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Traces of scientific geography in Pliny's *Naturalis Historia*

Аннотация. «Естественная история» Плиния Старшего содержит множество свидетельств таких авторов, как Евдокс, Пифей и Эратосфен, — в книгах II–VI, посвященных космологии и географии. В VII книге, наоборот, фактически отсутствуют ссылки на авторов научных географических трудов (за исключением цитаты из сочинения Евдокса в VII, 24 об индах). VII книга представляет своего рода собрание рассказов о диковинах и по существу выполняет психолого-литературную функцию.

На основе анализа приводимых в книгах II–VI цитат из сочинений античных авторов в статье показано, что наряду с приверженностью Эратосфеновой картине мира Плиний отражает и представления о мире римлян эпохи Флавиев. Следовательно, описание картины мира у Плиния основано, скорее всего, на астрономо-климатической концепции географии (восходящей к Эратосфену и дополненной Посидонием) и на астролого-климатической концепции (восходящей к Нигидию Фигулу). Влияние Посидония на содержание «Естественной истории» не затрагивает структуру карты мира Эратосфена, но заключается главным образом в разъяснении происхождения атмосферных явлений и геологических процессов, что позволяет говорить о существовании климатических поясов. Последнее обстоятельство можно рассматривать в качестве элемента эволюционирующей картины мира Евдокса и Эратосфена. Кроме того, латинские источники (прежде всего Варрон наряду с Нигидием Фигулом и Витрувием), по всей видимости, сыграли важную роль в передаче знаний греческих ученых, а также в использовании латинской астрономической лексики, о чем свидетельствует труд Плиния Старшего.

Ключевые слова: география, астрономия, Эратосфен, Евдокс, Пифей, Посидоний, карта мира, климатические пояса (параллели)

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Traces of scientific geography in Pliny's *Naturalis Historia*

Abstract. The text of *Natural History* contains many references to the scientist geographers such as Eudoxus, Pytheas and Eratosthenes in Books II–VI: these books include both cosmology and geography, while in Book VII, on the contrary, there is almost no reference to the scientist geographers (only Eudoxus is quoted in VII, 24 about the Indians). This book is a sort of container of wonders and seems to have a psycho-literary function: on one hand, it reassures the reader of the "opposition" and "distance" of those places compared to the one in which one lives, and, on the other, it emphasizes the importance of research which, in Pliny's time, had preserved and updated Greek science.

My analysis herein shows that quotations from ancient authors in Books II–VI point to the strong continuity between Eratosthenes and his conception of the world with that of the Romans under the Flavians. Hence, Pliny's description seems to come from a synthesis of both an astronomical-climatic conception (of Eratosthenes' origin and Posidonius' elaboration) and an astrological-climatic one (which derives from Nigidius Figulus). The influence of Posidonius on the *Naturalis Historia* does not affect the framework of Eratosthenes' map, but mainly involves the interpretation of the atmospheric phenomena that characterize the earth, thereby allowing us to hypothesize climatic bands. The latter are understood to be an evolution on the thinking of both Eudoxus and Eratosthenes. Then, among Latin sources, Varro (with Nigidius Figulus and Vitruvius) seems to have played an important role in the transmission of Greek science and in the creation of a Latin astronomical lexicon, as witnessed by the work of Pliny.

Keywords: geography, astronomy, Eratosthenes, Eudoxus, Pytheas, Posidonius, map of the world, latitudes

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In order to analyse the passages containing traces of scientific geography in the Naturalis Historia, it is necessary to deal with Pliny's method of working in order to understand the role of his study on the cosmos and the inhabited world. The Naturalis Historia is, in fact, a sort of updated "world inventory" that focuses on the Roman Empire in the Flavian age: "La cosmographie et la géographie sont l'introduction, le cadre mentale (à la fois géometrique et politique) qui permettra de saisir et de classer un inventaire de la nature entière" [Nicolet 1988: 96][1]).

Book II is dedicated to cosmography, while Books III–VI deal with geography. Book VII is dedicated to anthropology and clearly differs from any of his previous books.

This differentiation is already an example of Pliny's method, which catalogues the knowledge of his time in categories, with the aim to reflect the progress of the sciences and, at the same time, to show how some of them evolved.

The separation of geography and anthropology may seem strange in relation to the method used by ancient scholars to investigate: indeed, in Book VII, for example, we find all those wonderful aspects concentrated in Ethiopia and India. They are set out in such a way as to let us believe that these lands are "other places", characterized by exceptional flora and fauna, and described in such a way as to catch the reader's attention[2]. Through the fusion of *periegesis* and *paradoxographia*, again in Book VII, both *prodigiosa aliqua et incredibilia* reappear and are described with accuracy[3].

My initial observation regarding the theme of this discussion is that, in Book VII, there is almost no reference to the scientist geographers, such as Eudoxus of Cnidus, Pytheas of Massalia, Dicaearchus of Messene, Eratosthenes of Cyrene, or Hipparchus of Nicaea: only Eudoxus is quoted in Book VII, 24 about the Indians — about their feet being enormous in males and very small in females. We do not know if this information goes back to Ctesias, as Gisinger believed [Gisinger 1921: 20], or to a dossier on the wonders of India. But, if this was the only testimony we had about Eudoxus, we would certainly not consider him to be the pioneer of scientific geography.

Furthermore, regarding the authors mentioned on the wonders of India, the absence of Nearchus is notable among the explorers of Alexander[4]: indeed, he is mentioned five times in the Sixth Book (VI, 96, 97, 107, 109, 124), whereas Onesicritus

[1] For an evaluation of Plinian encyclopedism, see [Conte 1982: xvii; Murphy 2004: 4]. Cf. also [Naas 2002: 78–81; 2011: 60 ss.]. For a summary of the negative judgements, beginning with E. Norden, on Plinian encyclopedism cf. [Wallace-Hadrill 1990: 80–81] (with bibliography). For an innovative approach to Plinian encyclopedism cf. [French, Greenaway 1986; Serbat 1986: 2170 ("testament de la science antique"); Citroni Marchetti 1991; Beagon 1992; Doody 2010]. On the relationship between Plinian encyclopedism and Roman Imperialism cf. [Naas 2011: 57; Taylor 2015: 46–47]; for a critical position cf. [Laehn 2013].

[2] On the exceptional characteristics of "extreme" countries, particularly Ethiopia and India, cf. [Schneider 2004, passim.]. On the hypothesis that the zoological and botanical information may be related to the triumphant arrival in Rome of the exotic species mentioned cf. [Murphy 2004: 50–51]; Laehn noted how "the chronology of each section of the *Natural History* is structured around the dates when each of the products of Nature described therein first made their appearance in Rome' [Laehn 2013: 113].

[3] *NH* VII, 6. See [Healey 1999: 63–70] for the use of the terms mirabilia-miracula in the *Naturalis Historia*.

[4] On the expansion of geographic knowledge related to military expansionism according to Pliny and on the evaluation of the Alexander enterprise by the Naturalist, see [Cotta Ramosino 2001].

is mentioned only twice (81; 96): the description of Taprobane belongs in VI, 81–82 to the *prisci* with Onesicritus, Megasthenes and Eratosthenes, while at the time of Pliny *dilegentior notitia Claudi principatu contigit, legatis etiam ex ea insula advectis* (VI, 84).

As we know, Megasthenes enlightened Eratostothenes by providing him with a lot of information about India. His name appears three times in Book VII: men with backward feet and eight toes per foot (VII, 23); the Sirites, who had holes instead of a nose (VII, 25); and the Mandi, who lived in three hundred villages and whose females gave birth at the tender age of seven and who, at forty, were considered old (VII, 29).

In the quotations mentioned in Book VII, Pliny does not add any personal comments: his testimonies are listed in a sort of dossier of wonders with references to Ctesias, Crates, Agatarchides, Clitarchus, Artemidorus as well as to Aristotle. His description of the countries furthest away appears in the conclusion, with the aim to preserve and transmit, even in times of extended knowledge, an idea of Ethiopia and India fixed to the past.

This sort of container of wonders seems to have a psycho-literary function: on the one hand, it reassures the reader of the "opposition" and "distance" of those places compared to the one in which one lives and, on the other, it emphasizes the importance of research which, at the time of Pliny, had preserved and updated Greek science, as described in Books II–VI.

These books, which we will now consider, include — as already mentioned — both cosmology and geography, wherein the presence of the scientist geographers is conspicuous: we will examine here some important passages.

Eudoxus of Cnidus, who is mentioned seven times in the *Naturalis Historia* (II, 130; VI, 198; VII, 24; XVIII, 213; 312; XXX, 3; XXXI, 16), is quoted in II, 130 on the cyclicity of the winds, which, like other atmospheric phenomena, return to the same order within a four-year period (cf. II, 131).

Subsequently Pliny describes a type of wind known for its sudden gusts and which occurs in variable forms: among these, he mentions the wind coming from the clouds, called *ecnephias* by the Greeks. This explanation is reflected in the *Naturales Quaestiones* (II, 12, 5) of Seneca, who describes the effect of clouds colliding violently. Seneca ascribed to the clouds a specific role (*De nubibus*) [Vottero 1989: 107–111] drawn from ancient meteorological texts (especially those of Aristotle, *Met*. I, 9–12) as well as doxographic manuals (e. g. Aet., III, 4, in *DDG* 370a 12–13; b 23–25; Diog. Laert., VII, 153) and Posidonius, who transmitted to Strabo the subtle discussion of the winds, which may be read in I, 2.21 C29 (= F 137a EK) [Vottero 1989: 107–111].

Regarding the great problem of Seneca's sources in the *Naturales Quaestiones*, a prominent role seems to have been played by Posidonius[5], who took care of the meteorological aspects with a fortune witnessed by our tradition.

The "hunt" for Posidonius in Seneca's work has certainly produced questionable results, but undoubtedly, studies of Posidonius' meteorological aspects seem to have influenced, directly or indirectly, the Latin tradition, which, in turn, appears to have been acquired and reworked in the results of the Greek investigation, especially for the first cen-

[5] See [Vottero 1989: 38 with bibliography].

tury B.C. Posidonius seems to have had a leading role in the transmission of Greek science in Rome, where the Stoic approach to interpreting the cosmos received wide approval.

Therefore, I think that a survey on Posidonius' influence in the passages devoted to scientific geography in the *Naturalis Historia* could be a starting point for further reflection.

Let us first go back to the passages where Eudoxus of Cnidus is mentioned: Pliny quotes the scientist in VI, 198 (= F 369 Lasserre), where the location of Cerne and other oceanic islands is mentioned:

> *Insulas toto eo*[6] *mari et Ephorus conplures esse tradidit et Eudoxus et Timosthenes... Contra sinum Persicum Cerne nominatur insula adversa Aethiopiae, cuius neque magnitudo neque intervallum a continente constat; Aethiopas tantum populos habere proditur. Ephorus auctor est a Rubro mari navigant<e>s in eam non posse propter ardores ultra quasdam columnas — ita appellantur parvae insulae — provehi*.

The mention of Eudoxus and Timosthenes on Cerne is very important and, as we have not found this description in any other source, we therefore have to recognize that Timosthenes' knowledge should be strictly limited to the islands of the Mediterranean and the Red Sea[7]. As for Eudoxus, we know nothing about a description of the oceanic islands: and hence, it is from this Pliny passage, wherein Strabo mentions Crete [Gisinger 1921: 111–112], that Gisinger derived his idea for a catalogue on the islands, contained in Book VII of the *Periodos tes ghes.* This catalogue by Eudoxus would form the basis for successive "books on islands", and the best and most well-known of these is contained in Book V by Diodorus. We do not actually have any elements to support this hypothesis, but the fact that Pliny speaks of oceanic *complures insulae* gives us at least a glimpse of just one conception of the islands recorded around the various parts of the oikumene.

The island of Cerne, identified by Ephorus, according to Pliny, *contra sinum Persicum*[8], can be inserted into a geographical framework that finds analogies to the one by Posidonius: in fact, he imagined not a triangular Africa, as Eratosthenes did, but rather a trapezoidal one, as we learn from Pliny (VI, 57 = F 212 EK on India; VI, 197 on Ethiopia)[9].

In this conception of a trapezoidal Africa, with the Ethiopians located along the southern side of this quadrilateral, the Cerne of Ephorus represented the extreme south-eastern point of Ethiopia. Instead, in the representation by Eratosthenes — which probably derived from Annon — the island was located to the southwest. In conclusion, Cerne represents a sort of *trait-d'union* between two different traditions, linked to two attempts to circumnavigate Africa: from Annon in the West and Ephorus in the East [Bianchetti 1989].

If this interpretation of the Plinian text is correct, then we are led to believe that Pliny knew the geographies of both Ephorus and Posidonius. Pliny was able to

[6] *Eoo* [Detlefsen 1908, with references to VI, 56; 82; X, 58], cf. [Wagner 1888: 66].

[7] On Timosthenes, see [Wagner 1888; Gisinger 1937: 1310 ss.; Prontera 1992; Meyer 1998].

[8] Lasserre [1966: 266] thought that Eudoxus could also have spoken about the island of Cerne and located it in the Red Sea, like Ephorus (*FGrHist* 70 F172). In reality, there are no arguments for thinking that Eudoxus was mentioned here for Cerne in the Red Sea, like Ephorus.

[9] On Posidonius' Ethiopia cf. [Bianchetti 1990].

derive the mention of Eudoxus in the context of a description of the oceanic islands that included a specific idea on the form and extent of land and seas.

It is necessary, however, to add that on specific questions such as those regarding astrology in XVIII, 213, Pliny cites Eudoxus along with Hesiod, Thales, Anaximander, and Euctemon, and declares that he is following Caesar. Hence, since the passage probably comes from a specific dossier[10], we are led to believe that the use of dossiers on particular subjects could be integrated with the privileged sources, which we could call "guide sources" (Posidonius, Varro et al.) — and which were the basis of *Naturalis Historia* and primarily concentrated in the first six books.

Among the scientist geographers examined herein, **Pytheas** of Massalia is mentioned nine times in the *Naturalis Historia*[11]. Apart from the quotations in the 1st Book with the list of Plinian sources, we find four quotations in Books II and IV; in II, 187 Pytheas' name is linked to Thule: "which is six days of navigation from Britain to the north". The description of the island is part of a list of latitudes that includes Meroe, Alexandria and Britain, according to a system that probably belongs to Eratosthenes, which is cited in II, 186.

Pliny updates the information and states that "some attest that the phenomenon described by Pytheas on Thule, where the sun withdraws in the opposite direction in the winter solstice, occurs in Mona (Anglesey), about 200 miles from Camulodunum (Colchester)".

Instead, in II, 217 Pytheas is cited on the tides, which rise 80 cubits north of Britain[12]. The subject of the tides, already treated by Aristotle, was, as we know, at the centre of Posidonius' *The Ocean,* a work that was an essential update of Pytheas' theories. The long passage by Strabo (III, 5, 7–8 C173–174 = F 217 EK and comm.767–776)[13], which describes Posidonius' theory, even mentions the moon among the causes, and recalls, but does not cite, the explanation by Pytheas. The latter was clearly known to Posidonius, who was not only an expert observer, but also a deep connoisseur on the work of the Massaliote, echoed in the title (*The Ocean*).

The other passages that mention Pytheas are related to contexts that are dated up to the Roman expansion: IV, 94–95[14], wherein we find the description of the northern coast of Europe, is a rich dossier on the history of the name of the North Sea and its islands. Pytheas is mentioned as using the toponym Basilia — probably transmitted from Timaeus, who is also mentioned in XXXVII, 35, in a description of the coast of Germany that goes back to Pytheas.

As already pointed out [Bianchetti 1996], Pliny's passages regarding the Nordic context do not seem to show any contrast with Greek knowledge, but rather are a necessary integration of it. Indeed, the information obtained from the expedition sent

[10] Cf. also XVIII, 312 where Eudoxus is mentioned with Philippus, Callippus, Dositheus, Parmeniscus, Conon, Criton, Democritus; XXX, 3 on the chronology of Zoroaster's death, set 6,000 years before Plato's death; XXXI, 16 on a spring in Cilicia for which the testimony of Eudoxus is invoked together with that of Theopompus.

[11] I, 2c: Eratosthenes; I, 4c: Xenophon of Lampsacus; I, 37c: Sotacus; II, 187: Thule; II, 217: the tides over Britain; IV, 96: island Basilia, Balcia of Xenophon of Lampsacus; IV, 102: Isidorus on Gesoriacus-Calidonia distance; XXXVII,35: Sotacus on *aestuarium Metuonidis*.

[12] Pyth. F 7e [Bianchetti 1998 with comm., 148–149].

[13] On Eratosthenes' knowledge of the theory of tides elaborated by Pytheas and on Posidonius' theory cf. Aujac 1966, 285–286; 287–288 on Plin. *NH* II, 97–100.

[14] Pyth. F 16 [Bianchetti 1998 with comm., 200–204].

by Nero to the Baltic Sea — not before 55 A.D (*NH* XXXVII, 45) — was added not only to the data obtained by Tiberius' fleet, who recognized twenty three Frisian islands, but also included the information obtained by Germanicus' army that stopped on the islands between the Zuiderzee and the Ems. In conclusion, according to Greek sources, Pliny follows Timaeus in his criticism of the poets as well as the Greek fantastic versions for the origin of amber. He also followed Timaeus for his positive viewpoint on the description of the North Sea by Pytheas. There are many additions resulting from updates, especially for the area of Britain (IV, 104) and the exploration of the island, which the Romans completed in the last thirty years up to the Calidonian Forest. For Ierne-Ibernia, which is situated to the north of Britain (*super eam*), Pliny gets his information from Caesar in order to "update" the description of Timaeus, who is explicitly mentioned. But Pytheas is not mentioned at all.

In conclusion, even Pliny's knowledge of Pytheas' work does not seem to be direct and does not always occur through the same source: indeed, the references to the tides (II, 217), and perhaps also those on the latitude of Thule — inserted in a framework of latitudes from the southern to the most northern points — go back to Posidonius (and via the philosopher on to Pytheas and Eratosthenes). However, the quotations on the northern ocean coast derive from Timaeus, who wrote of an original return trip for the Argonauts, using the work of Pytheas [Bianchetti 2004: 3–10]. We have to say, however, that contrary to the critical attitude shared by Pliny and Timaeus regarding the fantasy stories of the Greeks in Books II–VI, many of these stories can be found in Book VII. In my opinion, this is an important fact, and sheds light on Pliny's method, for we know that he selected materials of different origin and value according to the themes set down in the *Naturalis Historia.*

This sort of reflection may also help us to understand why **Eratosthenes** is mentioned many times in Pliny's work — precisely, 24 times in total, and mostly concentrated in Books II–VI[15], where we find him mentioned 17 times, plus another five times in the 1st Book among the main sources[16].

In II, 247 Eratosthenes is cited with particular admiration: indeed, the scientist is defined *in omnium quidem litterarum subtilitate, in hac utique praeter ceteros sollers*, especially for his measurement of the terrestrial meridian, calculated at 250,000 stades, equal to 31,500 Roman miles, and considered *improbum ausum, verum ita subtili argumentatione comprehensum ut pudeat non credere*.

Then, Pliny inserts an unusual reference to Hipparchus[17], who would add a bit less than 26,000 stades to the one measured by Eratosthenes (see below), and concludes with an episode that sounds like an *exemplum vanitatis graecae maximum*. This is the story about Dionysodorus of Melos, *geometricae scientia nobilis*, who died of old age and was the protagonist of an extraordinary event. The women who had arranged his funeral are said to have found a letter signed by Dionysodorus in his tomb wherein it was written that the deceased had gone from his grave to the deepest point of the earth. The distance between the tomb and this point would have been 42,000 stades. Some unknown expert in geometry calculated that had the letter been sent from the centre of the earth, it was ascertained that earth's circumference would have been 252,000 stades.

[15] II, 185, 247; III, 75; V, 39, 40, 41, 47, 127, 132; VI, 3, 36, 56, 81, 108, 163, 171, 183.

[16] I, 2c; I, 4c; I, 5c; I, 6c; I, 22b.

[17] Hipparchus is mentioned among the foreign sources (I, 2a; I, 5c; I, 18c); on the moon (II, 53; II, 57); on the comet stars (II, 95); on the duration of the day (II, 188); on the earth's circumference (II, 247).

Pliny's critical attitude here towards *vanitas graeca* seems to demonstrate, through the reference to "some expert in geometry", the validity of Eratosthenes' measurement: the value of the ray actually emerges (C / 2π) from a formula where π is equal to three. Therefore, Eratosthenes' measurement would be confirmed.

The passage on the measurement of the terrestrial meridian brings to mind just how Pliny managed to give his support to the calculation made by Eratosthenes: indeed, if the episode of Dionysodorus is proof of *vanitas graeca*, the addition of 26,000 stades by Hipparchus — which finds no confirmation in the astronomer's fragments — and the criticism of those who do not believe Eratosthenes, is proof of the uncertain destiny of Eratosthenes' measurement, and of Pliny's strong defence. In the episode written up by the latter, we note the allusion to an alternative measurement to the one put forward by Eratosthenes, and which, indeed, could have come from Posidonius: for we know the latter calculated 180,000 stades as the earth's circumference. This is a measurement that Pliny, or perhaps his source, does not seem to share; however, it allows us to catch a glimpse of the problem, which dragged on up to the time of Ptolemy, and ended not in favour of the number proposed by Eratosthenes.

It is possible to correlate this passage, albeit partly in a different content, with VI, 211–220 on the *circuli* reported to ancient Greek science (*unam Graecae inventionis scientiam vel exquisitissimae subtilitatis*), which were called *paralleli* (*nostri… appellavere*) by the Greeks. The seven *circuli* cited by Pliny were related to the 7 *klimata* of the tradition, as witnessed by Ptolemy [Shcheglov 2004: 27–31]: they indicated the latitudes of certain sites on earth, calculated according to the duration of the longest and shortest days.

Much has been written on the concept of *klima* and its origin, and I would like to refer here to the excellent article by D. A. Shcheglov [2004] on "Geographia Antiqua": he retraced the history of the concept, the origin of which is attributed by modern scholars to Eudoxus of Cnidus[18].

The scientist who would then apply the concept of the inhabited world to the map must have been Eratosthenes, according to Honigmann's reconstruction [Honigmann 1929: 13–14, 54]. This was further confirmed by Shcheglov, who underlined how Eratosthenes was not so much involved in defining the precise latitudes of places based on the duration of the longest day, but rather on measuring the maximum breadth of the inhabited world in relation to the terrestrial meridian. Therefore, the six points chosen by the scientist (Meroe, Syene, Alessandria, Rhodes, Hellespont and Borysthenes) are located on the main meridian and can be interpreted by following the strong cartographic interest of Eratosthenes. The distances between one point and another are calculated in stades, with a "hodological" perspective, based on the travels of the Greek, both by land and by sea.

As to the points that marked the extremes of the inhabited world — northward and southward — neither of these were, originally, included in the system of the 7 *klimata*: as we know from Meroe and the "Country of Cinnamon", Eratosthenes calculated 3,400 stades[19] (symmetrically, the same parallel crossed both the "Country of Cinnamon" and Taprobane). Northward, from the mouth of the Borysthenes

[18] Eudox. F 350 [Lasserre 1966 and comm.: 259–260]. Cf. also [Heidel 1937: 98–99; Aujac 1966: 168; Prontera 2003: 196].

[19] Str. I, 4, 2 C63: cf. [Aujac 1966: 185–186]. Cf. also Plin. *NH* VI, 81 (= F III B, 18 Berger; Str. XV, 1, 13–14 C690 = F III B,12 Berger) for Eratosthenes' measure of Taprobane — Sri Lanka.

to the parallel of Thule, the scientist calculated 11,500 stades. These calculations, on an astronomical-geometric basis, were criticized by Strabo[20], especially for the northern segment, which would never have been measured before Eratosthenes. In fact, Pytheas had provided astronomical information about Thule, while the correlation made by Eratosthenes on the distance from the Borysthenes to the parallel of Thule would result from the combined calculations, which integrated the travel data and the measurements taken from the geometry of the sphere. Essentially, the aim of this procedure was to design a map, and therefore, as already observed by Shcheglov, it suggests that Eratosthenes' idea of *klimata* was different from both the Hipparchus system and the zone theory of Posidonius: neither Hipparchus, nor Posidonius, drew a map of the world, but they did carry out work on systematic divisions of land spaces according to their purposes, both of which were different.

Let us now return to Pliny's passage, which is pertinent to our subject: the table described in VI, 211–219 has a composite character. Here, the 7 astrological *klimata* (14h, 14h 24m, 14h 32m, 14h 40m, 15h, 15h 12m, 15h 36m) are combined with geographic *klimata*[21], which seem to find comparisons in the testimonies of not only Cleomedes and Martianus Capella (see table in [Shcheglov 2004]), but also that of Geminus.

In particular, the *klimata* of Cleomedes (Meroe 13h, Alexandria 14h, Rhodes 14h and ½, Hellespont 15h and Rome, with little more than 15h, Massalia 15h and ½, Celts 16h, Maeotis 17h, Britain 18h) show a Rome-Hellespont alignment, which we find in Pliny too, and which reveals an attempt to correlate the Eastern and Western areas of the oikoumene. It was an attempt that already had a precedent in the analogous latitude attributed — erroneously, according to Szabó [1992] — by Hipparchus to Massalia and Byzantium (43°) [Dicks 1960: 182–183].

The comparison with the table by Martianus Capella[22] reveals the difficulty to align Rome and the Hellespont: Rome is, in fact, on the fifth *klima*, with Macedonia and the river Tagus, in the West, while the Hellespont is on the sixth *klima* with Thrace and Gallia bordering with Germany. In Rome and the Hellespont, the longest day lasts 15 hours, but the shortest day lasts 9 hours in Rome and 8 hours at the Hellespont. By observing a remarkable analogy between the *klimata* of Martianus

[20] Ibid.

[21] Cf. II, 185 for the shadows in Troglodyte in the context of a list on the latitudes of Meroe, Alexandria, Italy, and Britain up to Thule.

[22] Mart. Cap. *Nupt*. VIII, 876–877: *Nam climata VIII sunt, sed proximum solstitiali Diameroes, deinde alterum Diasyenes, tertium Diaalexandrias,quod ducitur per Cyrenas in Africam Carthagini ab austro adiacentem, quartum et medium ex omnibus Diarhodu, quod per mediam Peloponnesum Siciliamque ductum ad ostium Baetis peruenit, quintum est Diarhomes per Macedoniam et altera, parte per Gallias et Lusitaniam ad Tagum descendens, deinde sextum per Hellespontum Thraciamque et confinem Germaniae Galliam, septimum Diaborysthenus, Ponticum mare et ab altera parte Germaniam Britanniamque praecidens; ultimum est ultra Maeotis paludes et infra Riphaeos montes.*

Ergo secundum climata dies dicantur. Diameroes maximus dies habet aequinoctiales horas XIII, minimus dies XI; Diasyenes maximus dies horas habet XIII, minimus X; Diaalexandrias maximus horarum XIIII, minimus X; Diarhodu maximus horas XIIII, minimus VIIII; Diarhomes maximus XV, minimus VIIII; Diahellespontu maximus horas XV, minimus VIII; Diaborysthenus maximus horas XVI, minimus VIII; Diarhiphaeon maximus XVI, minimus VII. Deinde cum prope cardinem aceesseris, longior dies semper breuiorque nox fiet; denique colligitur sub ipso sphaerae cardine semestrem diem esse.

Capella and those of Eratosthenes, as well as Martianus, who essentially focused his attention on the West, Honigmann [1929: 51] was able to hypothesize that the table of Martianus dated back to Varro, who is also considered a privileged source of Pliny. Hence, Pliny would have built his table on a nucleus of Eratosthenes, updated by Varro, while the astrological components would have been influenced by Nigidius Figulus and through him, by Serapion too.

It was Shcheglov who then came up with a derivation taken from Eratosthenes, also for the table of Ptolemy. We can see from the *Almagest,* and again from the *Geography*[23]*,* that he drew from Eratosthenes via Marinus of Tyrus: however, Ptolemy moved away from Eratosthenes in *Geography* for the extension of the oikoumene under the equator, for the definition of the meridian of reference, which, for Eratosthenes, passed from Alexandria[24] to Rhodes and the Hellespont, as well as for the measurement of the earth's circumference, estimated by Ptolemy to be 180,000 stades, compared to 252,000 stades by Eratosthenes.

For our subject, the measurement of the earth's circumference seems to be very important. In fact, while Ptolemy is linked to Posidonius, it is known that Hipparchus welcomed Eratosthenes' measurement.

Furthermore, we note that Geminus, in his *Introduction to Astronomy*, placed only Rome in the *klima* with the longest day at 15h.

To compare what we have set forth here, it shows that Pliny's table has important features:

The Naturalist considers the length of the longest day to be slightly different in both the Hellespont (fifth parallel: 15h) and in Rome (sixth parallel: 15 and ⅛ or 15 and ⅕ according to Nigidius Figulus)[25]. Rome is placed on the same *klima* as Massalia and other places that are very distant from each other.

For this sixth parallel, which also shows some analogies with the klima of Cleomedes, Pliny cites Nigidius Figulus who, in his work *De terris,* elaborated, within an astrological framework, astronomical data going back through Serapio to Hipparchus. This data would have been reworked, in the 1st century BC, by someone who wanted to place Rome within the seven *klimata*. It may have been Posidonius[26] who carried out the results of Greek and Roman research. Indeed, Rome played an important role in the work of Posidonius[27], who might have aligned Rome and Massalia, a city that had a central role in Pytheas' text, which undisputedly was a reference point for Posidonius, as previously noted.

Secondly, it is important to note that there is no mention of Alexandria in this passage by Pliny. Instead, Alexandria is mentioned in II, 186, and derived from Eratosthenes (integrated by the mention of the *klima* in Italy 15h).

Finally, there are some clues in Pliny's words about the northern latitudes:

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[23] Meroe (13h), Siene (13h ½); country south of Alexandria (14h), Rhodes (14h ½), Hellespont (15h), the area of the Middle Pontus (15h ½), the mouth of Borysthenes (16h).

[24] Cf. [Shcheglov 2004: 30 n. 85] for the *klima* of 14h through lower Egypt, probably on the influence of Hipparchus.

[25] For Honigmann [1929: 52] the information on Rome comes from Varro.

[26] Honigmann [1929: 52] for Varro with the citation to one day of 15h and ⅛ — which differs from the 15h and ⅕ by Nigidius Figulus.

[27] FF 49, 218, 253, 258 EK; cf. also the mention of Romans in FF 53, 67, 78, 257, 259, 260, 261, 263, 264, 265, 266, 272, 273, 274 EK.

> *Hactenus antiquorum exacta celebravimus. Sequentium diligentissimi quod superest terrarum supra tribus adsignavere segmentis, a Tanis per Maeotim lacum et Sarmatas usque Borysthenen atque ita per Dacos partemque Germaniae, Gallias oceani litora amplexi, quod esset horarum XVI, alterum per Hyperboreos et Britanniam horarum XVII, postremum Scythicum a Ripaeis iugis in Thylen, in quo dies continuarentur, ut diximus, noctesque per vices*.

The three northern parallels include the Borysthenes, part of Germany and the Gallic coast (16h), Britain and the Hyperboreans (17h), Thule and the Far North with its six-month night. From the fragments of Posidonius' work, it is not possible to make any noteworthy comparisons; however, the philosopher did speak about the Borysthenes (F 263 EK) when he told the story of Mitridates Eupator (100 BC), and he did not deny the existence of the Hyperboreans (F 270 EK), who were also mentioned by Pliny and placed by Posidonius περὶ τὰς Ἄλπεις τῆς Ἰταλίας.

As for the southern parallels, Pliny cites Meroe and Syene[28]: these places are also mentioned by Posidonius in the context of defining his "zones"[29]. Therefore, given these facts, I think it is quite possible to find Posidonius, rather than Varro, in Pliny's *diligentissimi*, as Sallmann has already put forward.

This hypothesis is supported by analogies between the tables of Pliny and Cleomedes, who knew the work of Posidonius well, as we learn in his *De motu circulari*: particularly in I, 6, 31–33 (= F 210 EK). Posidonius is quoted regarding a division into zones wherein, as per Strabo's testimony (II, 5.43 C135–136 = Posid. F 208 EK), there are terms such as παράλλελος or κύκλοςt which Pliny says correspond to *circuli* in Latin.

An implicit reference to Posidonius can be found, as already mentioned, in the critical reference (II, 247) to those who did not share Eratosthenes' measurement of the terrestrial circumference.

Posidonius, who "corrected" Eratosthenes' measurement of the earth, developed an original theory on *klimata*: starting from the astronomical notion inherited from Eudoxus and Pytheas with a measurement of *klimata* on a north–south axis, Posidonius came up with a theory that formed the basis of the modern climatic one, and included territories with similar physical, ethnic and atmospheric characteristics.

Posidonius acknowledged his debt to Eratosthenes, a recognition that was pointed out by D. Marcotte [1998; 2018], who also stressed Posidonius' role — already highlighted by Lasserre [1975] — in defining the correlation between latitude, soil fertility and the physical traits of living beings.

Posidonius attached great importance to the human factor in geography, and duly distinguished five areas on the terrestrial sphere as "useful from the point of view of human phenomena". Strabo, who criticized Posidonius' theory, also suggests that for the philosopher, human behavior and even political systems could, in some way, be related to *klimata*. This slow evolution of climatology seems, in my opinion, help us understand the genesis of the astrological interpretation, the results

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[28] Cf. *diligentissimi* in II, 246 (who know nothing beyond the Tanais); V, 40 (Polybius and Eratosthenes); VI, 141; VI, 170 (Juba); VI 219; X, 19 (Manilius); XI, 63; XIII, 31; XVIII, 20; XX, 262; XXV, 5 (Mitridas); XXX, 4 (Hermippus); XXIV, 65; XXXV, 131 (Nicia painter); XXXVI, 109.

[29] F 49 EK. Syene is also mentioned in FF 115; 210 EK.

of which may be read in Pliny. The fortune of this interpretation in Rome is mostly thanks to Nigidius Figulus[30].

Therefore, it could have been Posidonius, rather than Varro, who acted as the filter through which Pliny derived geographic climate data. Such are the bases of the description of the astrological *circuli* in the abovementioned passage.

In view of the information put forward today, we should acknowledge the significant influence of Posidonius (mentioned only nine times in the work of Pliny). The hypothesis of one single source, i. e. Varro, in the *Naturalis Historia*, is now fading [Sallmann 1971: 7–20], and therefore we have to recognize, in my opinion, a multiplicity of sources. Among these — for scientific geography — is Eratosthenes, who undoubtedly played a leading role[31]. But knowledge of Eratosthenes' work was probably not direct, and in all likelihood, it was Posidonius, even with his criticism on the extent of Eratosthenes' circumference of the Earth, who was the source that transmitted the nucleus of geographic science to Pliny. Of course, Erastothenes' map was updated by Pliny with extensively documented references to various Roman enterprises, albeit in different contexts[32]. Pliny explicitly cites Varro, for example, for the shape of the Caspian Sea being similar to a sickle (VI, 38), and this correction of Eratosthenes' conception of the Caspian was seen by researchers as proof of Varro being the guiding source for Pliny. These updates, however, do not

[30] Citroni Marchetti [1982: 126] underlines, in the famous expression *deus est mortali iuvare mortalem* (*NH* II, 18), the trace of a Stoic humanitarianism that is joined with praise of Vespasian's imperial policy.

[31] Posidonius in Pliny: I, 2c, 4c, 5c, 6c, 11c; II, 85; VI, 57; VII, 112. Cf. [Sallmann 1971: 70–74].

[32] See the denominations of the different sections of the Mediterranean Sea (III, 75), the distances Cyrene–Alexandria (V, 39) and Gades–Carthage–Canopus (V, 40), the distance Rhodes–Alexandria (V, 41). The information from Eratosthenes is also updated six times in Book VI, where the scientist is mentioned: in particular, the area of the Caspian sea, where the description dates back to the historians of Alexander, and updated (VI, 36) with information obtained from Artemidorus, Agrippa and other unspecified authors.

In VI, 51 Pliny reports that Alexander the Great used to say that the water of the Caspian was sweet, and M. Varro claimed that this kind of water was taken to Pompey during his military operations in the Mithridatic War. Varro added that during an exploration under the direction of Pompey, the Roman people ascertained that it took seven days to travel from India to the river Battro, a tributary of the Oxos in the Bactrian country and that, from this river, through the Caspian Sea and up to Cyprus, the merchandise coming from India could then be transported up to the Pontus in no more than five days, over land. This communication route is described by Eratosthenes (F IIIB, 67 = Str. XI, 7, 3 C 509) in the context of a story that derives from Patrocles, who was sent by Seleucus I to explore the Caspian Sea. The mission confirmed the ancient Ionian idea of an open sea, also accepted by Eratosthenes.

The Plinian text, where Varro is also mentioned in connection with the shape of the sea being similar to a sickle (VI, 38), constitutes one of the reasons why he is considered a leading source for Pliny. It must be said, however, that precisely the circumstantial nature of the information connected to the activity of Varro (*legatus* of Pompey in 65 and supporter of Pompey in the Mithridatic War) can explain the appeal of the Naturalist to Varro for precise geographical realities: [Healey 1999: 42–47]; cf. [Sallmann 1971: 245–246] on the importance of the roles played by Pliny, the *procurator* in various Roman provinces, a councilor of Vespasian and commander of the imperial fleet at Cap Misenus; see also [Cecconi 207: 313]).

Even the observations already made on India, where Agrippa, Posidonius and also Seneca are mentioned, can help us to understand Pliny's method: for he adds onto the image of the world derived from Eratosthenes and elaborated in the Claudian and Flavian ages, and updates it by demonstrating the importance of the Roman conquest.

affect Pliny's acknowledgement of either his sources or the writers who transmitted Greek science to the Naturalist: the idea of the world of *Naturalis Historia* belongs to Eratosthenes, and hence is an important basic element in understanding Pliny's attitude towards scientific geography.

To summarize my conclusions:

1. Pliny's adherence to Erastosthenes' conception of the world is probably linked to an idea of continuity, established by the Flavians and underlined by the Naturalist, between the empire of Augustus and the dynasty set up by Vespasian [Boyle 2002: 15–16]. We can read in *Naturalis Historia* — with great verisimilitude — a strong continuity between Greek science and the organization of space by the Romans[33]: just as Agrippa's map was connected to the one drawn up by Eratosthenes, which in turn could be considered the basis of Strabo's *Geography*. Hence Pliny's idea of the world remained consistent with that model, i. e. the one evoked in III, 17.

2. Posidonius' influence on the *Naturalis Historia* appears conspicuous: for this influence does not discuss the framework of Eratosthenes' map, but mainly involves the interpretation of the atmospheric phenomena that characterize the earth, thereby allowing us to hypothesize climatic bands. The latter are understood to be an evolution on the thinking of both Eudoxus and Eratosthenes. The description by Pliny therefore seems to result from a synthesis of the astronomical-climatic conception of both Eratosthenes' and Posidonius' viewpoints, added to the astrological-climatic one (which refers to Nigidius Figulus).

3. As for the role of Varro, cited 140 times in *Naturalis Historia*, his importance appears to be linked not only to precise geographic contexts, but also to the important lexical work that he, too, carried out. It is also known that Cicero, Nigidius Figulus and Vitruvius worked together with Varro on a Latin astronomical vocabulary which, by virtue of a sort of "lexical chauvinism" [Le Boeuffle 1987: 19], avoided any direct borrowing, and preferred to use morphological or semantic calques to render original Greek concepts: for example, ἀστρολογία becomes *siderum ratio.*

The great uncertainty, which is typical of the Latin lexicon, did not favour the progress of science because "la terminologia scientifica ha per ideale la monosemia dei suoi termini" [Perrot 1968: 296]: *cardo*, *axis*, *polus, vertex* are words that sometimes have precise, but multiple meanings. The case of *circuli* (VI, 211) — in Greek, παράλλελοι — which indicate *segmenta mundi* is emblematic of a process in which the Greek word is understood to be very strange (Hyg. *Astr*. I, 4.1; Mart. Cap. VIII, 817) but is preferred to the one that oscillates between the meaning of a "circle in the celestial sphere" (Varr. LL, IX, 24; *RR*, I, 2,4; Manil. I, 566 etc.) and that of a "circular trajectory of a star", or others [Le Boeuffle 1987: 89].

We could add more about Pliny's choices and method if we analysed the art of Pliny's lexicon: Pliny underlines the continuity between Greek and Roman science, and his language shows adaptations which help us understand the role played by scientists such as Posidonius, who acted as an intermediary between the Greek and Roman cultures.

The role of the *Naturalis Historia* is also great, and we hope that research on Pliny's text will continue at the levels witnessed here at this important conference in Moscow.

[33] Cf. Isager [2006: 120] for Pliny's awareness of the supreme level achieved by science at this time and for the decision developed by the Naturalist to narrate, in his work, the stages of this evolution.

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