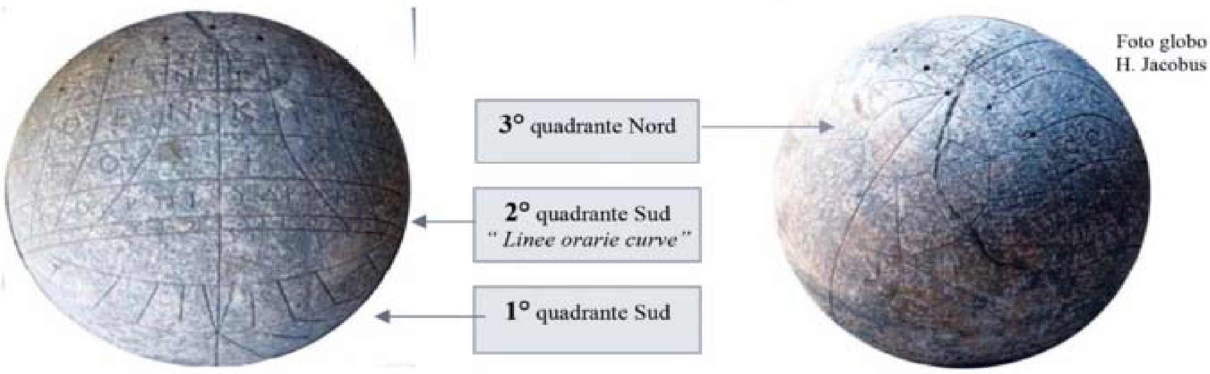


MORNING HOURS	ORE TEMPORARIE DEL MATTINO
AFTERNOON HOURS	ORE TEMPORARIE DEL POMERIGGIO
SUMMER SOLSTICE (S.S.) HYPERBOLA	**IPERBOLE SOLSTIZIO ESTIVO (S.E.)**
SUNSET	**TRAMONTO**
SUNRISE .	**ALBA**
MIDDAY	**MEZZOGIORNO**
EQUINOCTIAL LINE	**LINEA EQUINOZIALE**
WINTER SOLSTICE (W.S.) HYPERBOLA	**IPERBOLE SOLSTIZIO INVERNALE (S.E.)**
SUNRISE AND SUNSET ON THE EQUINOXES	**ALBA E TRAMONTO AGLI EQUINOZI**

TRACCIAMENTO DEL QUADRANTE N° 1 CON COMPASSO SU GLOBO CAMPIONE



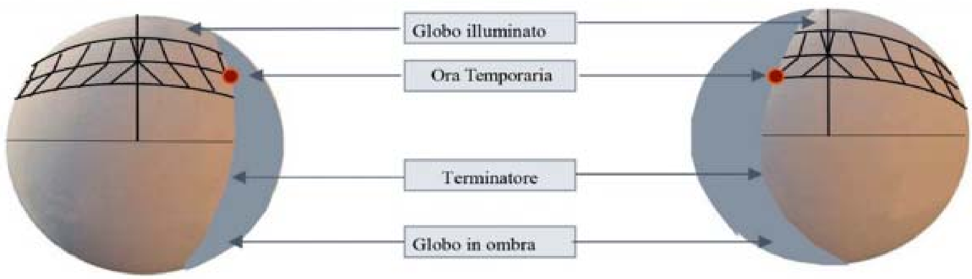
IMMAGINI DEL *GLOBO DI PROSYMNA*



To use the 1st *fishbone-like* solar quadrant of the Prosymna Globe, turn it to its latitude (**24°**) as explained in the article

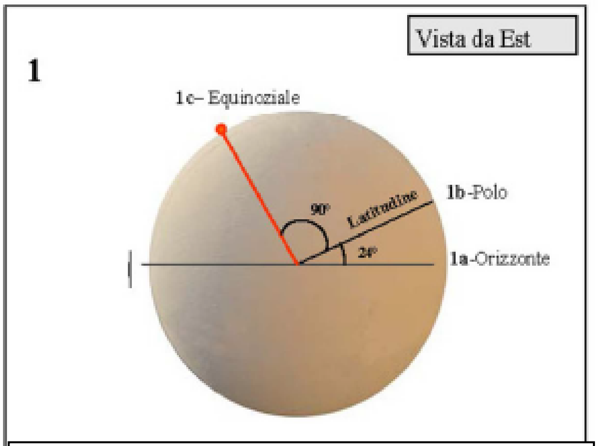
The *Prosymna Globe* will tell the right solar time only when at the latitudes for which it was designed: **24°**for the **1st** quadrant; **33°** for the **2nd** and **3rd** quadrants

CHE ORA E' ?

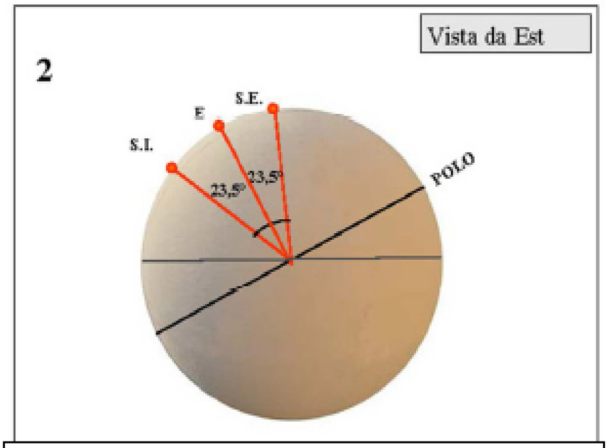


The terminator indicats the ninth **(IX)** hour.
-ninth hour - in a period of the year close to the Equinox.

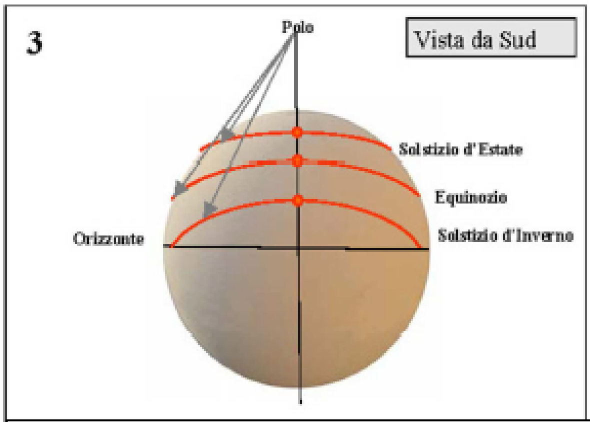
The terminator indicates the first **(I)** hour.
- first hour - in a period of the year close to the Winter solstice.



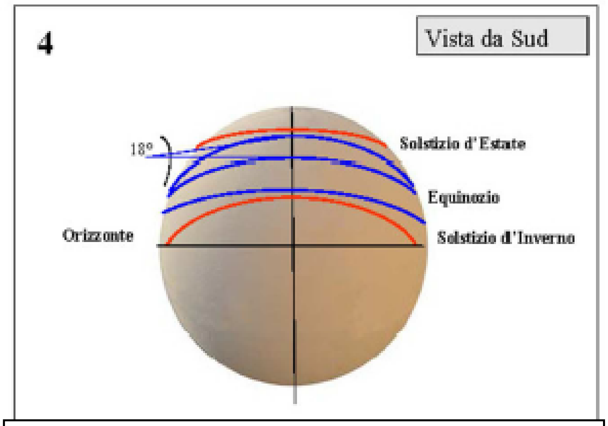
1a) Plotting of the Horizon line
1b) Latitude point* (24°) and pole position
1c) Point of the Equinoctial line (90° from the Pole)
*Construction of the Prosymna Globe according to the latitude of the **1st** *fishbone* quadrant.



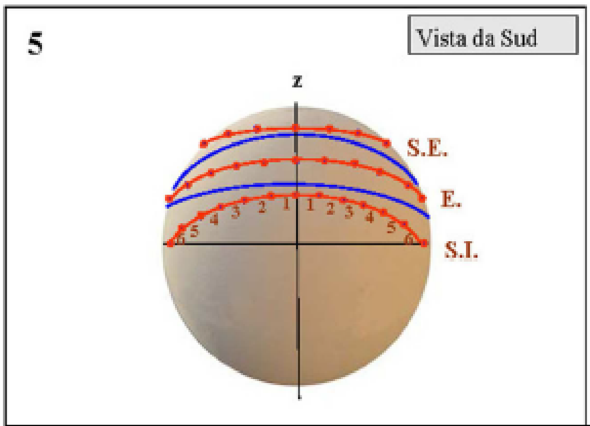
2a) Plotting of the Equinoctial line
2b) Plotting of the Solstice lines
+ 23.5° Summer solstice
- 23.5° Winter solstice



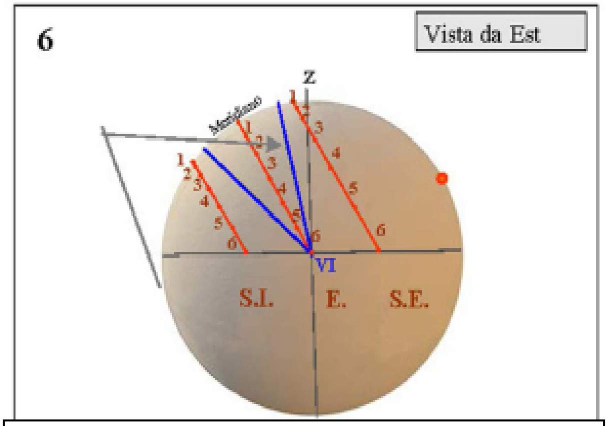
3a) Plotting of the meridian line and of the solar calendar, pointing the compass on the Pole (compass arc of 90°).



4a) Compass arc of 18° to reflect the angle on the quadrant of the Prosymna Globe (see stage 1).
4b) Plotting of the two arcs along the meridian line (compass arc of 90°).



5a) Subdivision of the globe indicating the Summer solstice, Equinox, and Winter solstice lines resulting in 12 equal sectors.



6a) Lateral view of the hour subdivision (See stages 1 and 2).

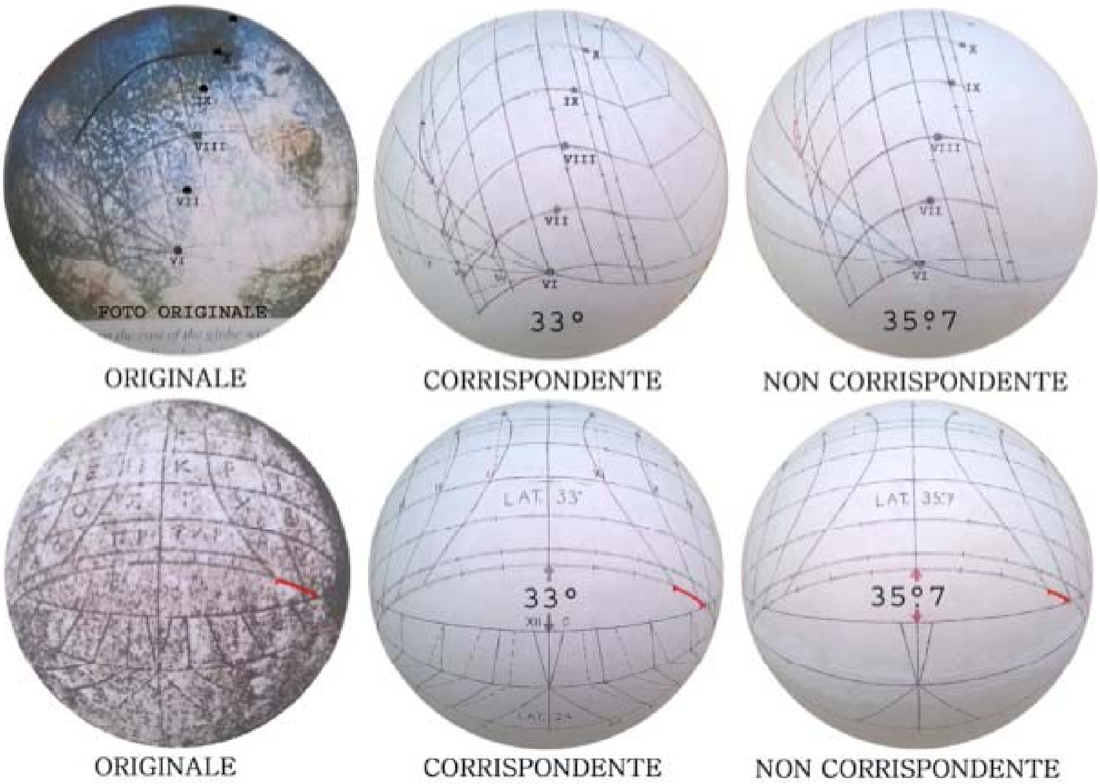
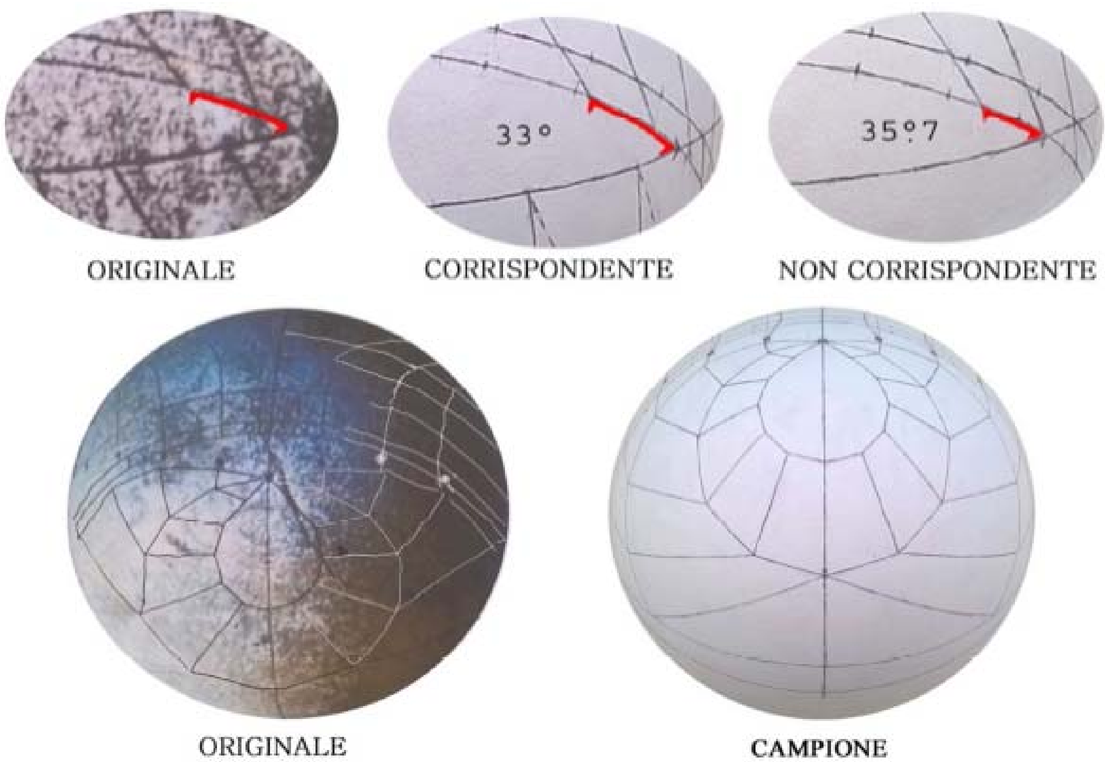


Fig. 9 - Il quadrante originale ed i quadranti costruiti alla latitudine di 33° e a 35.7° con le immagini di lato e di fronte.



ORIGINALE

24° CORRISPONDENTE