CHAPTER 8

The "Invention" of Geography: Eratosthenes of Cyrene

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We owe the "invention" of a profession to Eratosthenes of Cyrene, who first coined the terms geographer and geography for the scientific field that gained autonomy in Alexandria at the time of Ptolemy III and Ptolemy IV.[1] By defining himself as "geographer", Eratosthenes thus replaced the figure of the philosopher-researcher (who had previously investigated the "system of the world") with the scientist, *tout court*, whose specificity came not so much from the content, but more from the method of investigation.

1 Eratosthenes' Life

The times and places are revelatory about the personality and work of Eratosthenes, a progeny of the cultural *humus* that nurtured what might be defined as the greatest scientific revolution in antiquity. Cyrene, Athens, and Alexandria were the places where Eratosthenes first learned and later developed his activity. His life was spent within a social network that included his fellow countryman and poet Callimachus and Magas, the half-brother of Ptolemy Philadelphus, at a time when Cyrene, Alexandria and other centers under Hellenistic power were firmly linked together, and hence helped to create an international cultural *élite* that gave the impetus for scientific research to accelerate.[2]

From his native Cyrene, Eratosthenes moved to Athens to study the teaching of Zeno of Citium, who Strabo defined as "our Zeno" (1.2.34) for the close affinity that the geographer of the empire fostered towards Stoicism, which seemingly (1.2.2) was not sufficiently appreciated by Eratosthenes, who was more interested in the lessons of Ariston of Chios, Arcesilaus, Apelles,

1 Γεωγράφος appears for the first time in Strab. 1.1.16; 1.1.19; 2.5.2; 2.5.4; 2.5.34 in passages which echoed Eratosthenes. For Eratosthenes inventor of the term γεωγραφία see Aujac 2001, 65–66.

2 Bianchetti 2014.

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and Bion. It should be noted that Ariston and Arcesilaus, then students of Zeno, had broken away from Stoicism: Ariston adhering to Cynicism and Arcesilaus to a Platonic ideal. An ideal which came under heavy criticism upon the foundation of the New Academy, which was headed by Arcesilaus from 268 to 241 BC.

The adherence of Eratosthenes to the two aforesaid philosophers who, according to Strabo, were the masters who "deviated" from Stoicism—and therefore barely appreciated—constitutes the key to understanding Strabo's critical attitude toward Eratosthenes.

In fact, Strabo relentlessly underscored how superficial Eratosthenes was in carrying out his studies. The derogatory names like "Second Plato", "New Plato", "Pentathlos" or "Beta"[3] demonstrate how Eratosthenes' own contemporaries belittled him and reacted to his original, but complex personality.

Nevertheless, he did set up a proper "school of excellence" in Alexandria, where different methods were pertinent to different scientific fields. His *polymatheia* ventured into different spheres like poetry, grammar, astronomy, mathematics and geometry. But his inability to excel in any[4] of these fields, and his close connection with Platonic research might explain the difficulty his contemporaries had, as did subsequent generations, to fully evaluate Eratosthenes' innovative work. On one hand, he effectively drew on Platonic philosophy to understand the "system of the world" and, on the other, he worked toward the differentiation of knowledge, which was the basis of modern science.

This "revolution" occurred at the time of his stay in Alexandria, which perhaps began in 246 BC, when Eratosthenes was called to replace Apollonius Rhodius and manage the Royal Library, as well as to train the future crown prince, Ptolemy IV.

The dates of Eratosthenes' life are uncertain, and may be due to modern historians in their attempts to try and tally all the testimonies handed down to us. Only the ones in the Suda—the Byzantine Lexicon—seem to offer purely historic information: the lemma (*s.v.* Ἐρατοσθένης) affirms that Eratosthenes was called upon by Ptolemy III Euergetes to go to Alexandria, where he lived until the reign of Ptolemy V Epiphanes. It also states that he was "born in the

3 Suda, *s.v.* Ἐρατοσθένης; Marc. Her., *E. Per. Men.* 2 (*GGM* I 565). See Prell 1957/58, 133–143 on nicknames of Pythagoras (Gamma) and Apollonius of Perge (Epsilon); Manna 1986, 37–44; Geus 2002, 31–41.

4 Strab. 2.1.41 accusing Eratosthenes of being a mathematician in geography and a geographer in mathematics.

126ª Ol. (276–272), and died aged 80". The information in the Suda has mostly been consistent with other testimonies that also mention Eratosthenes as a contemporary of Callimachus,[5] Apollonius Rhodius, Euphorion, Timarchus,[6] Philochorus,[7] Archimedes.[8] On the contrary, the data seems to contrast with the one given by Strab. 1.2.2, who affirms that Eratosthenes was in Athens γνώριμος[9] together with Zeno, who died in 262, when Eratosthenes would have been 14 years old; in other words, at a precocious age for discipleship. With the aim of reconciling the various elements, Jacoby[10] suggested correcting the text of the Suda (ρκς' instead of ρκα') in order to set 296 as the year of his birth. But the correction may not be necessary. Since the date of Zeno's death is uncertain, it is, instead, possible to agree with the testimony of Diogenes Laertius,[11] who pinned the date to 130ª Ol. (260–256), thus leaving the conjecture that the 20-year-old Eratosthenes might have met the old philosopher in Athens in 256 BC.

Therefore, Eratosthenes' formative years in Athens—which would have made it possible for him to meet Strato of Lampsacus, "the physicist"—are followed by his full commitment to the prestigious institutions in Alexandria, such as the Royal Library and the Museum. In these two research centres, texts and precious objects were kept by systematically cataloging and transmitting data. Philology and geography were two disciplines sharing the same method and Eratosthenes, the philologist-geographer, demonstrated (via the correction of a text or a map) how the best edition could be reached: in philology, by *diorthosis* to restore the text (Homer's, first of all) close to the original one, and likewise in geography with an updated map.[12]

5 Tzetzes, *Prol.* p. 43.10 (= Xic Koster); p. 32.13 (= Xia II Koster); p. 23.1 (= Xia Koster).

6 Suda, *s.v.* Ἀπολλώνιος.

7 Suda, *s.v.* Φιλόχορος. On the dates of Philochorus' life (340–262/1) see *FGrHist* 328.

8 Procl., *Comm.in prim. Eucl.elementa*, p. 68.19–20 Friedlein, where Euclid is considered older than Eratosthenes and Archimedes (ca. 287–212 a.C.). See also Vitr. 1.1.17.

9 Strabo's expression is "une simple boutade" for Thalamas 1921, 32–34 who translates: "lui, qui a connu à Athènes ceux qui avaient été les successeurs de Zénon, n'a rien dit de Zénon même".

10 *FGrHist* 241 komm. 740. See also Fraser 1972a, 175; 1972b, II: 489 ff.; Knaack 1907, 358 ff. thought 284 BC; Blomqvist 1992, 54 thought 285.

11 Diog. Laert. 7.10. Dorandi 1991, 26 ff. for Zeno's death in 262/1. See Dicks 1981, 388. Aujac 2001, 9; Geus, 2002, 9–15 for dates between 276/5 and 195/4.

12 Jacob 1996, 901 ff.

2 Eratosthenes' Works

As a philologist, Eratosthenes' activity was primarily centred on Homer.[13] However, his interests turned to chronography in works such as *Olimpionikai* and *Chronographiai*. In the latter work, according to the testimony of Clement of Alexandria,[14] Eratosthenes would have embraced the period from the Trojan War (1184/3) up to Alexander's death (324/3), which was subdivided into ten periods with varied historical and literary information under the chronographical entries[15] (but it is not certain whether or not the dates in-between were created to synchronize with the Olympic years).

What is interesting here, however, are the writings on geography, which may also be connected with those on astronomy and mathematics, especially the *Platonicus*,[16] which contained definitions and interpretations of music and mathematics, destined to understand Plato's work. Eutocius of Ascalon,[17] in his commentary on Archimedes' *On the sphere and cylinder*, refers how Eratosthenes explained, in his work, the construction of the mesolabe (μεσόλαβον), to calculate «means» (μεσόγραφα).

The Suda Lexicon attests that Eratosthenes wrote Ἀστρονομίαν ἢ Καταστηρισμούς, probably in prose, on the ascension into the celestial sphere and on the transformation into stars of various people, mythological or not.[18]

2.1 *The Measurement of the Earth*

There is one testimony by Heron of Alexandria (*fl.* 65 AD) in the tract entitled *Dioptra*, as well as another testimony by Macrobius (*fl.* 400 AD) in the *Commentary on Cicero's Somnium Scipionis*,[19] where we find out that Eratosthenes wrote a work specifically on the measurement of the Earth (Περὶ τῆς ἀναμετρήσεως τῆς γῆς). The existence of this work has often been doubted,

13 See Bagordo 1998, FF 3–8; 21–23.

14 Clem. Alex., *Strom.* 1.21.138.1–3 (= *FGrHist* 241 F 1a); Harpocrat. *s.v.* Εὐήνος; Dion. Hal. 1.74.2 on which Niese 1888, 93 ff.; Geus 2002, 309–332. On the influence of Eratsthenes chronology on Apollodorus, see De Fidio 2002, 279.

15 Geus 2002, 317 against Knaack 1907, 382; Jacoby (*FGrHist* 241 komm.707); Bickerman 1963, 76 for Eratosthenes "the reorganizer" of all ancient chronology.

16 See Fraser 1972b, I: 419; II: 592.

17 Eutocius, *In Arch. circ. dim.* pp. 88. 17–23. See Hultsch 1910, 1214–1217; Heath 1921, 540; Fraser 1972b, I: 411–412.

18 Le Boeuffle 1965, 275–294; Bartalucci 1984, 283–300. On the genesis of the work: Martin 1956, 58–62; Pàmias, and Geus 2007, 24–34.

19 Heron, *Dioptr.* 35; Macrob., *In somn.* 1.20.9; see Galen. *Inst. log.* 12.2 ff.; Knaack 1907, 364; Thalamas 1921, 76; Geus 2002, 223–259.

but the fact that[20] Strabo ignored the complex procedure of Eratosthenes may serve to prove how independent the Alexandrine's *Geography* was compared to his other aforementioned work. Strabo even seems to allude to Eratosthenes when he says (2.5.4) that "the surveyor measures the distance from the equator to the pole, which is one quarter of the earth's circumference", a measurement that can be obtained from a partial figure. Even though Eratosthenes' procedure was quite the opposite, in that he derived partial numbers from the total, Strabo's testimony is indicative of the competence and skillfulness of a geographer-measurer, who would have had to, in any case, refer to Eratosthenes. The procedure for his measuring the earth's circumference (250,000 stades, which he perhaps rounded out to 252,000 for convenience sake),[21] is reported by Cleomedes (1.7.94–100), a contemporary of Ptolemy, and is based on a practical method applying approximate measurements aimed at getting a theoretical result. With reference to this theoretical measurement of the meridian—fixed at 252,000 stades—we can understand more about Eratostenes' stade, which modern historians have discussed so much. The stade had to measure—at least in a theoretical line—1/ 252,000: the stade was measured at 157,5 m., according to Hultsch, on the basis of a Plinian passage[22] and according to the most recent doctrine,[23] which also points out how Eratosthenes' measurement is not very far from the real one (39,690 km. compared to the average meridian of 40,000 km.). Eratosthenes' figures of the earth's circumference turned out to be remote from both Aristotele's, who thought there were 400,000 stades,[24] and from the

20 Aujac 2001, 54, n.39.

21 Seidel 1789; Bernhardy 1822; Berger 1880. See also Thalamas 1921, 163; Dragoni 1979, 211–212. Geus 2002, 234, finally holds that the two measurements are to be referred respectively to (250,000 stades) *On the Measuremente of the Earth* and (252,000) to *Geography*.

22 Plin., *HN* 12.53: *schoenus patet Eratosthenis ratione stadia XL, hoc est p.V*. See Hultsch 1882², 60–63; Müllenhof 1890, 259–296; Tannery 1893, 108; Aujac 1966, 176–179; 2001, 56–57; Fraser 1972b, II: 599, n. 312; Dutka 1993–1994, 63–64.

23 Tupikova, and Geus 2013, 21, who observed that this measurement is attested only indirectly in ancient sources. For one stade = 148,5 or 148, 8 m. = 1/10 of a Roman mile, see Lehmann-Haupt 1929, 1952–1960, who hypothesized the existence of seven different stades in use in ancient Greece; Prell 1956–1957, 549–563; Fischer 1975, 152–167. For one stade = 158,57 m. see H. von Mžik 1933, 105–112; for 168 m., Thalamas 1921, 159; for 166, 7 m., Gulbekian 1987, 362–363; for 177,4 m., Reymond 1924, 82; for 177,6 m., Niessen 1903, 241; Janvier 1993, 20–21; for 185 m., Dreyer 1914, 353; Dicks 1960, 42–46; Pothecary 1995, 49–67. Against the observation by Manna 1986, 41–42, who holds the stade of 185,5 m. in use in Egypt and therefore utilized by Eratosthenes, see Tupikova, and Geus 2013, 21 on the prevalence of Greek sources rather than Egyptian ones in *Geography*.

24 *Cael.* 2.14.298a.

one known to Archimedes,[25] which was perhaps predicated on Dichaearchus', who came up with 300,000 stades. Said results might therefore have stimulated Eratosthenes to further his research in order to provide a new solution for an old problem.[26]

However, if Archimedes' testimony could make us believe that Eratosthenes' measurement was not known during the period 230–220 BC (when the *Arenarius* was composed), the words of the Syracuse scientist would have disclosed that measuring the earth had been a widely debated problem, and that Eratosthenes had found an innovative solution related to his method, albeit with not much luck, given the predominance of a different measurement in later tradition i.e. Posidonius[27] and Ptolemy.

2.2 *Geography*[28]

It is plausible that after 225 BC, once he had finished educating the young Philopator and had gained the indispensable material support of the king of Egypt, that Eratosthenes might have dedicated himself to measuring the terrestrial globe, i.e. to start working as a geographer[29] and to begin constructing a map of the inhabited world.

It is difficult for us to evaluate how important the political factor was in Eratosthenes'work."To measure the earth" and "design a map of the *oikoumene*", were the two essential nodes of "organizing space" which were conceived and carried out in Alexandria within the contest of the Lagid court. Here, the sovereigns claimed the legacy of Alexander and gained recognition by spreading their ideology that crossed the confines of Egypt.[30] The close relationship linking Eratosthenes to the political world of the Ptolemies can be inferred, in my

25 *Aren.* 2.1.

26 Fraser 1970, 188–189. The hypothesis of Berger 1880, 107; 1903^2, 370, taken by Dreyer 1953^2, 174, is skeptically analyzed by Wehrli 1967^2, 77 and contested by Geus 2002, 226 n.89, due to the absence of references in the fragments handed down to us.

27 Posid. F 202 EK = Cleom. 1.10.50–52; see also Ptol., *Geog.* 7. 5. 12: Aujac 1969b, n. 143; 1993, 127–133.

28 References to Eratosthenes' geographical Fragments are accorded to Berger 1880.

29 For a study on the winds, deduced by the testimony of Ach. Tat., *Univ.* 33.2 = Eratosth. F III A, 41 Berger: "Eratosthenes too was interested in the winds", see Geus 2002, 253–256. For the relationship between Eratosthenes and Timosthenes, whose windrose of twelve spokes, centred on Rhodes, could be the basis of the Eratosthenic conception of the Mediterranean, see Prontera 2013, 207–217.

30 Bianchetti 2014, 35–48.

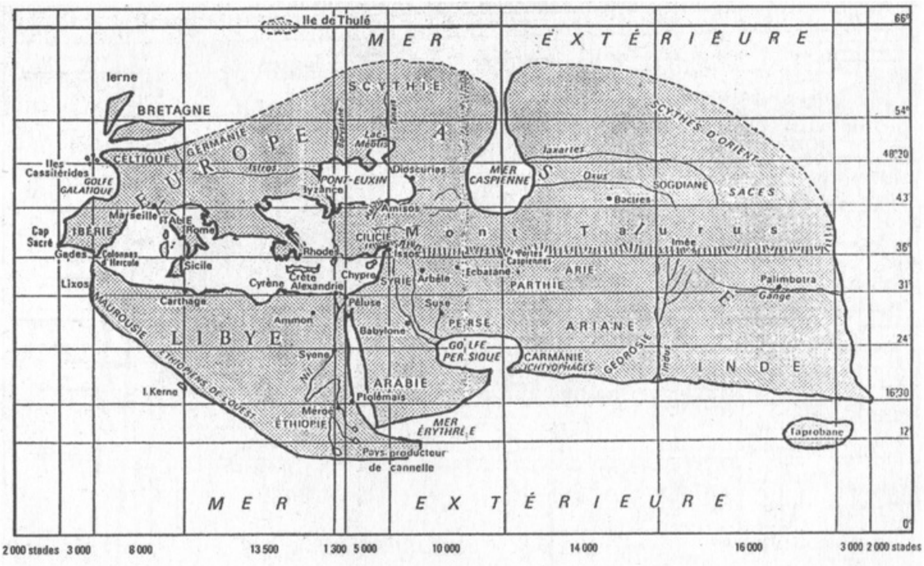

FIGURE 8.1 *The world map of Eratosthenes: a reconstruction, after Aujac 2001* (*Courtesy of* C.T.H.S.).

opinion, by his references to the sovereigns,[31] who had generously supported his task of measuring the territory in Egypt. This is also confirmed by his lexicon. For example, the inhabited world is compared in *Geography* to a *chlamys*-cloak, which was also the shape of Alexandria on the map.[32] Then, in order to divide the extent of Asia into sections, the scientist uses the term[33] σφραγίς, literally a "seal" or a cadastral parcel, which was derived from the lexicon of the Ptolemaic administration. We can also see a Ptolemaic perspective in the decision not to divide the inhabited world into continents: the ancient problem of the Libya-Asia boundary (already widely discussed by Herodotus[34] with reference to the geographical position of Egypt, which would end up being split in two parts if divided by a fixed border along the course of the Nile) presented a particularly difficult issue in the context of the Syriac wars. The silence of Eratosthenes on a geographical theme with political implications

31 Mart.Cap. 6. 598 = Eratosth. F II B, 41 Berger: *per mensores regios Ptolomaei*. On the Nilometre and land control of Egypt, see Bonneau 1964.

32 Diod. Sic. 17.52.3.; Strab. 17.1.8–10; Plin., *HN* 5.62; Plut., *Alc.* 26.8. See Préaux 1968, 176–187.

33 Thalamas 1921, 159; Geus 2004, 20 ff.; Marcotte 2005, 149–155. See also the terms μέρη, μερίδες, πλινθία which appears in Strabo: Berger 1880, 223; Geus 2007, 115.

34 Hdt. 2.15–16. See Lloyd 1989, 246–247.

could therefore have been indicative of an inevitable decision in his role as Royal Librarian. And lastly, even his adherence to one conception of the Mediterranean that, in measuring routes and giving centrality to Rhodes, mirrored the one of Timosthenes,[35] the admiral under Ptolemy II, may suggest that he was, somewhat, influenced by royal interests.

Therefore, taking into account the rich patrimony of empirical knowledge conserved in the repositories and texts at the Royal Library, as well as the results of the astronomic science, and the geometric method of Platonic derivation, Eratosthenes began to define the terrestrial sphere by first looking at the celestial sphere. He then delimited the space in the sphere occupied by the inhabited world to determine how the section of the sphere containing the *oikoumene* could be designed on a flat surface.

To study the terrestrial sphere, conceived as homocentric with the celestial sphere according to the theory of Eudoxus of Cnidus, the definition of the ecliptic was fundamental, namely the inclination of the zodiac with the equatorial plane. Oenopides of Chios (*circa* mid-5th century BC) had already found 24 degrees for this angle, considered to correspond to one side of a pentadecagon inscribed in the terrestrial circumference and hence calculated as 360:15 = 24°. Eratosthenes' procedure is different, as it is founded on the angular measurement of distance between the two tropics, calculated as 11/83 namely 47° 42' 40", according to Theon of Alexandria, a follower of Eratosthenes, or perhaps more probably 47°30'. Dividing this measurement by two, we obtain the inclination of the ecliptic expressed in degrees as **23° 50' (±30')**.

Modern scholars almost unanimously agree on the fact that this result may be Eratosthenes' more than any of his successors, such as Hipparchus and Ptolemy, who also accepted it. In fact, Ptolemy used a division of the circle in 360 parts and would have had no advantage by resorting to a fraction like the one in question.[36]

The astronomic method guiding Eratosthenes' geographic investigation was also featured in the research of Pytheas, who, in the second half of the 4th century BC, sailed from his native Massalia to Thule, thus providing us with a precise measurement of the latitude of Massalia. And from this city, he measured the latitudes of the different places he reached during his exploration, which probably went as far as the arctic zone, or thereabouts.

35 Prontera 2013, 207–217.

36 Fischer 1975, 152–167.

From this survey Eratosthenes took two important elements: (1) the latitude of Massalia (43°N), essential for drawing the Mediterranean, and (2) the definition of the arctic circle (66°N), essential for calculating the width of the world.

The astronomical definition of the arctic pole circle established at Thule[37] constitutes an important node of geographical knowledge. Up to then, this circle had been considered variable relative to the observation point. Aristotle, who appears not to know about Pytheas' investigation or, at least did not take it into account,[38] again reasoned in *Meteorologica* with a perspective that makes reference to the horizon of Rhodes and hence determines the arctic circle valid for the Greeks at 54°N, namely at the latitude of Hierne.

The decision to believe Pytheas' data, which had shown credibility under the *sphairopoiia* laws already theorized by Eudoxus, constituted a turning point of method and merit. And from this derived the development of the first "scientific" map of the world.

The passage from the celestial to the terrestrial sphere—identified by the arctic circles, the tropics and the equator—is clear in a passage of Geminus,[39] who, although not directly cited, seems to re-echo Erathostenes: "After measuring the maximum terrestrial circumference relative to the celestial meridian and having fixed the measurement in 252,000 stades with a diameter of 84,000 stades, the meridian is divided into 60 parts, with each section called a sixtieth and contains 4,200 stades, for if 252,000 stades are divided by 60, a sixtieth is 4,200 stades. The distances between the zones were thus set forth: two glacial areas, each occupying 6/60, or 5,200 stades; two temperate areas, each 5/60 wide or 21,000 stades; the torrid zone is 8/60 wide, hence from the equator to the tropics, from either of the two parts, there are 4/60 or 16,800 stades. From the terrestrial pole circle lying under the celestial pole circle up to the terrestrial arctic circle, there are 25,200 stades; from the terrestrial arctic circle, lying under the celestial arctic circle, up to the terrestrial tropic circle, situated under the celestial summer circle, there are 21,000 stades; from the summer tropic circle to the terrestrial equator, under the celestial equator, there are 16,800 stades."

From the laws on the sphere we may even deduce the possible habitability of the region south of the equator. On this subject Eratosthenes seemingly puts forward different solutions in both *Hermes* and *Geography*: in fact, in the poem about the five zones already theorized by Parmenides, the torrid zone is mentioned as uninhabited (Ach. Tat., *Univ*. 29 = F II A, 3). However, he seems to

37 Bianchetti 1998, 42–43.

38 Bianchetti 1998, 28–29.

39 *Isag*. 16. 6–9. Cf. Aujac 1975, 150.

have changed his mind in *Geography*, which Strabo commented on by saying: "For Eratosthenes, the region south of the equator is temperate" (Strab. 2.3.2 = F II A, 5). Modern scholars have tried to resolve this contrast by raising the possibility that *Hermes* preceded *Geography*.[40] In my opinion, Eratosthenes' framework seems to be the same in *Hermes* as it is in *Geography*. The reasons for the apparent contrast may be traced to the testimony of Strabo, who seems to distort Eratosthenes' thought in order to criticize Polybius and Posidonius. Both had effectively divided into two the zone crossed by the equator, and then hypothesized three zones for each hemisphere. Strabo therefore singles out Eratosthenes to reject the idea of a temperate zone existing below the equator, which Posidonius and Polybius would have taken from the Alexandrine. What it does not show however is that Eratosthenes had six zones in mind: he simply divided the earth into two hemispheres of similar features, but without the equator having the additional function of dividing the torrid zone in two.

What is very important here is the quality of the source transmitting the testimony. This is one of the basic problems for reconstructing Eratosthenes' geographic thought. His work has come down to us in a fragmentary condition, and essentially transmitted by Strabo. One example of Strabo's misunderstanding of Eratosthenes' conception comes, in all probability, from passages related to book 1 of *Geography*. Strabo accused Eratosthenes of being too critical of Homer. Instead, Strabo, who was a follower of Crates and the school of Pergamon, attributed all knowledge (including geography) to Homer. In reality, Eratosthenes' criticism was directed not so much at Homer's poems (on which the *diorthosis* of the philologist was expounded, in order to get a better text), but to that pseudo scientific vein that held Homer's poems to be a sort of encyclopedia, and useful for the needs of everybody. Although many considered Homer to be the father of all the sciences and referred to his verse to demonstrate the poet's *polymatheia*, it was Eratosthenes who compared his own scientific conception of geography with that of Homer's tales. For the Alexandrine, Homer could not have known the remote places like the Island of Aeolus or the Promontory of the Sirens, while for Strabo, Homer might have indeed conceived the *exokeanismos* of Odysseus.[41]

In Strabo's criticism we can detect, at least in part, his incapacity to comprehend the importance of Eratosthenes' research. This fact is noticeable in

40 Geus 2002, 122–128.

41 On the "defence of Homer " in Strabo see Biraschi 2002, 151–161.

regard to the theories of both Strato of Lampsacus[42] and Xanthus of Lydia[43] on the alterations of ground and sea levels. Xanthus, especially, having seen the persistent aridity under Artaxerxes and small seashells in the areas of Armenia, Matiene and Lower Phrygia deduced that the sea must have been much bigger in more ancient times (1.3.4).

Strato then hypothesized that the force of the waters had caused major changes in the terrestrial crust, for both the Black Sea and the Mediterranean had once upon a time been lakes. Their conformation then changed—the fracture of the Mediterranean was caused by the forceful breaking of rivers at the Pillars of Hercules, and the pressure of river waters flowing into the Black Sea caused the fracture of the Pontus Euxinus. These theories were shared by Eratosthenes but criticized by Strabo, who did not agree with the rationale provided by Eratosthenes on water currents, which were caused by the difference in seawater levels on either side. It was the study on the currents in the Strait of Messina, which changed direction twice over a 24 hour period, that drove Eratosthenes to link this inversion to the attraction of the moon, as Pytheas had already done in his hypothesis for oceanic tides. These themes—namely the analysis of oceanic movements and the consequences thereof—created a link between Pytheas, Dichaearchus (who studied the tides at the Strait of Messina) and Eratosthenes, and easily explains why Strabo was so critical of the three geographers.[44]

Nevertheless, Strabo's testimony is invaluable for its overall reconstruction of the Alexandrian map. Indeed, the geographer from Amaseia agreed with the framework and defended Eratosthenes vociferously from the attack launched by Hipparchus, who contested it on a geometric basis. Commenting on the drawing of areas considered to be problematic from an Augustan point of view (see, for example, the British Isles) while conserving the general structure of the map, Strabo handed down a reconstruction, albeit a somewhat unreliable one, of Eratosthenes' *Geography*. Notably, it is Eratosthenes' text which, for the first time, actually communicates with its map, thereby offering a scientific description of the entire inhabited world, complete with its contours.

It is likely that after a history of geographical thought and an analysis of the physical geography contained in book I, Eratosthenes might have set down, in book II, the mathematical and astronomical bases that would have

42 Teacher of Ptolemy II and then successor to Theophrastus as guide to the Peripatus: Wehrli 1950; Aujac 1966, 224–228; 2001, 73–79; Sharples 2011, 14–17.

43 Contemporary of Herodotus and author of *Lydiaka* (*FGrHist* 765). See Aujac 1966, 223–224; 2001, 74–76.

44 1.3.12 = Posidon. F 215 EK; see T 79 = *FGrHist* 746 F6b.

consented him to inscribe the inhabited world in one of the two upper quarters of the terrestrial sphere. The reasoning reported by Strabo[45] is clearly due to Eratosthenes (even though the scientist is not cited explicitly), especially for the reference to concrete elements (see the shape of the terrestrial hemisphere which, without the arctic ice cap, resembles an artichoke, and the shape of the inhabited world is similar to the Macedonian *chlamys*-cloak),[46] which permitted the delimiting of space to draw up the *oikoumene*.

Book III was essentially focused on the map. In other words, it was an attempt to transfer onto a flat surface the quarter of the terrestrial sphere where the inhabited world was inscribed: the system was founded on pinpointing two Cartesian axes, one drawn from the parallel identified by Dicaearchus,[47] and the other from the meridian measured by Eratosthenes himself and which crossed the reference parallel at Rhodes. On these two axes rested the Greek cloak-*oikoumene*. The contours of such were outlined, partly as a result of documentation collected and partly by deduction; this can equally be seen for the areas in the northeast and southwest, where the information (see below) was scant. A combination of data extracted from the experience of *periploi* and terrestrial journeys with a geometric division of space guided the drawing of the lines that crossed perpendicularly. In fact, the map was drawn using an orthogonal projection.

There are nine parallels resulting from Eratosthenes' description: the first, starting from the south, crossed the Country of cinnamon and Taprobane (Sri Lanka), and the others, going northwards, crossed Meroë, Syene, Alexandria, Rhodes, Massalia-Hellespont, Borysthenes, Hierne and lastly Thule, at the extreme north. According to Honigmann,[48] the concept of the parallel was already associated by Eratosthenes himself with the concept of *klima*, namely a latitudinal band that did not present significant variations of celestial phenomena. The idea of this wide band of 400 stades could even be dated back to Eudoxus, who theorized seven principal *klimata* (Meroë, Syene, Lower Egypt, Rhodes, Hellespont, the Pontus area and, lastly, the mouth of the Borysthenes). In opposition to this hypothesis, Dicks[49] held that it might have been Hipparchus who first theorized the astronomical concept of *klima*. In effect,

45 2.5.6 = Erat. F II B, 27.

46 Strab. 17.1.8; Plut., *Alex*. 26.8; Plin., *HN* 5. 62; cf. Diod. Sic. 17.52.3. For the cloak, see Tarbell 1906, 283–289.

47 Dicaearch. FF 109–111 W.

48 Honigmann 1929, 18–21.

49 Dicks 1955, 248–255; 1956, 243–247; 1960, 154–164. See also Berger 1880, 191–192; Thalamas 1921, 239 ff.

the systematic definition of *klimata*, identified by using an arithmetic division of 1°= 700 stades from the equator to the pole, was discovered by Hipparchus, but our sources also explicitly connect the *klimata* with Eratosthenes: in particular, Ps.Scymnus cites Eratosthenes[50] for both *klimata* and *schemata*. Even Strabo, who many times cites Eratosthenes and the *klimata*[51] in the ambit of Hipparchus' arguments, seems to report faithfully the affirmations of Eratosthenes, when he (Strabo) speaks of a latitudinal band of 400 stades (2.1.35), different from the one of 700 stades, of Hipparchus' matrix.

Then, the fact that this passage mentions the respective parallels of Rhodes and Athens (clearly derived from Eratosthenes) and then immediately after mentions the "evaluation of the *klimata*" is an argument in favour of Eratosthenes who possibly distinguished the two terms: (1) *parallelo*s indicating the parallel of the place, and (2) *klima* indicating the latitudinal band, i.e. the space between two parallels.

As for the measurement of the *oikoumene*, the length (μῆκος) was calculated by Eratosthenes on individual sections of the reference parallel and estimated at a bit less than 78,000 stades (exactly 77,800),[52] while the width (πλάτος) was estimated at 38,000 stades: the latter, when compared to the 252,000 stades of the meridian, constituted less than one quarter.[53]

Regarding length, Strabo aroused criticism especially relating to the figures to come up with a ratio of 2:1 between length and width. The Mediterranean tract—from the Pillars of Hercules to Pelusium—resulted in the number of segments (Pillars of Hercules-Carthage, Carthage-Canopus, Canopus-Pelusium = 23,000 stades) that overlapped the routes possibly already described by Timosthenes. Instead, the Pelusium-Euphrates segment (5,000 stades) followed an ancient trade route: the total tract from the Pillars of Hercules to the Euphrates was therefore 28,000 stades, calculated on a line parallel to the diaphragm of Dicaearchus. On the latter, the length of the terrestrial section was then calculated from Issus, along the Taurus, up to the eastern extreme of the mountain chain, and up to the eastern extreme of the *oikoumene*.

As parallels, the Euphrates-Nile tract (= 5,000 stades: Strab. 1.4.5 = F II C, 18) was equal to the Rhodes-Issus tract: the reasoning which consented the

50 Ps.Scymn.150 ff. Eratosthenes is mentioned also in v. 412 on the Peninsula Illica: Marcotte 2000, *ad loc*.

51 2.1.20 with the controversy of Hipparchus against Eratosthenes, which was contested for the *klimata*, a sign that the Alexandrine had touched on the argument. See also Strab. 2.5.34 = F II B, 16; Strab. 11.12.5 = F III A, 23.

52 Strab. 1.4.5 = F II C, 18.

53 Cf. Strab. 2.5.14.

measuring of unknown segments by means of the known ones—considered parallels—evidently consented to overcoming the difficulties linked to areas where information was lacking.

As already mentioned above, the western section of the map, i.e. the Mediterranean area, was not as long as the Asiatic area, known from the time of Alexander's great expedition. The Mediterranean remained, in any case, the most documented section, delimited by two parallels and two meridians which, crossing perpendicularly, gave a rectangular shape to "our sea". The (short) eastern side of this figure was formed by the meridian of Issus and Amisus; and the western one by the meridian of the Pillars of Hercules, a traditional frontier between "our sea" and the ocean.

The definition of the eastern side was, however, contested by Strabo, who polemically observed that the furthest point eastwards had to be Dioscurias, at Pontus Euxinus, and not Issus (2.5.25). Of the other two meridians that then crossed Eratosthenes' Mediterranean, the one passing Alexandria, Rhodes, and the mouth of the Borysthenes was the reference parallel, clearly constructed on the already cited centrality of Egypt, considered a hub for land routes and seaways.

Instead, the meridian of Carthage, on which the Strait of Messina and Rome[54] were also aligned, is clearly stretched, and the reasons for such may be hypothesized: the Pillars of Hercules-Strait of Messina tract was considered the same as the Carthage-Pillars of Hercules tract (8,000 stades) with the consequent alignment of Carthage and the Strait of Messina. The presence of Rome on this meridian may find an explanation in the fact that the route from the Pillars to the Latium coast via the Bonifacius Strait might have appeared analogous to the Pillars of Hercules-Strait of Messina tract. Moreover, we must take into consideration the role of importance assumed by Rome in the period when the conflict with Carthage had highlighted a polarity destined to become a heavy bearing axis in the history of the Mediterranean. This axis was transformed by Eratosthenes, a spectator of the first two Punic Wars, in stretching the alignment of the two centres on the meridian of the Strait of Messina[55]—a conception that was then overcome by a different idea of the Italian Peninsular, matured by Polybius, and subsequently by Strabo.[56]

As to the method, the above mentioned alignments let us understand that the historic-political importance of some centres might have influenced the

54 Strab. 2.1.40 = F III A, 40. See Fraser 1972b, I: 769 for a detailed discussion of Alexandrian knowledge of Rome in the third century BC.

55 Bianchetti 2013a, 293–314.

56 Prontera 1993, 387 ff.; 1996b, 335–341.

selection of the meridians and parallels: they do not differ, in fact, by regular distances, but underscore, on the map, points of important historic-political interest.

Opposite the Carthage, Alexandria, Pelusium parallel is the parallel of Massalia, which was set on the long side of the rectangle i.e. the Mediterranean. The criticism by Strabo,[57] who reproached Eratosthenes for not mentioning Dioscurias as the eastern extreme of the Mediterranean, allows us to see the emphasis placed by Eratosthenes on the historic component: "our sea" and the Pontus Euxinus were deemed a continuous sea for Eratosthenes, who selected Issus instead Dioscurias due to the role of Issus in Mediterranean history.

As previously mentioned, the eastern section of the map was much more extensive than the western one in length, and was divided in two by the Taurus mountain chain that separated northern and southern Asia.[58] It is clear that the function attributed to the mountain chain was an imaginary straight line running along Dicaearchus' reference parallel, and contrary to actual geography. In fact, the Taurus, according to Eratosthenes, was 3,000 stades wide[59] and its western offshoots were north of Issus and the Lycian and Panphilian coastlines. The information obtained by Alexander's historians related to the areas reached by Alexander's expedition had produced a quantity of data that enriched not only historic accounts (see Polybius and Arrian), but also geographic investigations, like those of Eratosthenes, Hypparchus, and Strabo, even with different viewpoints.

The traces of a hodological interpretation of space, which must have featured in the historic accounts of Alexander's companions, are also detected in the *Geography*,[60] whereas a geometric conception of space prevails. The tension towards an overall representation of the *oikoumene* may explain the particular division of Asiatic spaces. In addition to the two meridians of Rhodes and Issus, which delimited Anatolia, we find on Eratosthenes' map the meridian that crosses the Caspian Sea and the Persian Gulf (see below), as well as the one superimposed on the course of the Indus river and the two reaching the eastern extreme of the Taurus and the southern tip of India.

The drawing of the external contours of the *oikoumene*, but with an autoptic description missing (excluding the tract from the mouth of the Indus to the Persian Gulf, explored by Nearchus), was traced theoretically and analogically,[61]

57 Strab. 1.3.2 = F III B, 93. See Berger 1880, 339–340.
58 On the function of the diaphragm of the Taurus, see Prontera 2000, 99–107.
59 Strab. 2.1.37 = F III A, 16. See Bianchetti 2015 (forthcoming).
60 Prontera 2012a, 129–134; 2012b, 202–203.
61 Bianchetti 2012b, 155–171.

by respecting the proportions of an *oikoumene* that extended, north of the equator, up to the arctic circle.

The geometric method, transforming the trend of mountains, rivers, coastlines into lines, consented the drawing of figures called ***sphragides***[62]—"seals", cadastral Egyptian parcels or seals in wax of a ring used to stamp.[63]

The first of these sections—and a sort of model—was **India**. Its romboidal shape had the sides outlined by the southern and eastern seas, as well as the Taurus mountain chain and the Indus river. The shape, coming from both the Alexander's historians and Megasthenes (who drew largely on local sources),[64] maintained the proportions imposed by the basic structure of the map: the southern tip of India underwent, for such purpose, a forced rotation eastwards and was imagined by the same latitude as Libya's southern tip. Therefore, it is clear that the latitude of Libya, fixed north of the equator, produced the unreal analogy between East and West, indispensable in constructing a comprehensive map where large unknown areas are drawn by symmetry and analogy together with the known areas.

The second section was **Ariana**, delimited by the Indus to the east, the Taurus to the north, and the seas to the south and to the west by a line that went from the Caspian Gates to the promontories of Carmania and arrives at the eastern extreme of the Persian Gulf. The coastline of Ariana was drawn based on the account by Nearchus, who was commissioned by Alessander to sail from the mouth of the Indus to Babylonia.[65] The text, handed down by Arrian in the *Indiké*, indeed constituted an important source for Eratosthenes, who appears to have constructed upon this section of Asia the eastern part of his map.

If we hypothesize[66] that the precise knowledge of the Persian Gulf dated back to Nearchus, and hence the first definition of it as such (with the consequent possibility of hypothesizing the configuration of the Arabian Peninsula, to where Alexander sent his explorers), then we can comprehend the importance of this information, even for outlining of the meridian that Eratosthenes depicted from the Persian Gulf, via the Caspian Gates, up to the "most northern point" of the Asiatic coast.[67]

62 Thalamas 1921, 159; Geus 2004, 20 ff.; Marcotte 2005, 149–155.

63 See also the terms μέρη, μερίδες, πλινθία in Strabo: Berger 1880, 223; Geus 2007a, 115.

64 Bianchetti 2013b, 77–86. See also Zambrini 1985, 781–833.

65 On Nearchus see Zambrini 2007, 210–220. See also Bucciantini in this volume.

66 Bianchetti 2009a, 17–29.

67 Strab. 11.11.7. See Bianchetti 2012b, 155–171.

The Caspian Sea—described as an open sea by the explorer Patrocles[68] by order of Seleucus Nicator—corresponded to the Persian Gulf according to Eratosthenes. Hence, in deciding whether or not this was an open sea, in opposition to the Herodotean tradition of Persian origin,[69] the analogy attributed by the scientist to the position of the two gulfs, one to the south and one to the north of the Taurus, might have played a decisive role.

From the testimony of Patrocles on the possible sailing from India to the Caspian Sea, Eratosthenes deduced[70] the likelihood of sketching the coastline by uniting the mouth of the Caspian gulf with the eastern extreme of the Taurus line, along the 36th parallel. In the testimony, once again criticized by Strabo, who preferred the account of Apollodorus of Artemita, (11.6.4 = *FGrHist* 779 F 3c), the geographical area including the Taurus, the Caspian Gulf and the Asiatic coast was compared to the blade of a kitchen knife.

This type of comparison was necessary to draw a tract of coastline that was almost unknown and fitted in well with Eratosthenes' method which, as previously mentioned, relied on real objects (artichokes, cloaks etc.) to describe spaces that were not otherwise easily imaginable.

The importance of the meridian of the Caspian Sea, Caspian Gates and Persian Gulf also results from the function of the tract south of the Taurus in defining the western side of the **third *sphragis***, the south side of which followed the eastern coast of the Persian Gulf (measured along the royal road from Babylonia to Carmania, via Susa), while the western side overlapped the course of the Euphrates, and the northern side overlapped the Taurus chain.

Lastly, for the **fourth *sphragis*** we can reconstruct the western side, identified by a line that went from Tapsacos (at Rakka) to Pelusium, and overlapped an important communication route uniting Syria and Egypt.

For the northern half of the map, at least as far as Europe was concerned, Eratosthenes divided it into three promontories projecting southward into the Mediterranean:[71] the first promontory was the Peloponnesus; the second, Italy; and the third Liguria. These three promontories embrassed the Adriatic and Tyrrhenian Gulfs. This geografic area of Europ was also a topic on which Strabo sharply criticized Eratosthenes. Instead for Strabo the Peloponnesian promontory was made up of a number of smaller capes.

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68 On Patrocles (*FGrHist* 712) see Bunbury 1879, 573; Neumann, 1884, 165–185; Berger 1880, 94 ss; 1903^2, 72; Gisinger 1949, 2263–2273; Cary, and Warmington 1929, 151–152; Hennig 1936, 182–186; Gómez Espelosín 2000, 220; Aujac 2001, 185.

69 Daffinà 1968, 363 ff.; Bianchetti 2012b, 155 ff.

70 Strab. 2.1.17 = F II A, 10.

71 Strab. 2.1.40 = F III B, 97.

To conclude, we can see, in reference to Eratosthenes' work and his lack of success thereof, how strongly he was criticized by Hypparchus, who tried to dismantle the geometry of the Alexandrine map. However, Eratosthenes was also attacked by those who did not accept his measurement of the terrestrial circumference (Posidonius and Ptolemy) as well as by historians and geographers (*e.g.* Polybius and Strabo) who considered geography an instrument to govern the world. But in spite of the harsh criticism, the creation of Eratosthenes' map was likely kept in Agrippa's map as well as in Ptolemy's. With the last geographer of the ancient world, the scientific revolution ended and the Western world would forget the great results achieved by Eratosthenes in Alexandria.