Hipparchus on the Latitude of Southern India

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ERATOSTHENES PLACED INDIA between the latitudes he assigned to Athens and Meroe, viz. 36½° and 16°50′.[1] In reality, the southernmost point of India, Cape Comorin, is situated in 8°4′ lat. The resulting error of 8¾° in its position is one of the most disappointing of Eratosthenes' faults. Hipparchus criticized Eratosthenes' opinion on this point but, Strabo asserts, fell into the still greater error of bringing northern India to a latitude above Ireland (54°) and placing southern India farther north than 16°50′. Most scholars take Strabo's assertions at face value. The re-examination of his testimony offered in this paper shows that his account of Hipparchus' reasoning is wholly misleading, and that in fact Hipparchus argued that the northern frontier of India lies to the north of Athens, but not so far as Strabo claims, while southern India should be placed not to the north of Meroe (16°50′), as Strabo asserts, but to the south of 12⅖°. In section 2, I argue that a corroboration of this hypothesis comes from the evidence concerning Taprobane afforded by Pomponius Mela, Pliny, and Ptolemy. Comparison of their reports leads to the deduction that Hipparchus placed Taprobane near the equator, i.e. much farther south than the latitude 12½° suggested by Eratosthenes. In section 3, I argue that Eratosthenes' failure to find the true latitudes of southern India and Taprobane had been a direct consequence of his imperfect methods of mapping, while Hipparchus' success was entirely due to his improvements in this field.

[1] Eratosthenes gives all latitudes as stade distances from the equator, which I convert into degrees according to his estimate of the earth's circumference, 252,000 stades.

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1. *Strabo's misinterpretation of Hipparchus' thought*

Eratosthenes' geographical system was thoroughly criticized by Hipparchus of Nicaea in his treatise *Against the "Geography" of Eratosthenes* (ca. 135–128 B.C.).[2] As we know, Hipparchus was the first to place geography on a strictly scientific basis of astronomical observations and trigonometric computations, to use the grade grid, and to insist that the map must be based only upon exact measurements of latitude and longitude. It was from this perspective that he criticized his predecessors.

Strabo's *Geography*, bks. 1–2, is our only source of knowledge about Hipparchus' treatise. Strabo was a vigorous opponent of mathematical geography.[3] He based his picture of the world primarily on the system of Eratosthenes, especially as regards the eastern parts of Asia. Besides, it is well known that Strabo lacked the knowledge of mathematics and astronomy indispensable for understanding Hipparchus' arguments. This is why Strabo's account of Hipparchus' work often proves to be confused and erroneous, as Berger and Dicks have shown.

As I hope to show, Strabo's account of Eratosthenes' and Hipparchus' discussions of the latitude of southern India provides a clear example of how arbitrary and erroneous could be his understanding of Hipparchus' reasoning. Our analysis concentrates on three interrelated issues: (1) the latitude of the northern frontier of India, (2) the "breadth" of India (the total latitudinal dimension), (3) the latitude of its southern extremity. We consider in detail Eratosthenes' and Hipparchus' opinions on each of these three points.

[2] Two fundamental studies of Hipparchus' geography are H. Berger, *Die geographischen Fragmente des Hipparch* (Leipzig 1869) (briefly repeated in his *Geschichte der wissenschaftlichen Erdkunde der Griechen*[2] [Leipzig 1903]), and D. R. Dicks, *The Geographical Fragments of Hipparchus* (London 1960).

[3] For a general discussion of Strabo's attitude towards the earlier geographical tradition see J. Engels, "Die strabonische Kulturgeographie in der Tradition der antiken geographischen Schriften und ihre Bedeutung für die antike Kartographie," *Orbis Terrarum* 4 (1998) 63–114; K. Clarke, *Between Geography and History. Hellenistic Construction of the Roman World* (Oxford 1999) 197–210.

Strabo starts with an account of Eratosthenes' concept of Indian geography (2.1.1 [67–68] = Erat. F III A 2).[4] Eratosthenes argued that (1) the northern frontier of India is formed by the Taurus ridge which runs along the parallel of Athens and Rhodes (which he placed at roughly 36½°) throughout its length; (2) for the "breadth" (north/south) of India one should accept Patrocles' estimate, 15,000st (stades); (3) the southern extremity of India should be placed on the parallel of Meroe (roughly 16°50′). Accordingly, Eratosthenes rejected alternative estimates of the "breadth" of India given by Megasthenes and Deimachus, namely 20,000st or even 30,000st, as exaggerated,[5] and also thought it necessary to correct the "old maps" that showed the eastern part of the Taurus ridge bending towards the north-east, thus bringing up India well north of the parallel through Athens and Rhodes.[6] In order to verify all these proposals, Eratosthenes made two "geometric" constructions, which we discuss in section 3.

Strabo then turns to Hipparchus' objections to Eratosthenes. Concerning the first issue, Hipparchus only points out briefly that there are no real astronomical observations that would have determined the latitude of the Taurus ridge north of India, and therefore there is no basis for any correction of the old maps whatsoever, and in particular for those suggested by Eratosthenes (2.1.11 [71] = Hipp. F II 2/F 14).

Concerning the "breadth" of India, Hipparchus argues that Eratosthenes' exclusive preference for Patrocles' data and

[4] Strabo is cited from S. Radt (ed.), *Strabons Geographika* I (Göttingen 2002); in translations I follow D. R. Dicks and H. L. Jones (Loeb). Hipparchus' fragments are numbered according to Berger and then Dicks, Eratosthenes' according to H. Berger, *Die geographischen Fragmente des Eratosthenes* (Leipzig 1880).

[5] Strab. 2.1.4 (68); 2.1.17 (74) = Deimachus *FGrHist* 716 F 2c; 15.1.12 (690) = Megasthenes *FGrHist* 715 F 6c = Deimachus F 2a; Megasthenes supposed the north-south extent of India to be greater than the west-east, and gave it more precise figures, 22,300st (Arr. *Ind*. 3.8 = F 6b; 2850 *m.p.* Plin. *HN* 6.57) or 32,000st (Diod. 2.35.2 = F 4).

[6] On these maps: F. Prontera, "ΑΡΧΑΙΟΙ ΠΙΝΑΚΕΣ nella geographio di Polibio," *ΠΟΙΚΙΛΜΑ: Studi in onore di Michelle R. Cataudella in occasione del 60° compleanno* (La Spezia 2001) 1063–1064.

disregard for Megasthenes' and Deimachus' figures are unfounded. Here Hipparchus follows the principle of economical thinking: he points out that whereas Eratosthenes relies solely on Patrocles' data, he has left aside all other data—from Megasthenes, Deimachus, and the old maps—which are greater in number, mutually agree with each other, and contradict Patrocles' data.[7] So Hipparchus prefers Megasthenes' and Deimachus' figures which make India extend to the north much farther than the parallel of Athens and, accordingly, make the Taurus ridge bend towards the northeast, as it was shown on the old maps.[8]

In order to refute Hipparchus' criticism, Strabo tries to show that his assumptions inevitably lead to absurd conclusions. Strabo combines the figure of 30,000st, favoured by Hipparchus, with Eratosthenes' latitude of the southern extremity of India, and, as a result, comes to the absurd conclusion that Bactria and Aria—regions north of India—should be situated, according to Hipparchus (Strabo claims), at 3800st north of the parallel of Ierne (≈ 54½°), and even north of the northernmost part of Celtica (≈ 61°), as Hipparchus himself put it (2.1.17–18 [74–76]). Strabo, as well as Eratosthenes, believed that Bactria and Aria lie at about the latitude of Hellespont (≈ 41°; see section 3).

Most scholars take Strabo's account as a faithful reproduction and a constructive criticism of Hipparchus' obviously erroneous ideas.[9] In what follows I shall try to show that this is

[7] So Berger, *Hipparch* 94–96.

[8] Hipparchus' logic is correctly explained by I. V. Piankov, *Srednyaya Aziya v antichnoi geograficheskoi traditsii. Istochnikovedcheskii analiz* (Moskow 1997) 143–144 (in Russian).

[9] P. F. J. Gossellin, *Recherches sur la géographie systématique et positive des anciens* I (Paris 1798) 18, 28–29, 41, 56–59, plates I–II; C. G. Grosskurd, *Strabons Erdbeschreibung* I (Berlin 1831) 121 n.4; E. H. Bunbury, *A History of Ancient Geography*[2] II (New York 1959) 12–13; A. Forbiger, *Handbuch der alten Geographie*[2] I (Hamburg 1877) 203; P. Camena d'Almeida, *De Caspio mari apud veteres* (Cain 1893) 32–33; H. Rid, *Klimatologie in den Geographica Strabos. Ein Beitrag zur Geographie der Griechen* (Keiserslautern 1903) 22; G. Knaak, "Eratosthenes 4," *RE* 6 (1909) 374; A. Rehm, "Hipparchos 18," *RE* 8 (1913) 1679; J. O. Thomson, *History of Ancient Geography* (Cambridge 1948) 205–206; Dicks, *Hipparchus* 35, 123; C. Jacob, "Cartographie et rectifica-

not the case. I argue that Strabo has badly misunderstood Hipparchus' reasoning about the latitude of southern India, and as a result has completely distorted his picture of Indian geography.

Strabo describes at length and criticizes thoroughly all the absurdities that result from taking the "breadth" of India as 30,000st. It is remarkable, however, however, that he does nothing to support his criticism by a direct reference to Hipparchus' words, which could have attested that he really accepted Eratosthenic latitude for southern India and placed Bactria and Aria to the north of Ierne. On the contrary, Strabo's words enclosing the whole discussion of this question, at the beginning and at the end, reveal that these two assumptions that he ascribes to Hipparchus are in fact his own inventions.

(1) at the beginning (2.1.12 [71] = Hipp. F 15 Dicks):

> ὅρα γάρ, εἰ τοῦτο μὲν μὴ κινοίη τις τὸ τὰ ἄκρα τῆς Ἰνδικῆς τὰ μεσημβρινὰ ἀνταίρειν τοῖς κατὰ Μερόην, μηδὲ τὸ διάστημα τὸ ἀπὸ Μερόης ἐπὶ τὸ στόμα τὸ κατὰ τὸ Βυζάντιον, ὅτι ἐστὶ περὶ μυρίους σταδίους καὶ ὀκτακισχιλίους, ποιοίη δὲ τρισμυρίων τὸ ἀπὸ τῶν μεσημβρινῶν Ἰνδῶν μέχρι τῶν ὀρῶν, ὅσα ἂν συμβαίη ἄτοπα.
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> For consider how many absurdities would result *if one were not to eliminate* [the assertion] that the southern capes of India rise opposite to the regions about Meroe, and that the distance from Meroe to the mouth [of the strait] at Byzantium is about 18,000st, and yet *should make* [the distance] from southern India to the mountains 30,000st.

(2) at the end (2.1.20 [76–77] = Hipp. F IX 4/F 17):

> νυνὶ μὲν οὖν ὑποθέμενοι τὰ νοτιώτατα τῆς Ἰνδικῆς ἀνταίρειν τοῖς κατὰ Μερόην, ὅπερ εἰρήκασι πολλοὶ καὶ πεπιστεύκασιν, ἐπεδείξαμεν τὰ συμβαίνοντα ἄτοπα. ἐπεὶ δὲ ὁ Ἵππαρχος οὐδὲν ἀντειπὼν τῇ ὑποθέσει ταύτῃ νυνί, μετὰ ταῦτα ἐν τῷ δευτέρῳ ὑπομνήματι οὐ συγχωρεῖ, σκεπτέον καὶ τοῦτον τὸν λόγον.

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tion," *Strabone. Contributi allo sudio della personalità e dell'opera* II (Perugia 1986) 53; W. Hübner, "Hipparch," *Geographie und verwandte Wissenschaften* (Stuttgart 2000 = *Geschichte der Mathematik und der Naturwissenschaften in der Antike* 2) 99.

> Now up to this point, *having taken as a hypothesis* that the southernmost parts of India rise opposite to the regions about Meroe (which many have stated and believed), we have pointed out the absurdities that result [from it]. So since Hipparchus, *who offered no objections to this hypothesis up to this point*, later on *refuses to assent to it* in Book II, we ought to consider his arguments on this matter also.

The conditional clause εἰ τοῦτο μὲν μὴ κινοίη τις … ποιοίη δὲ in the first passage strongly suggests that Hipparchus did not accept the premises that Strabo takes as a basis for his criticism. In the second passage Strabo expressly shows that his arguments are based entirely on the fact that he has accepted (ὑποθέμενοι) the Eratosthenic latitude for southern India, despite the fact that Hipparchus actually rejected it (οὐ συγχωρεῖ).[10]

Next, Strabo turns to what Hipparchus actually said about the latitude of India. First, he quotes a passage in which Hipparchus emphasizes that it is impossible to decide whether two distant regions lie at the same latitude or not without a comparison of their *climata*, or, to render the general meaning of this term, without precise measurements of their latitudes (the text is given in section 3; on the term *clima* see below). Then Strabo remarks (2.1.20 [77] = Hipp. F IX 4/F 17 = Erat. III A 10):

> τὸ δ' ἐν τῇ Ἰνδικῇ κλίμα μηδένα ἱστορεῖν, μηδ' αὐτὸν Ἐρατοσθένη. εἰ δὲ δὴ καὶ αἱ ἄρκτοι ἐκεῖ ἀμφότεραι, ὡς οἴεται,[11] ἀποκρύπτονται,

[10] Cf. Berger, *Hipparch* 97, *Eratosthenes* 160; Dicks, *Hipparchus* 127; Piankov, *Srednyaya Asia* 144.

[11] There is a contradiction in the MSS. reading: ὡς οἴονται, ἀποκρύπτονται, πιστεύων. G. Kramer and A. Meineke suggest the conjecture οἴεται – πιστεύων; Berger, *Hipparch* 93, accepts this and supposes that Megasthenes is meant; G. Aujac (ed.), *Strabon. Géographie* I.2 (Paris 1969) 28, and Radt, *Strabons Geographika* 191, think Eratosthenes; Dicks, *Hipparchus* 68–69, translates "as Eratosthenes and Philo believe." But Eratosthenes could hardly be meant here, for in the very next sentence Strabo says that he expressly rejected Nearchus' report. Berger, *Eratosthenes* 178, 180–181, correctly notes it and accepts the reading οἴονται – πιστεύοντες; so also Grosskurd, *Erdbeschreibung* 127 n.2. I suggest that it would be much more reasonable to take Hipparchus as the subject of οἴεται – πιστεύων, for the whole section 2.1.20 from φησὶ τοίνυν onwards is clearly introduced as a rendering of his views,

πιστεύων τοῖς περὶ Νέαρχον, μὴ δυνατὸν εἶναι ἐπὶ ταὐτοῦ παραλλήλου κεῖσθαι τήν τε Μερόην καὶ τὰ [ταῦτα] ἄκρα τῆς Ἰνδικῆς.

Nobody gives any account of the *clima* in India, not even Eratosthenes himself. In fact, if it is true that both Bears set there, as [Hipparchus?] assumes on the evidence of those who follow Nearchus [*FGrHist* 133 F 16], then it is impossible that Meroe and the capes of India lie on the same parallel.

The phrase "if … both Bears set there … it is impossible that Meroe and the capes of India lie on the same parallel" clearly comes from Hipparchus who uses the same reports to characterize the latitudes of the Cinnamon Country and of Syene (in Eratosthenes' system, $12\frac{1}{2}^{\circ}$ and 24° respectively): (1) the Cinnamon Country is the southernmost latitude "where the whole of the Little Bear is contained within the arctic circle and is always visible" (2.5.35 [132–133] = Hipp. F V 3b/F 43); (2) Syene is the southernmost latitude at which "the whole of the Great Bear is visible within the arctic circle, excerpt the legs, the tip of the tail, and one of the stars in the square" (2.5.36 [133] = Hipp. F V 4/F 47). It is also remarkable that, when Marinus of Tyre uses the observations of the Little Bear to determine the latitude of south Arabia, he openly refers to Hipparchus' authority and takes Hipparchus' value, $12\frac{2}{5}^{\circ}$, for the southernmost latitude at which the Little Bear is still visible in whole (Ptol. *Geogr*. 1.7.4, I p.17 Müller).[12] Other instances of star observations were used by Hipparchus to characterize the latitudes of Alexandria, the mid-Pontus, and the mouth of the Borysthenes (2.5.38, 41–42 [133–135] = Hipp. FF V 6, 14, 15c/FF 48, 52, 53).

Berger and Dicks correctly point out that if Hipparchus had taken the reported observations of the Little Bear as a basis for

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and the sentence at issue is intended, I will argue, to prove Hipparchus' main thesis concerning the latitude of southern India. It is also remarkable that Strabo uses the parenthesis ὡς οἴεται only when he refers to Hipparchus (2.1.29 [81], 2.1.36 [88]; other occurrences: ὡς οἰονταί τινες 8.3.9 [311], 9.2.20 [407], ὡς οἶμαι 16.4.26 [781], as evidenced by the TLG CD-ROM.

[12] On Marinus of Tyre: E. Honigmann, "Marinos 2," *RE* 14 (1930) 1767–1794; A. Wurm, *Marinus of Tyre: Some Aspects of His Work* (Chotebor 1931).

determining the latitude of southern India, he would have placed it on the parallel of the Cinnamon Country or farther south. Nevertheless, they deny this possibility and view Hipparchus' remark that "nobody gives any account of the *clima* in India, not even Eratosthenes himself" as a real clue to his thought. They infer from this remark that Hipparchus had some doubt as to the reliability of the reports about the Little Bear, and therefore has chosen to make no definite decision about the latitude of southern India, restricting himself to criticism of Eratosthenes.[13]

Berger's and Dicks' interpretation of Hipparchus' approach to the question of southern India fits in with their general view of his work: they suppose that Hipparchus' main concern was not to solve particular problems, but rather to criticize his predecessors in order to develop more reliable methods for composing a map in future.

My contention is that Berger's and Dicks' reconstruction of Hipparchus' reasoning about India is wrong because it is entirely dependent upon Strabo's interpretation of Hipparchus' statement τὸ δ' ἐν τῇ Ἰνδικῇ κλίμα μηδένα ἱστορεῖν, μηδ' αὐτὸν Ἐρατοσθένη, which is seriously misleading, as I will show. In order to refute this statement, Strabo takes the reports about the visibility of the Bears as referring to the *clima* of India, and thus gives grounds to suppose that in saying so Hipparchus distrusted these reports as well (2.1.20 [77]):

> εἰ μὲν τοίνυν περὶ τῶν ἄρκτων ἀμφοτέρων ὅτι ἀποκρύπτονται συναποφαίνεται τοῖς εἰποῦσιν Ἐρατοσθένης, πῶς περὶ τοῦ ἐν τῇ

[13] Berger, *Hipparch* 14, 94–98, *Eratosthenes* 179–181; Dicks, *Hipparchus* 123, 126–127; K. Abel, "Zone," *RE* Suppl. 14 (1974) 1049, 1959. Berger argues that an indirect reflection of Hipparchus' stance is found in Strabo's words at the beginning of his description of India (15.1.12 [690]): νῦν δὲ τοσοῦτον εἰπεῖν ἱκανόν, ὅτι καὶ ταῦτα συνηγορεῖ τοῖς αἰτουμένοις συγγνώμην, ἐάν τι περὶ τῶν Ἰνδικῶν λέγοντες μὴ διισχυρίζωνται, "Suffice it to say now that [my opinion] adheres to the common opinion of those authors who ask our pardon if in what they say about India, they do not speak with assurance." However, it seems that this passage could be more reasonably taken as an allusion to Eratosthenes who was very sceptical about his predecessors' reports on India. Cf. numerous examples: 1.2.15 (24); 2.1.9, 19, 20 (70, 76–77); 15.1.7–9 (687) = Erat. F I B 23, III A 9, 10.

Ἰνδικῇ κλίματος οὐδεὶς ἀποφαίνεται, οὐδ᾽ αὐτὸς Ἐρατοσθένης; οὗτος γὰρ ὁ λόγος περὶ τοῦ κλίματός ἐστιν. εἰ δ᾽ οὐ συναποφαίνεται, ἀπηλλάχθω τῆς αἰτίας. οὐ συναποφαίνεται δέ γε, ἀλλὰ τοῦ Δημάχου φήσαντος μηδαμοῦ τῆς Ἰνδικῆς μήτ᾽ ἀποκρύπτεσθαι τὰς ἄρκτους μήτ᾽ ἀντιπίπτειν τὰς σκιάς, ἅπερ ὑπείληφεν ὁ Μεγασθένης, ἀπειρίαν αὐτοῦ καταγιγνώσκει, τὸ συμπεπλεγμένον νομίζων ψεῦδος, ἐν ᾧ ὁμολογουμένως καὶ κατ᾽ αὐτὸν τὸν Ἵππαρχον τό γε μὴ ἀντιπίπτειν τὰς σκιὰς ψεῦδος ἐμπέπλεκται.

Now if Eratosthenes agrees with those who say of both Bears that they do set, then how [could one assert] about the *clima* in India that "nobody gives any account of it, not even Eratosthenes himself"? For this statement concerns the *climata*. But if [Eratosthenes] disagrees [with this statement], then let him [anyway] be free from the accusations! And [indeed] he disagrees. On the contrary, when Deimachus says that nowhere in India either do the Bears set, or do the shadows fall in the opposite direction, as Megasthenes has assumed, [Eratosthenes] convicts him of ignorance, regarding as falsehood this double claim, in which one statement is confessedly false, namely that the shadows do not fall in the opposite direction, as it is acknowledged also by Hipparchus.

But the sequence of Hipparchus' arguments shows that he (as opposed to Strabo, Berger, and Dicks) drew a clear distinction between the information on the *clima* of India, which was lacking, and the reports about the Bears. First Hipparchus states that "it is impossible to determine that two places are on the same parallel without a comparison of *climata*", and adds an example of what he means by the term *clima*, particularly in the case of Meroe:[14] the observations of the sun's elevation and the measurements of the shadow-to-gnomon ratios at the equinox and the solstice made in this region. Then, Hipparchus concludes that "no one makes any report on the *clima* of India," which clearly implies that he is speaking of precisely the same kind of data. It is only after this phrase that he introduces and discusses the reports about the Bears, thus indicating that in his view it has nothing to do with the concept of *clima*.

[14] So Berger, *Eratosthenes* 177–178 n.5.

It is worth noting that the two principal methods of determining latitude mentioned by Hipparchus in reference to the term *clima* (measurements of the shadow-to-gnomon ratio and of the length of the longest day) had been known since Eudoxus of Cnidus.[15] Probably it was Hipparchus who first introduced the third method, based on the positions of the fixed star (e.g. what stars reach the zenith and what stars are always visible or invisible at the given latitude);[16] he called these data τὰς γιγνομένας ἐν τοῖς οὐρανίοις διαφοράς.[17] This was an additional reason for him not to include these data into the concept of *clima*.

In my view, therefore, contrary to Berger and Dicks, Strabo's statement (2.1.20 [77], quoted 366 above) that Hipparchus denied that southern India lies at the latitude of Meroe implies that he did propose an alternative and specific solution to this problem. It seems quite unlikely that Hipparchus, who took the reports about the Bears as a basis for determining the latitude of the Cinnamon Country, could have changed his opinion of the reliability of the same observations in the case of India. So his rejection of the Eratosthenic latitude for southern India may only be explained as an indication that he proposed to

[15] Fr.68 Lasserre, from Hipp. *Comm. ad Arat*. 1.2.22 (p.23 Manitius). See especially Á. Szabò and E. Maula, *Les débuts de l'astronomie, de la géographie et de la trigonométrie chez les grecs* (Paris 1986) 154–157. The standard references on the concept of *clima*: E. Honigmann, *Die sieben Klimata und die πόλεις ἐπίσημοι* (Heidelberg 1929); O. Neugebauer, *A History of Ancient Mathematical Astronomy* (Berlin/Heidelberg/New York 1975), 43–45, 333–336, 725–733.

[16] This was noted by Szabò and Maula, *Les débuts* 92. Hipparchus was the first to compile a catalogue of stars with their coordinates in degrees, and it was only such a catalogue that made it possible to use fixed star observations to determine terrestrial latitude.

[17] Strab. 2.5.34 (131–132) = F III 3/F 39. Grosskurd, *Erdbeschreibung* 179 n.1, has noted that this concept was distinguished from that of *clima* which referred to the position of the sun; Dicks has failed to recognize this distinction, taking the visibility of stars as an element of the concept of *clima*: D. R. Dicks, "The ΚΛΙΜΑΤΑ in Greek Geography," *CQ* N.S. 5 (1955) 248–255, at 255, and *Hipparchus* 160.

place it at a more southerly latitude, e.g. that of the Cinnamon Country,[18] but this idea has been misunderstood by Strabo.

By contrast, in the very next sentence after the discussion of whether or not Eratosthenes gave any account of the *clima* in India, Strabo asserts that Hipparchus placed the southern extremity of India farther north than the latitude of Meroe (2.1.20 [77]):

> ἐν ᾧ ὁμολογουμένως καὶ κατ᾽ αὐτὸν τὸν Ἵππαρχον τό γε μὴ ἀντιπίπτειν τὰς σκιὰς ψεῦδος ἐμπέπλεκται. καὶ γὰρ εἰ μὴ τῇ Μερόῃ ἀνταίρει, τῆς γε Συήνης νοτιώτερα εἶναι τὰ ἄκρα τῆς Ἰνδικῆς συγχωρῶν φαίνεται.
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> … in which [in Deimachus' words] one statement, that the shadows do not fall in the opposite direction, is confessedly false, as is acknowledged also by Hipparchus. For it seems [that when Hipparchus says so] he agrees that the southernmost capes of India lie, if not opposite to Meroe, then [at least] farther south than Syene.

But the construction of Strabo's statement, being introduced by φαίνεται, signals clearly that it represents only his own conjectures triggered by Hipparchus' refusal to accept Deimachus' statement that nowhere in India do shadows fall southward (cf. 2.1.27 [80–81] = Hipp. F X 2/F 21). Strabo's phrase betrays most clearly his complete lack of understanding of Hipparchus' arguments, which required some knowledge of astronomy.[19]

The assumption that Hipparchus moved the extremity of India farther south than $12^2/_5^o$ eliminates all the absurd conclusions that Strabo deduced from his having adopted Megasthenes' and Deimachus' estimates of the "breadth" of India. Probably Hipparchus did really suppose that northern India

[18] A similar assumption: S. Bianchetti, "Dall'astronomia alla cartografia: Ipparco di Nicea," in *ΠΟΙΚΙΛΜΑ* 151; S. Bianchetti, "Gli errori delle tradizioni classiche nel pensiero geografice tra tarda antichitâ e medioevo," *ΣΥΓΓΡΑΦΗ: Materiali e appunti per lo studio della storia e della letteratura antica* (Como 2002) 201; but without a detailed argumentation.

[19] Cf. Dicks, *Hipparchus* 128; Piankov, *Srednyaya Asia* 144.

should be placed farther to the north (in keeping with the old maps), but not so far as Strabo imputes to him.[20]

2. *Pomponius Mela, Pliny, and Ptolemy on Hipparchus' latitude of Taprobane*

Our assumption that Hipparchus brought down southern India farther to the south than the position assigned to it by Eratosthenes is supported by Pomponius Mela's reference to Hipparchus' views about Taprobane (3.7.70 = Hipp. F VIII 2/F 5):[21]

> *Taprobane aut grandis admodum insula, aut prima pars orbis alterius Hipparcho dicitur, sed quia habitatur nec quisquam circum eam isse traditur, prope verum est.*
>
> Taprobane is said to be either a very large island, or, by Hipparchus, the first part of another world, but since it is inhabited, and no one reportedly has circumnavigated it, [the latter interpretation] is as good as true.

Unfortunately, the text in the single surviving MS. *Vat.* 4929 is corrupt: the reading *ipparchus* makes no sense. Most scholars from the fifteenth century till the end of nineteenth adopted the conjecture *Hipparcho* suggested by H. Barbarus.[22] In the twentieth century R. Hansen's conjecture *id parcius* (in the sense "this more rarely") has prevailed,[23] even though it has no decisive

[20] Piankov suggests that Hipparchus did adopt the figure of 30,000st. But Strabo does not support his claim that Hipparchus accepted this figure with a direct citation of his words: Dicks, *Hipparchus* 189. It is more likely that Hipparchus did not state a preference for any one of the different figures reported by Megasthenes and Deimachus, and it is Strabo himself who has taken the greatest figure in order to emphasize the absurdity of the Hipparchan constructions.

[21] A. Silberman (ed.), *Pomponius Mela. Chorographie* (Paris 1988) 87.

[22] H. Barbarus, *Pliniae castigationes item emendatio in Melam* (Cremona 1495).

[23] R. Hansen, "*De Chorographia* des Pomponius Mela," *Jahrbücher für classische Philologie* 24 (1878) 497–498; J. Fink, *Pomponius Mela und seine Chorographia* (Rosenheim 1880) 12; K. Miller, *Mappae mundi. Die ältesten Weltkarten* VI (Stuttgart 1898) 120 n.1, 166; L. Malavialle, "Le littoral de l'Inde d'après Pomponius Mela (III, 67)," *RPhil* 24 (1900) 29; W. Kroll, "Hipparcheum," *AJP* 59 (1938) 349–350; K. G. Sallmann, *Die Geographie des alteren Plinius in*

advantages.[24] It is no wonder that most historians of geography accept the conjecture *Hipparcho*,[25] for despite the linguistic awkwardness, it is corroborated by the fact that Mela's statement embodies at least two of the most important ideas put forward by Hipparchus in geography. First, Hipparchus not only contested the prevalent belief that the *oikoumene* is an island surrounded by the single ocean (as, for instance, did Herodotus 4.45 and Polybius 3.38), but he also argued for the opposite doctrine, that the land must stretch far beyond the limits of *terra cognita*.[26] In Mela's report, Tabrobane is viewed in keeping with this doctrine. Second, it was also Hipparchus who not only assumed (as did, for instance, Polybius 34.1.16 = Strab. 2.3.2 [97]) that the *oikoumene* stretches farther south than had usually been admitted, but considered that the equatorial latitudes are actually inhabited and must be treated in a geographical study.[27] We shall see below that Mela's report intimates that Tabrobane is situated near the equator.

The phrase *orbis alter* appeals to one of the basic and the best-known theories of ancient scientific geography, that the southern hemisphere contains another *oikoumene*, symmetrical with

ihrem Verhältnis zu Varro. Versuch einer Quellenanalyse (Berlin/New York 1971) 123–124 n.90; P. Parroni (ed.), *Pomponii Melae De Chorographia libri tres* (Rome 1984) 420–421; F. E. Romer, *Pomponius Mela's Description of the World* (Ann Arbor 1998) 122; Silberman, *Mela* 298 n.3; S. Faller, *Taprobane im Wandel der Zeit: Das Sri-Lanka-Bild in griechischen und lateinischen Quellen zwischen Alexanderzug und Spätantike* (*Geographica historica* 14 [Stuttgart 2000]) 50–51.

[24] See Berger, *Erdkunde* 462 n.2; Silberman, *Mela* 298 n.3.

[25] Gossellin, *Recherches* 43–44; Bunbury, *History* II 6 n.8, 365–366; Forbiger, *Handbuch* 203; Berger, *Hipparch* 81–82, *Eratosthenes* 190, *Erdkunde* 462; Rehm, *RE* 8 (1913) 1680; F. Gisinger, "Geographie," *RE* Suppl. 4 (1924) 618, 673; F. Gisinger, "Pomponius 104," *RE* 21 (1952) 2399–2400 n.1; Thomson, *History* 208 n.2; Dicks, *Hipparchus* 116; Abel, *RE* Suppl. 14 (1974) 1060; I. G. Kidd, *Posidonius* II *The Commentary* (Cambridge 1988) 762; J. S. Romm, *The Edges of the Earth in Ancient Thought. Geography, Exploration and Fiction* (Princeton 1994) 133; Piankov, *Srednyaya Asia* 144.

[26] Strab. 1.1.9 (5–6) = Hipp. F VIII 1/F 4; cf. 1.1.8 (5). See Berger, *Hipparch* 79–82, *Erdkunde* 462; Dicks, *Hipparchus* 148, 206.

[27] Strab. 2.5.34 (131–132) = Hipp. F III 3, V 1/F 39. Berger, *Hipparch* 30–31, 41. This point needs further discussion.

ours. Therefore, if Hipparchus took Taprobane as a *first part* of this *oikoumene*, he must have placed it near the equator.[28]

Corroborating evidence is found in Pliny and Ptolemy. Pliny reports of the Indian mountain Maleus, near which the shadows fall northward for half the year and southward for the other half, the Bears are not visible (in whole), but the south pole is. The first mention of this occurs within his list of examples of latitude measurements (2.184):

> *in Indiae gente Oretum mons est Maleus nomine, iuxta quem umbrae aestate in austrum, hieme in septentrionem iaciuntur. quindecim tantum noctibus ibi apparet septentrio.*

In his description of India, this report is repeated with some other details and with a reference to Baeton, one of Alexander's bematists (6.69):[29]

> *Monaedes et Suari, quorum mons Maleus, in quo umbrae ad septentrionem cadunt hieme, aestate in austrum, per senos menses. septentriones eo tractu semel anno adparere, nec nisi quindecim diebus, Baeton auctor est; hoc idem pluribus locis Indiae fieri Megasthenes. austrinum polum Indi D[i]amasa vocant.*
>
> Monaedes and Suari, in whose land is Mt. Maleus, upon which shadows falls towards the north in winter, towards the south in summer, for six months. According to Baeton, the Bears in this region are visible once in a year, only for 15 days [*FGrHist* 119 F 4]; according to Megasthenes, the same occurs in many places of India [715 F 7b]. The Indians name the south pole Diamasa.

Pliny apparently had no clear idea of the location of Mt. Maleus: he placed the Monedes and Suares in the valley of Ganges, while the Oretes actually lived in Baluchistan. Such inconsistencies undermine the credibility of these details for the localization of Mt. Maleus. But the description of astronomical phenomena indicates that the source of information about Mt.

[28] This was noted by Piankov, *Srednyaya Asia* 144.

[29] E. Schwartz, "Bematistai," *RE* 3 (1899) 266–267; E. Schwartz, "Baiton," *RE* 2 (1896) 2779.

Maleus (Baeton?) must have placed it somewhere at the equator.

Incidentally, in the *Geography* Ptolemy mentions the mountain of Μαλαία situated on Taprobane near the equator (7.4.8), and in the *Almagest* he assigns Taprobane the southernmost latitude, 4¼°, provided by his table of parallels (2.6.2, I p.104 Heiberg). Hence it is very likely that the names *Maleus* and Μαλαία refer to the same mountain.

Taken together all these facts lead to the following conclusions: (1) Mt. Maleus was initially placed on Taprobane, (2) the latitude of Taprobane was determined by Ptolemy's predecessors from astronomical observations near this mountain, (3) it was Hipparchus who had placed Taprobane at the equator, probably on the basis of these observations.

3. *The fundamental difference between Eratosthenes' and Hipparchus' methods of mapping*

One thing remains unclear: why did Eratosthenes, possessing numerous reports of astronomical observations which could have given him the correct latitude of southern India and Taprobane, fail to use them?[30] Against the background of Hipparchus' success, this failure of Eratosthenes is still more surprising, since both geographers had the same sources of information. I suggest that the explanation of Hipparchus' success and Eratosthenes' failure can be found in the fundamental difference between their methods of mapping.

In Eratosthenes' geography, the basis of the map was formed by two coordinate axes termed στοιχεῖα, viz. the principal parallel and meridian intersecting at Rhodes. Positions of all localities must have been determined with respect to these στοιχεῖα by means of two perpendiculars to them drawn through the point in question and measured in units of

[30] At least four authors did report on the visibility of the Bears: Baeton (above), Nearchus (Strab. 2.1.20 [77] = *FGrHist* 133 F 16), Onesicritus (Plin. 2.185, 7.28), Megasthenes (2.1.20 [77] = 715 F 7a, Diod. 2.35.2 = F 4, Plin. 6.69 = F 7b).

distance.[31] These perpendiculars constituted an irregular grid of auxiliary parallels and meridians. This method of mapping is clearly described by Strabo.[32]

I will try to show that it was this method that Eratosthenes followed to construct his map of India. Let us consider the line of his reasoning in criticizing the old maps and constructing his own conception.

Eratosthenes gives two geometric "proofs" (πίστεις) of his conception.[33] First, he juxtaposes three facts (2.1.2 [68] = Erat. F III A 2): (1) the southern extremity of India (to judge "from climatic conditions and celestial phenomena," ἀπό τε τῶν ἀέρων καὶ τῶν οὐρανίων) should be placed on the latitude of Meroe, (2) the "breadth" of India amounts to 15,000st according to Patrocles (the most trustworthy authority in his opinion), (3) the distance from Meroe to Athens is also about 15,000st along the meridian. Therefore, the northern boundary of India should be placed at the latitude of Athens.

Second, he lays out other facts (2.1.3 [68]): (1) the road from Amisus to Bactra passes along the parallel of Hellespont, (2) the distance from Amisus to Issus is 3000st along the meridian, and the length of the pass leading though the Taurus ridge from India to Bactra is the same (according to Deimachus),[34] (3) the distance from Meroe to Hellespont is ≈ 18,000st, and the "breadth" of India including the Taurus ridge is the same.

[31] On this method: C. van Paassen, *The Classical Tradition of Geography* (Groningen 1957) 39–42; G. Aujac, *La Géographie dans le monde antique* (Paris 1975) 71–76; Jacob, *Strabone* 52–53; F. Prontera, "Sulla basi empiriche della cartografia greca," *Sileno* 23 (1997) 50–54; Bianchetti, *ΠΟΙΚΙΛΜΑ* 148. On the empirical basis of Eratosthenes' geography: Prontera; K. Geus, "Measuring the Earth and the *Oikoumene*: Zones, Meridians, *Sphragides* and Some Other Geographical Terms used by Eratosthenes of Cyrene," in R. Talbert and K. Brodersen (eds.), *Space in the Roman World: Its Perception and Presentation* (Münster 2004) 9–26.

[32] 2.5.16 [120] = Erat. F III A 24; cf. 2.5.34 (131). See Berger, *Eratosthenes* 198–200, *Erdkunde* 405–406, 428, 476–478.

[33] Cf. the commentary by Berger, *Eratosthenes* 175–176.

[34] Strab. 2.1.14 (72) = *FGrHist* 716 F 2b; 1.37 (88–90); 11.1.3 (490); 14.5.22 (677).

These facts prove that northern India lies on the latitude of Athens and southern India on the latitude of Meroe.

From this we see that Eratosthenes, in agreement with his general method of mapping, determines the position of southern India with respect to his two basic axes: (1) he links it to the region of Meroe, which lies on the main meridian, using a fixed parallelism between them, and (2) takes Patrocles' "breadth" as a perpendicular dropped from southern India on the main parallel.

But how did Eratosthenes find the exact latitude of southern India? Strabo's account could give the impression that he had first determined the latitude of southern India from some observations of celestial phenomena (τὰ οὐράνια) and then used it to prove that the Taurus ridge lies at the latitude of Rhodes. This impression is not substantiated by other evidence, for, I will argue, Eratosthenes did not in fact have such astronomical observations to determine the southern latitude of India and would not have accepted any report on southern India as a basis for further deductions about its latitude.

As shown in section 1, Strabo makes clear that Eratosthenes had at his disposal only such astronomical observations in southern India that he condemned as false: namely that the Little Bear is not always visible (Strab. 2.1.20 [77] = Erat. III A 10). Therefore, Strabo's assertion about τὰ οὐράνια used by Eratosthenes seems to be misleading.

I can support this conclusion by comparison with three other examples of how Eratosthenes argues that two distant regions lie at the same latitude.

In two cases, the only argument used by Eratosthenes is the similarity of climatic conditions. It is in this way that he argues that Taprobane lies at the same latitude with the Cinnamon Country (because of τὴν γὰρ κρᾶσιν τῶν ἀέρων παραπλησίαν εἶναι, Strab. 2.5.14 [119] = Erat. F III A 12), as well as Bactra with Amisus (καὶ τοῖς ἀνέμοις ἐλέγχεται καὶ ὥραις καὶ καρποῖς καὶ ταῖς ἀνατολαῖς αὐταῖς, 2.1.11 [71] = F III A 11).

As to the third example, E. Honigmann has correctly pointed out that a passage of Strabo reflects the essence of Hipparchus'

objections against Eratosthenes' method of determining latitude (2.1.35 [87] = Hipp. F V 10a/F 18 = Erat. F III A 15):[35]

> καίτοι ἐκεῖνόν γε καὶ παρὰ τετρακοσίους σταδίους αἰσθητὰ ἀποφαίνεσθαι τὰ παραλλάγματα, ὡς ἐπὶ τοῦ δι' Ἀθηνῶν παραλλήλου καὶ τοῦ διὰ Ῥόδου. ἔστι δὲ τὸ πρὸς αἴσθησιν οὐχ ἁπλοῦν, ἀλλὰ τὸ μὲν ἐν πλάτει μείζονι τὸ δ' ἐν ἐλάττονι· μείζονι μέν, ἂν αὐτῷ τῷ ὀφθαλμῷ πιστεύωμεν ἢ καρποῖς ἢ κράσεσιν ἀέρων πρὸς τὴν τῶν κλιμάτων κρίσιν, ἐλάττονι δ', ἂν δι' ὀργάνων γνωμονικῶν ἢ διοπτρικῶν.
>
> [Eratosthenes claimed] that differences [in latitude] are perceptible by sensation even within 400st, as [for example] between the parallel of Athens and that of Rhodes. However, "by sensation" is not a single [method], but there is one [method] for larger scale and another for smaller. In order to determine *climata* for larger scale, we rely upon naked-eye, or fruits, or climatic conditions. For smaller scale, we rely upon the instruments, such as gnomon or diopter.

I entirely concur with Honigmann in taking Strabo's words to imply that Eratosthenes determined the difference between the latitudes of Athens and Rhodes from αἴσθησις (the naked-eye's perception), but Hipparchus emphasizes that αἴσθησις must be used only for rough determination of the difference in latitude between distant regions (such as, say, Ethiopia and Scythia), whereas the exact estimate of latitude requires special measurements.

The same distinction is made by Strabo between the reports of travelers used by Eratosthenes and the exact measurements required by Hipparchus in the case of Amisus and Bactra. Strabo argues that Eratosthenes' assumption that Amisus and Bactra lie on the same latitude is proved by "the winds, vegetation, and risings of the sun," and adds support (2.1.11 [71] = Hipp. F II 2/F 14):

> πολλαχοῦ γὰρ ἡ ἐνάργεια καὶ τὸ ἐκ πάντων συμφωνούμενον ὀργάνου πιστότερόν ἐστιν … ὥστ' οὐδ' ἐκεῖνο εὖ λέγει τό "ἐπειδὴ οὐκ ἔχομεν λέγειν οὔθ' ἡμέρας μεγίστης πρὸς τὴν βραχυτάτην

[35] Honigmann, *Klimata* 19–20.

λόγον οὔτε γνώμονος πρὸς σκιὰν ἐπὶ τῇ παρωρείᾳ τῇ ἀπὸ Κιλικίας μέχρι Ἰνδῶν, οὐδ' εἰ ἐπὶ παραλλήλου γραμμῆς ἐστιν ἡ λόξωσις ἔχομεν εἰπεῖν, ἀλλ' ἐᾶν ἀδιόρθωτον, λοξὴν φυλάξαντες, ὡς οἱ ἀρχαῖοι πίνακες παρέχουσι."

For often the clearness and mutual agreement of all [data available] are more trustworthy than [measurements] by an instrument … So [Hipparchus] is not right when he says: "Since we cannot tell either the ratio of the longest day to the shortest or of the gnomon to its shadow along the mountainsides from Cilicia to India, nor can we say whether the mountain range slants along the parallel, we should leave it uncorrected, as the old maps show."

The two passages show the fundamental difference between Eratosthenes' and Hipparchus' methods. While Eratosthenes considered it possible to judge the latitude from climatic conditions,[36] Hipparchus rejects this method as too rough and stresses that only accurate instrumental measurements of latitude are permissible in geography.

Precisely the same thesis underlies Hipparchus' criticism of Eratosthenes' assumption that southern India lies on the latitude of Meroe (2.1.20 [77] = Hipp. F IX 4/F 17):

φησὶ τοίνυν ἀνταιρόντων ἀλλήλοις [τῶν] ἐπὶ τοῦ αὐτοῦ παραλλήλου κειμένων, ἐπειδὰν τὸ μεταξὺ ᾖ μέγα διάστημα, μὴ δύνασθαι γνωσθῆναι αὐτὸ τοῦτο ὅτι εἰσὶν ἐπὶ τοῦ αὐτοῦ παραλλήλου οἱ τόποι, ἄνευ τῆς τῶν κλιμάτων συγκρίσεως τῆς κατὰ θάτερον τὸν τόπον.

[Hipparchus] says, then, that if regions rising opposite to each other lie on the same parallel, whenever the distance between them is great, it is impossible to determine this very fact, that they are on the same parallel, without a comparison of *climata* of each of two places.

[36] On this "bio-geographical" method of Eratosthenes: Berger, *Eratosthenes* 181, 183–184, 191, *Erdkunde* 467–469; Abel, *RE* Suppl. 14 (1974) 1049, 1059–1060; especially on the case of India: K. Mannert, *Einleitung in die Geographie der Alten und Darstellung ihrer vorzüglichen Systeme* (Leipzig 1829) 92; Thomson, *History* 134, 166.

Therefore, Hipparchus' criticism implies that when Eratosthenes placed southern India and Meroe at the same latitude he relied only upon comparison of climatic conditions, but not upon celestial phenomena as Strabo asserts at 2.1.2 (68).[37]

The first of Eratosthenes' "proofs," as presented by Strabo, could leave the impression that Eratosthenes had first determined the latitude of southern India and then used it to prove that the Taurus ridge lies at the latitude of Rhodes.[38] This impression, however, is refuted by the fact that Eratosthenes, so far as we know, had no such information about southern India—this is especially emphasized by Hipparchus[39]—that would have allowed him to place it exactly at the latitude of Meroe. The comparison of climatic conditions could only give him an approximate result. The report, which Eratosthenes did accept, that the shadows in southern India can fall southward (Erat. III A 10, quoted above 364) indicates only that this region stretches somewhere to the south of the tropic.

More likely, Eratosthenes' reasoning went in the opposite direction and in agreement with his general method of mapping: he tried to determine the latitude of southern India from the latitude of the Taurus ridge, which he regarded as firmly established, and the "breadth" of India taken as a perpendicular distance between them. This assumption is confirmed by a number of facts.

First, the idea of the Taurus ridge, stretching along the latitude of Rhodes throughout its length and forming the northern frontier of India, was first formulated by Dicaearchus,[40] and then accepted by Eratosthenes as one of the foundations of his geographical system (F III A 1–7).[41] On the

[37] Cf. similar considerations of Berger, *Eratosthenes* 180–181, Thomson, *History* 134, 166. Dicks' assertion (*Hipparchus* 126–127) that Eratosthenes, unlike Hipparchus, did use the observations of the Bears to place southern India on the parallel of Meroe is odd and quite unfounded.

[38] As was suggested by Mannert, *Einleitung* 81–82.

[39] Strab. 2.1.20 (77) = Hipp. F IX 4/F 17.

[40] F 110 Wehrli = Agathem. *Hypotyp.* 1.5. Cf. A. Diller, "Agathemerus, *Sketch of Geography*," *GRBS* 16 (1975) 59–76.

[41] See Berger, *Erdkunde* 378–379, 417–418.

other hand, we have no reason to assume that the latitude of southern India had been determined by anyone before Eratosthenes.[42]

The sequence of Eratosthenes' thought, as presented by Strabo, also conforms to this assumption. First he points out that the Taurus ridge passes along the parallel of Athens throughout its length (2.1.1 [67–68]), and only after that (ταῦτα δ' εἰπὼν οἴεται, 2.1.2 [68]) he turns to the corrections of the old maps. Therefore, the two geometric constructions that he develops should be considered not as a *proof* that the Taurus lies on the parallel of Athens but rather as an additional *verification* of this thesis.

The assumption that Eratosthenes determined the latitude of southern India from that of its northern frontier and the stade distance reported by Patrocles can explain why he failed to use the astronomical observation in southern India. Only this line of thought, which is consistent with Eratosthenes' general method of mapping, could have afforded him a basis that he would have considered reliable enough to condemn the reports about the visibility of the Little Bear as contradicted by the conclusions about the latitude of southern India that he reached by applying this method.

In Hipparchus' geography, the basis of the map was formed by a number of coordinates of latitude and longitude determined from astronomical observations and expressed in degrees independently of one another.[43] As we noted above, Hipparchus was the first to use observations of the stars to determine latitude. It is no wonder that, following this method,

[42] Berger, *Eratosthenes* 176–177, takes Strabo's words τὸ τὰ ἄκρα τῆς Ἰνδικῆς τὰ μεσημβρινὰ ἀνταίρειν τοῖς κατὰ Μερόην (2.1.2 [68] = Erat. F III A 2; cf. ὅπερ εἰρήκασι πολλοὶ καὶ πεπιστεύκασιν, 2.1.20 [76] = Hipp. F 17 Dicks) as a proof that southern India was placed at the latitude of Meroe already before Eratosthenes. This interpretation, however, lacks support. More likely, Strabo could have meant those geographers who adhered to Eratosthenes' opinion, such as Artemidorus and Posidonius (cf. Agathem. *Hypotyp.* 1.2 [pp.60–61 Diller, Posidonius *FGrHist* 87 F 98a]).

[43] This method is described by Ptolemy in *Geog.* 1.4.3; see H. von Mžik, *Des Klaudios Ptolemaios Einführung in die darstellende Erdkunde* I (*Klotho* 5 [Vienna 1938]) 21–22 n.1.

he took the star observations in southern India and on Taprobane as the most reliable basis for his map of India.[44]

The controversy between Eratosthenes and Hipparchus on the question of the latitude of India affords a clear example of how an improvement in the methods of scientific geography made it possible to correct earlier mistakes and to obtain a truer picture of the world.[45]

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[44] A similar difference is found between Eratosthenes' and Marinus' approaches to the determination of the latitude of southern Arabia: Marinus relied upon star observations in Arabia (Ptol. *Geogr*. 1.7.4), whereas Eratosthenes used measurements of the length of the Red Sea, as explained by Berger, *Eratosthenes* 294–297.

[45] I am very grateful to the Editorial Board of *GRBS* for their revision of my English. All remaining errors and omissions are of course my own.