‡3 The Ptolemy GEOGRAPHY's Secrets

[Which *GEOGRAPHY* Secrets Were Secret from Ptolemy?]

Distillate from 3 Decades of DR Researches into Ptolemy's *Geographical Directory*, 1979-2007[1]

Zero Longitude Revealed: Cape Verde Isles
Old Egyptian Accuracy vs Greek
Marinos' Date and Authorship
Astrologers' *Handiest Tables*

In Memory of a Brilliant Friend
AUBREY DILLER 1903-1985

A Why a Network of Exactly 360 Sites' Geographical Hours?

A1 The famous Ptolemy *Geographical Directory* (henceforth "*GD*"), popularly called "The Geography" or "Geographia", is in eight Books. It was commissioned in the 2nd century AD for the use of Serapic astrologers (§D5). We will here adopt the fine English edition of its text by Berggren & Jones 2000 (henceforth "B&J"). But don't miss the lovely new complete Stückelberger & Graßhoff 2006 edition (henceforth "S&G"). If you know German. And even if you don't. The *GD* begins with explanatory Book 1, which tells of Ptolemy's incorporation of thousands of sites' geographical places from the work of an earlier geographer, Marinos of Tyre. Then, Books 2-7 list about 8000 sites' positions, expressed consistently in **degrees** to 1/12th degree precision: longitudes in degrees east of the **Blest Isles** (Cape Verde Islands: §F4), and latitudes in degrees north or south of the Equator.[2] The *GD* then concludes with what DR contends (§A4) resembles and-or partly constitutes the data-base grid-network computationally (eq.1) underlying the precision-corrupted (§§D1, D5, & K10) positions of *GD* Books 2-7, namely: Book 8, whose data are expressed entirely in **hours** (not degrees), a list of 360 sites' longitudes in hours west or east of **Alexandria** (not the Blest Isles); and, instead of latitude, longest-days M (for Summer Solstice) in hours, where parallels at $1^{\mathrm{h}}/4$ or $1^{\mathrm{h}}/2$ intervals of M were called "klimata". E.g., longest-day $M = 14^{\mathrm{h}}1/2$ was called the Rhodos klima where $L = 36°$ (via eq.1).

[1] These investigations were posted on the *DIO* website in 2006-2007, at www.dioi.org/gad.htm. Unless otherwise indicated, *GD* section-numbering here follows that of Karl Nobbe 1843-5 (henceforth cited as merely "Nobbe"), numbering which is also followed as closely as possible by the excellent new edition, Stückelberger & Graßhoff 2006 (henceforth "S&G").
Note that the present paper forgoes the use of accents for Greek words. Diller himself pointed out accents' superfluity, since classical-era Greek lacked them. During a DR 1987/6/1 visit to the Vienna Papyrus collection, the same view was expressed by the collection's chief, as well as by the able Dutch scholar Peter Sijpesteijn, who happened to be visiting the same day.

[2] *DIO*'s people are amazed at a long tradition of suggestions that the *GD* may well be the earliest geographical work ever to use spherical coordinates. This is less scholarship than a relic of Neugebauer-salesmanship for Ptolemy. (Origin: Neugebauer 1975 pp.337, 846, & 934; and see p.280 for parallel celestial semi-claims for the *Almajest*, despite the 2nd century BC Hipparchos *Comm*'s listing of dozens of stellar Right Ascensions & Declinations.) Long before Ptolemy, Strabo reported a Nile map consistent (Rawlins 1982N) with use of spherical geographical coordinates, and which goes back at least to Eratosthenes (3rd century BC) — a map so antique that it does not even use degrees.

A2 Aubrey Diller was (1983/3/6 letter to DR) the 1st scholar to point out the 360-site total and to suggest its deliberateness.[3]

A3 The longest-day M (in hours) at a site is a sph trig function of latitude L (in degrees) and the Earth's obliquity ϵ (also in degrees), by an equation known at least since *the 2nd century BC* (Hipparchos [*DIO 5* & *DIO 16* ‡3]) — a remarkable historical revelation, primarily owed to the mathematical investigation of Aubrey Diller 1934. [Readers not into sph trig may now skip from here to §B.]

The equation for computing each klima (§A1) attested for the 2nd century AD at *Almajest* 2.3:

$$\cos(15M/2) = -\tan\ L \tan\epsilon \tag{1}$$

(where obliquity ϵ was usually taken to be 23°5/6 or [the discovery of Diller 1934] 23°2/3).

A4 Why different data-format for *GD* 2-7 vs *GD* 8? Two potential answers:

[1] Books 2-7, like the Important Cities part of Ptolemy's *HanTabl*, are in the form of Marinos' manual or map, presumably after his (though see §C1) systematic tectonic mass-alterations (*GD* 1.4 & B&J p.46) to force macro-geographical accord (through eq.1) with the above-hypothesized (§A1) network-grid-basis, which had been severely pre-corrupted by roundings (§§D1&D5) in tables long used by astrologers. Remarks at, e.g., *GD* 1.18 suggest that, like (following?) astrologer Hipparchos, Marinos clumped (§D4) cities under parallels. Also, Marinos gave primacy (*GD* 1.20.3 & 24.3; and below at §M6) to Hipparchos' 36° parallel (arc θ-κ-λ in Fig.1 [p.50]) through the east-Mediterranean island of Rhodos, suggesting both an astrological-tradition connexion and even the possibility that Marinos' table of rounded-longest-day parallels (for at least the Mediterranean-region) was a hand-me-down from Hipparchos, whose main observatory was located on Rhodos (D149), probably just north of the town of Lindos. (See Rawlins 1994L §F [pp.42-45].)

[2] The data of Book 8 are not for a map — but are in precisely (§D2) the hour-based form for astrologers' convenient use in computing a horoscope for a site other than Alexandria (D149), which was obviously the standard meridian for astronomical & astrological ephemerides in the Hellenistic world.[4] So *GD* 8 could have been called the *Handiest Tables* — perfectly set up for astrologers' convenience. [Some versions of the *Handy Tables* operate likewise: Neugebauer 1975 p.938 n.9.] Listing cities by longest-day superficially appears odd & cumbersome, and it gave no special aid when *using* data for maps. (To the contrary: §D3 [b].) However, astrological tables of the outdoor-invisible "Ascendant" (*Almajest* 2.8) — the corner-stone of astrological "house"-division for horoscopes — were simply easier to *computationally construct in the 1st place* (math provided at *ibid* 2.7), for longest-day values than for latitude values, back in the ultra-longhand-calculation days of early use of sph trig. The computational utility of longest-day is easy to show: for A = Ascendant, and ST = Sidereal Time, one can calculate:[5]

$$\cot A = (\cos[15M/2] - \sin ST)\cos\epsilon/\cos ST \tag{2}$$

— simpler than using latitude L with a formula combining the foregoing 2 equations:

$$\cot A = -(\tan L \sin\epsilon + \sin ST\cos\epsilon)/\cos ST \tag{3}$$

Thus, most available ancient astrological tables of houses (e.g., *Almajest* 2.8) were arranged (§D2 [1]) by klimata (§§A1&D4).

A5 Astrologers' other key invisible celestial point was the "Midheaven". But the Midheaven MH is latitude-independent. So, for any latitude, one need only consult (in *Alm* 2.8's tables) the "Sphaera Recta" columns (Toomer 1984 p.100), which tabulate the relation $\tan MH = \tan ST/\cos\epsilon$.

[Note added 2018. See *DIO 22* ‡3 §§K&S for origin of & problems caused by klimata.]

B The Greek *GD*'s Best Latitudes: Non-Greek Egypt & Phoenicia

B1 Fortunately, some cities' accurate latitudes appear to have survived; two particular groups are consistent (if we include 2′ stellar refraction & 1°/12 rounding) with that optimistic conjecture. In Lower Egypt (Rawlins 1985G p.260; *GD* 4.5.53-55): Memphis (D151), Cairo [fortress "Babylon"], and On [Heliopolis]. Note (in the context of astronomy-based latitudes): these 3 sites cluster around the ***most accurate astronomical-surveying-oriented*** ancient building, the GreatPyramid,[6] whose rounded latitude is correct at *GD* 4.5.54 (Cairo [Babylon], thus adjacent Giza): exactly 30°00′. In Phoenicia (modern Lebanon):

[3] See Aubrey Diller 1984's scrupulously-wrought establishment of the text of the entire contents of Book 8 at www.dioi.org/gad.htm. The total of his site-lists is 359. Nobbe's total is 358. But Nobbe omits Tarentum and Sousaleos, while Diller semi-omits Limyra. (Though, see end of this fn.) Merging the lists, we have exactly 360 sites in 26 sections, corresponding to *GD* 2-7's 26 maps. Sections: 10 of Europe (118 *GD* 8 sites), 4 of Africa (52 *GD* 8 sites), 12 of Asia (190 *GD* 8 sites).

I propose scholars' agreement upon a conventional numbering of all 360, based upon the sequence of Diller's XZ Codices, dovetailing with the UNK Codices (to cover sites either skipped), which follows Diller's desire to give primacy to the former. We use prefix D, to number every *GD* 8 site, so that "D x" refers to the x^{th} site. Adding to Nobbe's edition of *GD* 8: Tarentum (*GD* 3.1.12, 8.8.4) as site D53, Sousaleos (*GD* 3.3.4, 8.9.3) as site D63. (Note that we are dovetailing these two sites into Nobbe in passages that [exceptionally] already list more than one site — which may help explain these two oversights.) To Diller's version, we add Limyra (*GD* 5.3.6, 8.17.25) as site D193, Diller XZ Codices Asia-Map 1 site #22→#22a: "Myra", whose coordinates are identical to Nobbe's "Limyra" at *GD* 8.17.25. D192 is UNK's item#22, whose coordinates are identical to Nobbe's *GD* 8.17.23, "Myra" (*GD* 5.3.6). Note that one finds "22a" in Diller's hand in the left margin of his p.X13, showing that he suspected the need to add this site as the final touch to perfecting his epochal document. I.e., even at age eighty-plus, his sharp eye was still missing nothing!

[4] The very choice of longest-day (instead of latitude) as *GD* 8's measure of northerliness tips us off to the astrological connexion. (Hardly a stretch: recall that Ptolemy compiled the superstitious horoscope-delineation book that is still astrologers' bible: the *Tetrabiblos*. Note that the geographical table in his astrologer-oriented *Handy Tables* was at this stage still inconveniently in degrees.)

[5] It will help to provide an example, using the *Almajest* 2.8 table for Rhodos (D189) at Sidereal Time (the Right Ascension of the meridian, or Hour Angle of the Vernal Equinox) $21^{\text{h}}23^{\text{m}}36^{\text{s}}$ = 320°54′ (which is chosen to avoid interpolation in step 1, as will be evident):

Adding 6^{h} or 90° gives 50°54′ (the rising point on the Equator). Then, find 50°54′ in the *Almajest* 2.8's "Accumulated Time-Degrees" column for Rhodos (longest-day $M = 14^{\text{h}}1/2$, the basis of this column's ancient computation and arrangement): *Almajest* 2.8 (Toomer 1984 p.101). The value on the same row in the column "10° Intervals" is zodiacally 10° of Gemini or 10°GEM 00′ = ecliptically 70°, so that is the Ascendant. The Descendant (ecliptical point that is setting) is opposite: 250° or 10°SGR 00′ (10° of Sagittarius). The Midheaven (polar longitude of transitting zodiac point) is then found by linear interpolation on Toomer 1984 p.100: in the "Accumulated Time-Degrees" column, under the "Sphaera Recta" heading, we find 312°32′; 320°54′ (*ST*) exceeds this by 8°22′ of the 9°58′ interval corresponding to the 10° interval between 10°AQR 00′ and 20°AQR 00′ (in the column "10° Intervals"), so: add 10°(8°22′/9°58′) = 8°24′ to 10°AQR 00′, which yields Midheaven = 18°AQR 24′ (18°.4 of Aquarius) on the zodiac or ecliptical longitude 318°24′. The Nadir is opposite: 138°24′ or 18°LEO 24′. (This establishes the 4 cardinal points of the astrological houses for the chosen place & time. Division of each quarter into 3 parts then establishes the 12 astrological houses, but said division differed between house systems. Tables of houses, presumably though not demonstrably sph trig-based, go back at least as far as Theodosios of Bithynia's "Houses", 2nd century BC.) Finding Ascendant & Descendant (and thus house-divisions) is the sole use most modern astrologers have for geographical latitude. (Ancients also used latitude to enter parallax tables, but such scrupulousness is rare among today's astrologers.) Geographical longitude was used merely for additively converting (§D2 [3]) local time to ephemerides' standard zero-meridian, presumably that of Alexandria.

[6] All three latitudes are correct — perhaps a notable *Egyptian* achievment, since the *GD* lists Heliopolis (the Greek name for On) at the wrong latitude (exhibiting a peculiarly Greek error: $-1°/4$ from asymmetric gnomon), not realizing (similarly at §K5) that it is the same place as the holy city called "On" by the Egyptians and Genesis 41.45. Suggestively, the correct latitude is associated with the ancient Egyptian name, not the later Greek one. Details at Rawlins 1985G p.260.

Acre (Ptolemais), Tyre (§C2) & Sidon have errors of only a few miles, not quite as right-On as the Egyptian trio, but nonetheless impressive for antiquity — and highly unusual for the *GD*, suggesting that Marinos in Phoenicia (like Hipparchos at Rhodos) got particularly accurate latitudes from his own observations or from those of local astronomers or navigators, even while (fn 10) absorbing and relaying ordmag 1° errors for regions outside his or his associates' direct experience. Of these 6 sites, only Memphis (D151) is listed[7] in *GD* 8.

B2 The implication: those major cities not listed in *GD* 8 and civilized enough to desire and afford astronomers (note §D6) show a better chance of having accurate *GD* 2-7 latitudes (§§J2&K11) than those which don't.

C The Unresolved Mystery of Marinos the Phoenician

C1 Why hasn't it been previously noted that *GD* Book 1's extensive critical discussion of Mediterranean-region scholar Marinos' data fails to provide unambiguously a single Marinos latitude in degrees for any Mediterranean city? — or, indeed, any city within the Roman Empire.[8] So, though Marinos' latitude for the extra-Empire city Okelis (§H2) (D281) hints at inferior accuracy, we cannot tell for sure whether his Important City latitudes were as corrupt as the *GD*'s. I.e., the *GD*'s silence (fn 8) on Marinos' latitudes within the Empire leaves open the possibility that his latitudes for Mediterranean or Roman Empire sites were accurate (if so, *GD* data-degradation occurred after his time) — and were thus suppressed for disagreeing with those of Hipparchos. (Similarly at fnn 8&19). But would encyclopedist Ptolemy expend the huge effort required for shifting 8000 data to dovetail with an underlying grid-network's few hundred important cities? (Ptolemy does report [*GD* 1.18] that much of Marinos' data for minor cities were incomplete and-or scattered, so serious labor [on someone's part] was required for subsequent estimation of positions' precise longitude & latitude, whether or no accurate or [§I7] even real.) Yet, if (fn 19) Marinos were an astrologer, why would he give longitudes in degrees — and worse, in degrees from the Blest Isles, not Alexandria? (Yet, Ptolemy's astrologer-fave *Handy Tables* did likewise.)[9] With arguments available in both directions, it is hard to be sure how much responsibility (for the corruption of *GD* 2-7's latitudes) is borne by Marinos. In favor of Marinos being a geographer, not an astrologer, is his measure of longitude in degrees from the Blest Isles. Which in turn implies that key sites' latitude-corruption from rounded longest-day klimata was not Marinos' doing.

C2 After all, how is it that an (apparently) eminent geographer from Phoenicia (a legendary naval center, where latitudes & stellar declinations would have been vital for navigating commercial vessels if nothing else) was ultimately — via his own or others' sph trig — depending, for his latitudes, upon crudely-rounded (§D6) astrological tables? (Of longest-day data: see below at §D1.) *If* he was. Note (§B1) that the Marinos-of-Tyre-based *GD* 5.15.5&27 latitude of Tyre is just about exactly correct (to its 1°/12 precision) if founded upon observations of circumpolar stars (affected by c.2′ of atmospheric refraction), a wise

[7] Memphis' XZ (ms-tradition) longest-day (14^h) appears independent; but the ultra-precise UNK value ($13^h19/20$) looks like it may have been adjusted-to (computed-from: eq.1) an accurate latitude — suggesting (fn 12) post-Ptolemy tampering. See the learned observations of B&J (p.44) upon the two ms-traditions' relative trustworthiness and purity.

[8] A deliberate omission? I have doubts on that point; however, such silence would be similar to the slyness (see also fn 45) evident in his *Almajest* 3.1 suppression-silence regarding the times of the solstice-observations of Aristarchos (truncated: Rawlins 1985H) & Hipparchos (good to 1^h!), omissions 1st stressed by the late W.Hartner (letter to DR). See Rawlins 1991H §§A5&B3-5 [pp.50-52]. Note the key correlation: these two solstices are the only members of Ptolemy's extensive set of times of solstices & equinoxes that do not agree with his (Hipparchan) tables, and they are the only ones for which he hides the hour. (Each disagreed with the tables by 1/4 day.)

[9] The actual purpose of using the Blest Isles as longitude zero was probably to eliminate east-west positional sign-ambiguities — just as NPD (§H2) does for north-south.

and effectively parallax-free latitude-determination method which may (§B1) go back to the time of the Great Pyramid.[10] Was the purpose of Marinos' geography naval? Or natal?[11]

D Astrologers' Handiest Tables, InterRelations, Accuracy Degraded

D1 *GD* 8.2.1 states that the data of Book 8 were computed (via eq.1) from latitudes & longitudes. However, a detailed mathematical case has been made by Rawlins 1985G pp.260f that — though the remote-past origin of longest-day M data were obviously computed from latitudes — the highly (§§D5, K10, & L5) corrupted latitudes of major cities listed in *GD* Books 2-7 must have been computed (via eq.1) from **conventionally over-rounded longest-day *M*-data** (§A4) of just the sort[12] we see in Book 8. Flagrant examples appear below, e.g., Babylon (fn 16) & SE Asia (§K7). The suggestion here is that distortions in *GD* latitudes go back at least to Hipparchos, while the distortions in longitude probably occurred later than Hipparchos, since they involve a shift (fn 25; ‡1 §J4) from the Hipparchos 252000-stade Earth-circumference (fn 47) to the 180000-stade Earth-circumference which fellow-Rhodian Poseidonios seems to have switched to (Strabo 2.2.2) during the 1st century BC. (Though Taisbak 1974 eruditely wonders if this switch wasn't much later.) The *Almajest* was still using the larger Earth-size during the mid-2nd century AD, and the earliest rock-certain attestation of the smaller value's use is by Marinos, around the same time.[13] (Columbus' belief, that the shortest trip to China's Kattigara [D356] was westward not eastward, was much influenced by Marinos' over-tiny Earth.) Conversely,

[10] See Rawlins 1985G pp.255-256, as well as Rawlins & Pickering 2001; see also *DIO 13.1* [2003] (www.dioi.org/vols/wd1.pdf) [pp.2-11]. Similarly, Hipparchos knew his own latitude, but seems (§B1) to have been weak elsewhere, e.g., placing Athens a degree south of its actual latitude (Hipparchos *Comm* 1.11.3&8) and Babylon 2° 1/2 north (§L6) of its — both values copied (fn 10) by the *GD*.

[11] If latitudes based upon longest-day data were Marinos', this would raise the suspicion that he was an astrologer. (Possible, but — as already noted [§C1] — his reckoning longitude in degrees *and* from Blest Isles is contra this idea.) Were famous ancient astrologers analogous to modern popular-science writers and publications (www.dioi.sno.htm), where ubiquity, lucre, and hype obscure innumeracy, thereby nourishing blind-leading-blind multi-generational replication (e.g., www.dioi.sti56.html#rlbk) of unreliable scholarship?

[12] This is not to deny that some *GD* calculations went in the other direction (§D1) — nor even to reject the distinct possibility that *GD* 8 was entirely computed from *GD* 2-7 (data themselves already corrupted by calculations from a prior pool of longest-day data) as alleged. But some differences (fn 7) in the two mss-traditions (Diller's XZ & UNK) occasionally remind us that post-2nd-century AD revisions of the *GD* 8 values may have attempted arranging consistency, in the same spirit that latitudes in *GD* 2-7 were adjusted at some point (at or before Hipparchos' era), according to the DR theory of the *GD*. Note that the latter theory (§D1) has here been limited to proposing the high likelihood that data of the *sort* (§D4) provided in *GD* 8 underlay *GD* 2-7's major cities.

[13] B&J p.14 n.10 show excellent judgement in rejecting a misguided but persistent tradition of manipulating the stade, to force disparate ancient Earth-measures to agree with each other or reality. See also ‡1 §J1; Rawlins 1982N; Rawlins 1996C ‡1 §C14 & fn 47 [p.11]. The formerly unpopular but evidentially-insistent fact (‡1 §J3) that Eratosthenes' Earth-circumference was *genuinely* (not illusorily) high by 1/5, and Marinos-Ptolemy's too low by 1/6, is shown by at least 5 considerations: [1] Ptolemy's 4/3-expansion ($130^m \rightarrow 172^m 1/2$) of the Rome-Babylon longitude-difference, between *Alm* & *GD*. [2] The *GD*'s similarly large (33%-40%) systematic over-estimate of many actual longitudes. See the least-squares test of Rawlins 1985G p.264, leading to p.265's table of reconstructions. (The first scholar to sense that ancients had multiplied longitudes by adjustment-constants when adopting new Earth-sizes, seems to have been Pascal Gossellin *Géographie des Grecs* 1790. See his several tables exploring the hypothesis; also Rawlins 1985G n.22, which credits Gosselin & van der Waerden for this penetrating realization.) [3] DR's neat common explanation (***using the same 185 meter stade***) of BOTH C-values' errors from atm refr of horizontal light (§‡1 §A4 & §K) with 1/6 the curvature of the Earth. [4] Strabo 1.4.1 reports that the largeness of Eratosthenes' C came under later scholarly attack. [5] Ptolemy's faked *GD 1.4.2* Carthage longitude argues for expansion by 4/3 (fn 45).
All 5 of these evidences are consistent with each other and with realization that Marinos & Ptolemy (or their source[s]) adopted the genuinely smaller Earth entailed by the 700→500 stades-per-degree

there are plenty of hints (e.g., Memphis' $13^{h}57^{m}$: fn 7) that the majority of *GD* 8's non-major cities may have been directly computed (via eq.1) from data of the sort found in *GD* 2-7. (Note strong evidence that neither section was directly computed from the other: §E2.) E.g., the greater precision of *GD* 2-7 data is obviously often impossible (fn 26) to derive by computing from *GD* 8 — while the reverse is frequently possible (see §D5 for cause). Further, late copies of Ptolemy's *Handy Tables* (a work probably earlier than the *GD*) contain a list of c.360 Important Cities' (364 in Halma's ed.) latitudes and longitudes in degrees, very similar (though not identical) in selection, bulk, and sequence to *GD* 8. It may be that Ptolemy simply computed the non-key sites of *GD* 8 from something like this list, as a handiest-possible (§A4) add-on to crown his *GD*.

D2 However *GD* 8 was accomplished, it was an astrologer's-dream Handiest Tables (§A4 [2]), *the only example of its type that survived from classical antiquity*:
[1] All latitudes expressed in longest-day, for (§A4 & eq.2) easy entry into tables of houses.
[2] All longitudes expressed vis-à-vis Alexandria, and
[3] in hours — for converting local time to Alexandria time, to enter Alexandria-based tables for computation of the zodiacal positions of Sun, Moon, & planets.

D3 B&J p.29 notes (as did Rawlins 1985G pp.261f) specific cases where key cities' latitudes must have been computed[14] from longest-day. Regarding the preface to *GD* 8:
[a] The preface's comments on map-distortions belong with parallel material back in *GD* 1.
[b] One of the most obvious arguments against *GD* 8's data being for (non-warped) maps is that longest-day data are not linearly related (§A4) to latitude. (Note shrinking of klimata-bands with recession from the Equator at, e.g., S&G 2:748-751.)
[c] The *GD*'s regional maps have come down to us. Granted, they are not originals; nonetheless, their fidelity to the *GD*'s regional dividers strongly suggest that these are the originals in essentials. Though the maps' margins bear longest-days marks (inevitably at large latitude intervals), the densely-marked, dominant north-south co-ordinate (linearly related to up-down distance on each map) is latitude in *degrees*. Which is necessary because these maps depict the locations of thousands of cities (not the hundreds of *GD* 8), the great majority of whose positions are not given at all in *GD* 8, while all their longitudes and latitudes are in *GD* 2-7. More indicative yet, the maps measure longitude not in *GD* 8's *hours* east or west of *Alexandria*, but in *GD* 2-7's *degrees* east of the *Blest Isles*.
(See the beautiful reproductions of several such maps between pp.128&129 of B&J.)
So: why would *GD* 8's preface be discussing the construction of regional maps actually based upon the data of *GD* 2-7? Is this more residual evidence (see further yet at fn 17) of patch-work authorship? What evidence connects Marinos to the construction of *GD* 8? The absence[15] of his native coastal Phoenicia from *GD* 8 proves his non-authorship of it.

D4 Tyre's absence from *GD* 8 only adds to the evidence (§E & §G1) that *GD* 8 is not directly connected to Marinos-of-Tyre's Books 2-7. So it would be wrong to over-claim that *GD* 8 is the father of *GD* 2-7. Uncle or cousin might be nearer the mark: §E1 §G2. For, longest-day data (the stuff of *GD* 8) are obviously the basis of the full work's flawed

shift. Thus (‡1 §J2), there is not only no case-for but no longer even *any need-for* the literature's ever-reappearing attempts (see, e.g., Rawlins 1996C §C14 & fn 47 [p.11]) to claim that Eratosthenes got-the-right-answer for the Earth's circumference but expressed it using an undersized stade.

[14] A semi-ambiguity: *Almajest* 2.13 predicts the upcoming *GD* and refers to degrees vs the Equator for latitudes (like *GD* 2-7) but speaks of placing sites by degrees (the measure of Books 2-7) while using (fn 43 [1]) the Alexandria (D149) meridian of Book 8 (and of E.Mediterranean astronomers & astrologers); so it conclusively favors neither side on the relation between the *GD*'s two data-sections.

[15] In Nobbe's edition, at *GD* 8.20.18 (Jerusalem D247) the spelling of "east" changes from ανατολασ [anatolas] to εο [eo] for most of the rest of *GD* 8. If the switch (which occurs only in some mss) is meaningful, it is possible that it is connected: [a] to the compiler's departure (at about this point) from a map of the Roman Empire to an extra-empire map of different format (and less reliability), and this perhaps led [b] to the accidental omission of coastal Phoenicia, possibly due to the 2 maps' different order of site-listing around the nearby seam. More patch-workery?

grid-network of Important Cities' latitudes (§D5) — a grid which typically misplaced geographically-key cities by ordmag a *degree*, grossly mislocating their latitudes, e.g., Byzantion (D87 [Istanbul]) by 2° (though, as B&J p.29 n.37 rightly marvel, the false *GD* latitude continued to be believed at religiously non-empirical Byzantion until c.1000 AD!); Carthage (D131) by 4°, a huge error (revealed at Rawlins 1985G p.263 as due to false L) that enormously distorted maps of N.Africa (up to the Renaissance, over 1000^{y} later). Not to mention Babylon (D256) by 2°1/2 (fn 10; Rawlins 1985G n.13) — a discrepancy which is difficult[16] to reconcile with a modern historian-cult's non-empirical insistence (fn 46) that Greece had high-astronomy debts to Babylon. DR suspects (§A4) that the latitudinal shortcomings of the *GD*'s basic grid-network derive primarily from astrologer Hipparchos (not Marinos or Ptolemy): see at GD 1.4.2 (& 8.1.1) on Hipparchos' listing-clumping of cities of differing latitudes under the same klimata (§A3), for astrologers' convenient entry (§A4) into common longest-day-based tables of houses. This degenerative step typified the fateful laxity (www.dioi.org/cot.htm#twvr) which DR's §D1 theory proposes was the prime source[17] of latitude-accuracy's corruption in *GD* 2-7.

D5 Rounding klimata to fractions of hours (*GD* 8's practice) correlates to FAR cruder precision than rounding latitudes to twelfths of degrees, which is the precision of Books 2-7's data. Ancient longest-day tables often rounded M to the nearest $1^{h}/4$. (See, e.g., *Alm* 2.6, Neugebauer 1975 pp.728f.) But when using eq.1 in the Mediterranean region, *a longest-day error of merely 5 timemin would cause an error of nearly a full degree*. And ordmag 1° is the actual (terribly crude) accuracy of the data of Books 2-7. (Example of degeneracy [SE Asia] traced in detail at §K10.) This is (along with the plethora of places whose latitudes fall conspicuously upon exact klimata) one of the best arguments for the Rawlins 1985G theory that rounded longest-day data (*GD* 8's or its type) were the basis (§G3) for the key-city latitudes of *GD* 2-7. Note the historically vital (if paradigmist-verboten)[18] lesson imparted: competent ancient geography's heritage to us was corrupted — *crippled* (§G2) might be a more accurate indictment — *by the societal ubiquity of a pseudo-science*, astrology (§D4). But keep in mind (*DIO 4.3* ‡15 §C3) that Ptolemy worked for the newly-cosmopolitan, astrology-saturated Serapic religion, and doing horoscopes internationally requires (then & now) 3 manuals: astronomical tables, geographical tables, & interpretational handbook. Ptolemy's prime works were: *Almajest*, *GD*, & *Tetrabiblos*.

[16] It is common knowledge (§L6) that the longest-day value (*GD* 8.20.27) for Babylon (D256), $14^{h}5/12$, is a rounding of $14^{h}2/5$ — which is 3/5 of a day and the M basis of computation (§G2 [c]) of the revealingly inaccurate latitude $L = 35°$N (*GD* 5.20.6), $2°28'$ (148 nautical miles) too far north.

[17] There remains the question of whether Hipparchos was responsible for the fateful step of converting (via eq.1) crude tabular longest-day M values from hours to degrees of latitude L. In the light of DR's 2007 realization (www.dioi.org/cot.htm#hrbc) of just how admirably accurate Hipparchos' longitudes may've been, the odds that he was not the culprit are enhanced. Has the remarkable irony been noted that the *Geographical Directory* (at *GD* 8.1.1) itself scoffs at the common folly of clumping cities under parallels? Or that this contradicts *GD* 1.4.2, where Hipparchos is praised for his alleged aloneness in performing the very same clumping? Of course, the *GD* 8.1.1 complaint is merely that parallel-lists [like the pre-Ptolemy one of Pliny (77 AD): analysed at Rawlins 1985G p.262] waste time and space, but the statement is valuable in its suggestion of ancient currency of the very lists upon which the DR theory is founded. (Said currency could help a defense of Hipparchos as not-necessarily the unique source of the *GD*'s macro-errors; however, his attractive fame and his citation by both Marinos [*GD* 1.7.4] and Ptolemy [*Almajest*, *passim*] argue in favor of his culpability here, though see speculation above [in this fn], on his longitudes.) We needn't speculate anyway, on the existence of lists of a few hundred key cities' coordinates. Just such a list survives, e.g., in the Ptolemy *Handy Tables*, the Important Cities table of which (N.Halma 1:109f [1822]), appears closely related (§K4) to *GD* 8 in both quantity and sequence: 364 sites in all, with 12 not in *GD* 8, and 8 missing in *HT*. See also the two Important Cities lists (fn 43) provided in E.Honigmann 1929 [pp.193f]: Vatican 1291 [493 sites] and Leidensis LXXVIII [a comparable number of sites]. These lists' positions are [like *GD* 2-7] given entirely in degrees east of Blest Isles and north of the Equator.

[18] See ‡2 fn 67 & *DIO 2.1* ‡3 §C10 [p.31].

D6 Suggested Solution to Two Mysteries As shown in the tables of Rawlins 1985G p.262, *GD* latitude-errors for major cities are often sph-trigonometrically consistent with the §D1 theory. See eq.1 or Rawlins 1985G p.261, for the relevant math. See also discussion (*ibid* p.259) of a further revealing point: without the DR theory presented there & here (§C2), how could one reasonably explain two shocking oddities (which had evidently escaped the notice of previous commentators): [1] *GD* latitudes (as already noted) are *two ordmags* cruder than ancient astronomers' latitude-accuracy. (Roughly: a degree vs an arcmin.) [2] The *GD* latitude errors' large size (again: ordmag a *degree*) is comparable to that of its pre-expansion (fnn 13&25) sources' longitude errors — this, though: [a] The former should be 30 times smaller than the latter. (Or 41 times smaller, if eclipse-observations aren't taken as raw-data pairs.) [b] Again, real astronomers knew their latitude to ordmag an *arcmin*.[19]

E *GD* 8's Disconnect: *GD* a Hybrid

E1 The order of data-listing for *GD* 2-7 and *GD* 8 are similar. (And the former's 26 local maps correlate in designation and sequence with the latter's.) This suggests (§D4) some sort of inter-causation or co-causation. (*GD* 8.2.1's statement that *GD* 8's data are from degree-lists does not say that they were those of *GD* 2-7, though that may be the implication and-or the truth.)
E2 However, throughout the *GD*, we find repeated instances of differences in order-of-listing.[20] Which argues against *GD* 8 being computed directly from[21] *GD* 2-7 or vice-versa.
E3 Decades ago, Aubrey Diller pointed out to DR that the *GD* never mentions Book 8 — until the reader arrives there.
E4 DR has noted something similar: throughout *GD* 1, there is no mention of Alexandria,[22] Ptolemy's claimed home and his *Alm*'s prime meridian. By contrast, *GD* 1 mentions such sites as: Thule (D1), Ravenna (D56), Lilybaeum (D67), Carthage (D131), Rhodos (D189), Canopus (Ptolemy's true home), Syene (D154), Meroë (D165), Arbela (D261), Okelis (D281), Kattigara (D356), among many others. Since Ptolemy is a multiply-convicted plagiarist (Pickering 2002A; Duke 2002C), one may ask: is it credible that

[19] Rawlins 1982G p.263 fn 17. Note that *GD* 1.2 shows awareness that astronomical observation is the most reliable basis of latitude-measure. This returns us to the question: if sophisticated cities knew their latitude (§B2), how did most of these data get corrupted by astrologers? Was there a long astrological tradition (§C1) of geographical tables, which Marinos (note *GD* 1.17.2's semi-connexion of astrologers' klimata to Marinos) and-or Ptolemy felt forced to assent to the flawed important-cities latitudes of? Just as usually-equant-preferring Ptolemy may've felt forced to go along (in the *Almajest*) with Hipparchos' flawed but long-pagan-sacred eccentric-model solar tables.

[20] E.g., Nîmes (D29) & Vienne (D28): *GD* 2.10.10-11 & 8.5.7. (B&J p.106 vs p.122.) Kasandreia (D101) & Thessalonike (D95): *GD* 3.13-14 & *GD* 8.12.10&4. Pergamon (D178) & neighborhood: *GD* 5.2.14 & 8.17.10. Hierapolis (D237) & Antioch (D236): *GD* 5.20.13&16 & 8.20.8&7. Teredon (D259) & Babylon (D256): *GD* 5.20.5&6 & *GD* 8.20.30&27. Kattigara (D356) & Thinai (D355): *GD* 7.3.3&6 & *GD* 8.27.14&12.

[21] See §G1. For the consistent sites, either there were calculations of one section's data from the other (in one or both directions) or scrupulous attention was paid (fn 25) to math-consistency between the two sections (whether at the outset or during later editors' touchings-up) — though there are occasional inconsistencies, e.g., the longitude of Rome (D49): *GD* 3.1.61 puts Rome $36°2/3$ west of the Fortunate Isles, while *GD* 8.8.3 puts Rome $1^{h}5/8$ east of Alexandria. (Itself $60°1/2$ east of Blest Isles by *GD* 4.5.9, or 4^{h} [60°] by *GD* 8.15.10. See Rawlins 1985G n.25.) But $(60°1/2 - 36°2/3)/(15°/\text{hour}) \approx 1^{h}7/12 < 1^{h}5/8$. Similar incompatibility: Salinae (*GD* 3.8.7, 8.11.4, D79). See also §K3.

[22] Nobbe 1:46 inserts Alexandria at the 14^{h} klima (*GD* 1.23.9), but it is clear from Müller 1883&1901 (1883) 1:57, B&J pp.85&111, and S&G 1:116 n.4 that this was not in the original, which (in *GD* 1.23) named only four klimata north of the Equator: Meroë [D165] (13^{h}), Syene [D154] ($13^{h}1/2$), Rhodos [D189] ($14^{h}1/2$), Thule [D1] (20^{h}). Selection repeated *GD* 7.5: B&J p.111. Note that Alexandria [D149] is mentioned at *GD* 7.5.13-14.

allegedly (*Almajest* 3.1) Alexandrian Ptolemy would write a preface to his *Geography* which never mentions his own city, when it is the prime meridian for his astronomical works, for his earlier-announced (*ibid* 2.13) forthcoming geography, and for *GD* 8?

F Blest Isles Ignored & Identified: the Cape Verde Islands

F1 Conversely, the Blest Isles, the *GD ekumene*'s west bound (and *GD* 2-7's implicit prime meridian), have no *GD* 8 entry. In *GD* 8, this linch-pin site is only mentioned at two places, rather *in-passing*: at *GD* 8's prime meridian Alexandria (*GD* 8.15.10) and at the *GD ekumene*'s east bound, Thinai (*GD* 8.27.13), where it is noted that Thinai is 8^{h} east of Alexandria and thus 12^{h} east of the Blest Isles.
F2 Yet another oddity: the *GD* repeatedly states that the Blest Isles are the west bound of the *ekumene*. (Though, curiously, not at *GD* 7.5.2, even while soon after saying so at *GD* 7.5.14.) Yet the writer of *GD* 1 does not explicitly state that all the longitudes of *GD* 2-7 will be measured from the Blest Isles; and the Blest Isles have no entry in *GD* 8. Its position appears[23] under Africa at *GD* 4.6.34. Additionally, one notes that there is not a single absolute longitude in *GD* 1 — every longitudinal value is given in strictly differential terms. Now, if one is writing a preface to a compendium that provides the longitude-east-of-Blest-Isles of 8000 sites, one would think that the east-of-BI part just might get mentioned somewhere. Instead, *GD* 1 is completely non-committal regarding what will be the prime meridian of the work. And *GD* 2.1 (the preface launching the reader into the 8000 sites) is likewise. (If one were just grabbing — virtually unedited — a preface to another work, something like this could easily happen.)
F3 In the *GD*, there are (§F4) a few islands near Mauretania at about the latitude of the Canaries, which are the hitherto-standard identification of Ptolemy's Blest Isles. (E.g., S&G 1:455 n.200, which scrupulously notes that the identification of the Blest Isles with the Canaries is uncertain.) But these islands are not *GD*-listed at or even very near longitude zero; nor is the center of the real Canaries longitudinally beyond the real western hump of Africa, which is where the western-most anciently-known land obviously ought to lie.
F4 *GD* 4.6.33 lists some non-zero-longitude off-shore islands, incl. "Kerne" at 5°E & c.26°N, latitudinally & phonetically near the Canaries which at (actually) c.28°N, are the better part of a thousand miles north of Ptolemy's six "Blest Isles", listed by him (Nobbe ed. *GD* 4.6.34) at longitudes 0° (four) or 1° (two), at latitudes ranging from $10°1/2$ to 16°N: about right for the Cape Verde Islands. (Actual CVI latitudes: c.75 nmi N&S of 16°N.) Same isles also visible[24] on *GD* maps, strung (exactly 60° W of Alexandria) along a longitude of about 0° (S&G: $0°1/2$), & 400 mi west of the (actual) western-most point (hump) of Africa (Dakar, Cap Vert) at latitudes that are again a convincing match for the Cape Verde Islands, *which are therefore firmly identified as the Blest Isles*.
F5 The *GD*'s knowledge of the Cape Verde Islands stands as a testament to ancient explorers' courage: they are indeed c.400 mi from Cap Vert, the mainland's nearest point. (By contrast, eastern Canaries are barely off the NW-Africa shore.) So the islands' discoverer was himself the nearest thing to an ancient Eriksen or Columbus. Over 1000^{y} before sailors discovered tacking, trips there were presumably extremely rare and hazardous. Possibly galley-slave rowing-power was the key to the ancients' knowledge of the Cape Verde Islands. And perhaps they were regarded as Blest because European civilization had not yet significantly uplifted the inhabitants by the introduction of its ever-brewing wars & their ever-resultant slavery.

[23] Thanks to Alex Jones for reminding DR of this.

[24] E.g., B&J plate 6 (c.1300 AD); same in plate 1, marked as "Fortuna insula". Also S&G 2:838 & volumes' inside-covers. Online at http://en.wikipedia.org/wiki/Image:PtolemyWorldMap.jpg, the same six "Fortunate" islands can be seen at the west end of Ptolemy's world map, again at a position close to that of the Cape Verde Islands. The astonishingly persistent previous confusion presumably originated with realization that the 5th of the 6 islands listed at *GD* 4.6.34 is named "Kanaria Nesos".

G Hours as the Route of All Evil in Ptolemy's *GD*

G1 Looking at *GD* 1-7 and *GD* 8 as separate sections of the *GD*, one must notice that each of the two sections' cross-citations of the other's prime meridian is paltry at best (and could well have been from later interpolation) — so let's keep our eye on the main point: there is no mention of the Blest Isles in the *preface* to *GD* 8, any more than there is any mention of Alexandria in the *forward* (*GD* 1) of *GD* 1-7. It would be hard to ask for better evidence that neither (§D1) section was the immediate *direct* source of the other's totality.

G2 But let us return to the essence of the DR theory (§§D1&D5, fn 12) that the data of *GD* 2-7 were based upon data of the *type* found in *GD* 8, and fix upon the main points regarding the source of *GD* 2-7's major-site data:
[a] Whereas all latitudes were originally measured angles (method: *Almajest* 1.12), the inaccuracy of the latitudes in *GD* 2-7 show that these data had been corrupted by subjection to crude rounding (§D5) for astrologers' longest-day tables in *hours*, before being computationally converted into the latitude-degree data that ended up in *GD* 2-7.
[b] All astronomically-based longitudes in *GD* 2-7 were originally in *hours*,[25] as noted in *GD* 1.4. This, because based upon comparisons of lunar-eclipse local-times.[26]
[c] Thus we have arrived at a hitherto-unappreciated realization (obvious example at fn 16): ironically, every jot of the astronomically-determined data of the basic network of cities underlying *GD* 2-7's thousands of *degree*-expressed positions, was at some point (during its mathematical descent from its empirical base) rendered in *time*-units: hours. As proposed in Rawlins 1985G.

G3 And, as a result of rounded longest-days (§D5) and Earth-scale shifting (§L3), these hour-data became the semi-competent-occultist conduit (§D1) for data-corruption which tragically destroyed a sophisticated civilization's laboriously accumulated high-quality astronomically-based ancient geographical data.

[25] Wrongly (fn 45), Ptolemy believed (*GD* 1.4&12-13) that eclipse-based longitudes were rare. (The method of finding longitude-differences between sites by comparing local times of simultaneously-observed lunar eclipses, was obviously well known. See, e.g., Strabo 1.1.12 or *GD* 1.4.2. Least-squares tests on ancient longitudes show that the eclipse method had been extensively used by genuine ancient scientists: Rawlins 1985G §§5&9 [pp.258-259 & 264-265].) And so he assumed that generally-accepted longitudes were primarily based upon travellers' stade-measured distances (terrestrial) instead of eclipse-comparisons (celestial) — a crucial, disastrous error, which undid generations of competent scientists' eclipse-based accurate longitudes-in-hours and thereby wrecked (§L3) the *GD*'s longitude macro-accuracy in angle. (Though not in distance: *idem.*) Note: said mis-step must have occurred before the hypothetical dovetailing (fn 21) of *GD* 2-7 and *GD* 8, perhaps (§D1) in the 1st century BC.

[26] A number of network-cities' *GD* 2-7 longitudes could have been calculated directly from *GD* 8 or its source, using Alexandria (D149) longitude (east-of-Blest-Isles) 60° 1/2 (*GD* 4.5.9) or 60° (*GD* 8.15.10). Some examples:
London (*GD* 2.3.27, 8.3.6, D4), Bordeaux (2.7.8, 8.5.4, D21), Marseilles (2.10.8, 8.5.7, D26), Tarentum [Diller 1984 Codices XZ Europe-Map 6 site #5] (3.1.12, 8.8.4, D53), Brindisi (3.1.13, 8.8.4, D54), Lilybaeum (3.4.5, 8.9.4, D67), Syracuse (3.4.9, 8.9.4, D68), Kyrene (4.4.11, 8.15.7, D146), Meroë (4.8.21, 8.16.9, D165), Kyzikos (5.2.2, 8.17.8, D176), Miletos (5.2.9, 8.17.13, D181), Knidos (5.2.10, 8.17.14, D182), Rhodos (5.2.34, 8.17.21, D189 — allowing for common [Rawlins 1994L §F3] ancient rounding of $1^h/8$ to 8^m), Jerusalem (5.16.8, 8.20.18, D247), Persepolis (6.4.4, 8.21.13, D271).
However, these could as easily have been computed in the other direction. The majority of less grid-critical sites' degree-coordinates couldn't (§§D1&D5) have been computed directly from those of *GD* 8 (at least in its present state), but could've gone the other way; e.g., Smyrna (5.2,7, 8.17.11, D179) & Pergamon (5.2.14, 8.17.10, D178).
Given the *GD* as it stands, if *GD* 8 is contended to be the direct ancestor of *GD* 2-7's longitudes, one would have to argue that the underlying network-basis was far less in number than *GD* 8's 360 sites — which, if we are speaking of sites whose longitudes (vs Alexandria) had been astronomically determined, would not (in itself) be an unreasonable contention.

H Precession and Aristarchos

H1 Precession is the difference in the length of the tropical and sidereal year, caused by a gradual shift of the Earth's axis — an ancient discovery which we can easily trace back to Aristarchos (not-so-coincidentally also the 1st astronomer to publicly announce that the Earth moved), since[27] he is the earliest ancient cited to two different year-lengths. Aristarchos flourished c.280 BC: 1 1/2 centuries before Hipparchos, hitherto generally regarded as precession's discoverer. Both of Aristarchos' yearlengths are provided at Rawlins 1999 §B7 [p.33]; see also Rawlins 2002A fnn 14&16 [p.8].
H2 Precession was known to the author of *GD* 8.2.3.[28] Thus, the *GD* 1.7.4 discussion seems awfully strange,[29] since it here quotes the statement of Marinos of Tyre (c.140 AD: §I1) that all the constellations rise&set in the tropical geographical regions — with the sole exception of UMi, which becomes ever-visible after a northward traveler passes latitude $+12^\circ 2/5$, Hipparchos' long-precessionally-obsolete NPD (North Polar Distance = declination's complement) for α UMi. (I.e., modern "Polaris": the brightest star in UMi, and the most northern easily-visible UMi star for us; the most southern for Hipparchos.) And α UMi's NPD actually was $12^\circ 27'$ (Decl = $77^\circ 33'$) at Hipparchos' chosen epoch, -126.278 (128 BC Sept.24 Rhodos Apparent Noon: Rawlins 1991H eq.28 [p.58]). Marinos further states that this parallel is 1° north of Okelis, which he mis-places (§C1) at $11^\circ 2/5$ N latitude.[30] (A poor estimate, since Okelis (D281) [modern Turbah, Yemen] is actually at $12^\circ 41'$N, $43^\circ 32'$E.) Yet, by Marinos' time (§H2), α UMi's NPD had precessed down to about 11°: in 140 AD, $10^\circ 59'$. So, his statements prove he didn't account for precession. But the most peculiar aspect of this matter is that *GD* 1.7.4 makes no comment at all on Marinos' flagrant omission of precession — and this though Ptolemy is (as usual) in full critical mode (alertly questioning [*GD* 1.7.5] whether any of Marinos' discussion is based upon the slightest empirical research), and though the writer of the *Almajest* certainly knew (*Alm* 7.2-3) the math of precession. Comments:
H3 There can be little doubt that the authors of *GD* 1.7.4 and *GD* 8.2.3 were not the same person.
H4 If Okelis were where Marinos placed it, α UMi's ever-visible circle would have been south, not north of Okelis.
H5 Has it been noted that, by the time of Marinos & Ptolemy, α UMi was (thanks to precession) no longer the most southern of UMi's seven traditional stars?! — η UMi and especially 3rd magnitude γ UMi were much more so. Indeed, for the time of the *GD*, γ UMi was *over a degree* ($1^\circ 04'$ at 160 AD) more southern than α UMi. (Shouldn't the "Greatest Astronomer of Antiquity" [‡2 §G2] have known this? — especially since he pretended he'd cataloged the whole sky's stars: *Almajest* 7.4. I.e., the *GD* 1.7.4 statement on α UMi disagrees not only with the sky but with Ptolemy's own tables.[31] Similar cases at fn 45.) Thus, γ UMi had long since assumed the distinction (one interjected by Marinos, ironically) of being the outrider-star whose NPD determined whether a geographical region was far enough north to attain UMi-ever-visibility. (Note that *GD* 6.7.7 puts Okelis at latitude 12°N [and false-Okelis at $12^\circ 1/2$]; so, creditably, the *GD*'s Okelis latitude was closer to reality than to Marinos. Note also that 12° is almost exactly the theoretical

[27] Note: not a single historian has yet indicated publicly that he understands this rather self-evident point. (Though some have privately.) Which gives us hope that sociology can yet attain to the predictivity of astronomy. (See ‡2 Epilog [p.31].)

[28] *GD* 8.2.2 by the arrangement of B&J or 8.B.2 in Diller 1984 (the only reliable English translations) at *DIO 5*.

[29] Though some experts disagree: B&J p.65 n.23 & p.120 n.3.

[30] Is this a revised&multibungled re-hash of an original Hipparchos estimate that Okelis was on the arctic (ever-visible) circle of α UMi? — which would have been correct in 170 BC and OK to ordmag $0^\circ.1$ during his career.

[31] Even Ptolemy's very insufficiently precessed plagiarism of Hipparchos' star catalog has γ UMi $9'$ south of α UMi.

[www.dioi.org/fff.htm#csvv] ever-visible latitude for all of UMi at the *GD*'s epoch, since γ UMi's NPD was $11°56'+$ in 160 AD.)[32] As noted, the foregoing strongly suggests (see also §D4) that the same person did not write *GD* 1.7.4 and *GD* 8.2.3. And several other features suggest independently that the *GD* is a patch-work[33] opus. Thus, the above analysis of *GD* 1.7.4 provides another powerful augmentation of that evidential collection.[34]

I Marinos Mis-Dated?

I1 Nowadays, it seems to be almost universally assumed (e.g., Neugebauer 1975 pp.879 & 939) that Marinos flourished very early in the 2nd century AD, sometime during Trajan's reign, around 110 AD.[35] Which is curious, since in c.160 AD (or perhaps even later: §I2) Ptolemy refers to Marinos as (*GD* 1.6.1 emph added): "*the* most recent [of those] of our time" who have attempted a large geography. Now, if you were currently writing of a geographer of the mid-*1950s*, would you speak of him so? (*GD* 1.17.1 has been taken to indicate that Marinos was retired or dead by Ptolemy's day, but the passage is hardly unambiguous on that point — and would make more sense if Marinos' latest publication was merely 5 or 10 years past.)

I2 Moreover, Alex Jones points out (2007/5/23 conversation) that the forward dating of Marinos would help solve a problem first emphasized at Schnabel 1930 p.216: when did Ptolemy become aware that people lived south of the Equator? *Almajest* 2.6 says the S.Hemisphere is unexplored, though Marinos says otherwise and (§M1) the *GD* agrees. This implies, since the *Almajest* might have been compiled during Marcus Aurelius' reign (Rawlins 1994L Table 3 & fn 45 [p.45]), that Marinos' date could be as late as c.160AD.

I3 The argument adduced to date Marinos to much earlier (than Ptolemy) is that Marinos' work took into account names of sites reflecting the changing Empire, e.g., Trajan in Dacia (*GD* 3.8, 8.11.4 [roughly modern Romania]) up to c.110 — but not later in Parthia (*GD* 6.5, 8.21.16-18 [roughly modern Iran]) and north Africa. But how sure is such tenuous reasoning? How strongly should it rank? — in the face of:

[a] *GD* 1.6.1's plain statement of Marinos' contemporariness, and

[b] the incredibility of the long-orthodox implicit assumption that, in a busy mercantile empire, a succession of macro-geographers (*GD* 1.6.1 implies plurality) suddenly ceased for 1/2 a century!

I4 Moreover, why assume that Marinos adopted all the latest name-changes? Ptolemy didn't: his preface's criticisms complain (*GD* 1.17.4) that Marinos misplaced the Indian trading town Simylla (D330) and didn't realize that the natives call it Timoula. Yet the *GD*'s data-listings (*GD* 7.1.6 & 8.26.3) both retain Marinos' name: Simylla, not Timoula. B&J n.53 (p.76) note an even more revealing careless retention:[36] Marinos' Aromata latitude. So, what should be tested isn't whether *all* but whether *any* post-Trajan geography appears in the *GD*.

I5 Especially since it doesn't seem that there'd likely be many changes. After all, it's well-known that Dacia was the last solid addition to the Roman Empire. (It may not be coincidental that around this time the Roman army was becoming predominantly alien-mercenary.) Trajan's army was of course stronger than Dacia's. (So, we know who ended up with Dacia's gold, some of it possibly pictured in Fig.2.) But it wasn't stronger than that of the Parthian Empire; thus, the attempted-rape[37] victim got in all the Part'n shots, and the puppet ruler whom Trajan had placed into power at the then-capital (Ctesiphon [D262], near Babylon [D256]) passed on soon after, as did Trajan (117 AD). Trajan's adventure in Parthia having been an expensive failure, his two successors chose not to try expanding the empire. Hadrian (117-138) did not share certain current warlords' fiscal profligacy. Similarly for Antoninus Pius (138-161 — which takes us up to the time of Ptolemy's geographical work). These points recommend some caution before we draw conclusions on Marinos' date from lack of the-very-latest Parthian information.

I6 Next, we note that the most notorious exception to the non-expansion policy of Hadrian occurred in Palestine. In 130 AD, he visited Jerusalem and ordered its re-building. Since Hadrian's family name was Aelius, he re-named Jerusalem: "Aelia Capitolina". (His supervision evidently triggered a local revolt — put down in 132-134, with Hadrian sometimes on the scene.) So, does the *GD* reflect the change? Yes: *GD* 5.16.8 lists "Ierosoluma [Jerusalem], which is called Ailia Kapitolias". And *GD* 8.20.18 lists "Ailia Kapitolias Ierosoluma" without further comment but obviously reflecting the same up-to-date[38] information. Therefore, we have indication that both the *GD*'s data-sections (*GD* 2-7 and *GD* 8), previously adduced to date Marinos to c.110, actually contain material from the 130s or later.[39]

I7 An example of the fruitfulness of the foregoing:
Almost 2 centuries ago, H.Müller made the brilliant observation that a *GD*-listed N.German town "Siatoutanda", was probably non-existent, just (another: fn 45) Ptolemy-compilation mis-read of a foreign language: Tacitus' Latin description (*Annals* 4.73) of a N.German battle-retreat ("ad sua tutanda"). This does not stop our ancient geographer from providing (§C1) highly specific[40] coordinates: longitude 29° 1/3, latitude 54° 1/3 (*GD* 2.11.27). As is

[32] Likewise, 1000 nmi to the southwest of Okelis: regarding the location of the two lakes feeding the Nile, the *GD* astutely makes a major correction to Marinos in placing both lakes much nearer the Equator than Marinos had them. (In reality: the Equator runs through the eastern source, Lake Victoria. And the western source, lake-pair Edward & Albert, straddles the Equator.) Remarkably, the *GD*'s maps of Africa were still consulted by geographers in the mid-19th century, when these lakes were finally 1st reached by Englishmen. (See *J Roy Geogr Soc 29*:283, *35*:1, 7, 12-14; *Proc RGS 10*:258.)

[33] Also fn 45. See Rawlins 1985G p.260 (On vs Heliopolis: fn 6) and p.266 & fn 6. We find similar hints of patch-workery throughout the *GD*, e.g., at *GD* 1.24.11-vs-17, as the lettering for two consecutive projection-diagrams are needlessly shuffled. (See B&J p.91 n.80.) See also another Ptolemy-compiled work, the *Almajest*, where, e.g., the mean motion tables' Saturn→Mercury order of the planets (*Alm* 9.3-4) is the reverse of the Mercury→Saturn order followed in their fraudulently (Rawlins 1987 pp.236-237 item 5; Rawlins 2003J §K) alleged derivation at *Alm* 9.6-11.8. For more such patch-work indications, see frequently here, and at Thurston 1998A end-note 17 [p.17] & Rawlins 2002V §C [p.76].

[34] Indicia of such patch-workery in the *GD* are frequently noted here, due to the inexplicably-repeated modern claim of coherent unity for each of Ptolemy's works.

[35] Quite aside from the present discussion: for compelling evidence against this date, see H.Müller's clever discovery: §I7.

[36] These situations remind one of the common modern mis-interpretation (Rawlins 2002B fn 7 [p.12]) of *Almajest* 3.7 to mean that no Babylonian astronomical records came through to Ptolemy prior to 747 BC, though the actual statement is rather that *continuous* records went back that far.

[37] Over 4 centuries of botheration, Parthia repelled three Roman invasions: [1] swallowing the army of Crassus (suppressor & crucifier of Spartacus, and member of the 1st triumvirate), [2] exhausting emperor Trajan, and (after a temporary setback at Marcus Aurelius' hands) [3] slaying last pagan emperor Julian the Apostate (unless he was fragged). And, yes, "parting shot" is thought to come from Parthian archers' tactic of shooting arrows even when retreating or pseudo-retreating.

[38] Such an explicit update is rare in the *GD*'s data-body. Another such passage, even more unusually discursive, is found at *GD* 7.4.1, where it is stated that Taprobane (modern Sri Lanka [though known as Ceylon in Diller's & DR's youth]) was formerly called Simoundou but is now called Salike by the natives. Comments are even (very atypically) added, describing Salike's women and local products ranging from meal & gold to elephants & tigers. It seems likely that the mention of both Ailia Kapitolias and Salike were late additions to the *GD*, a point we will shortly (fn 39) make use of. (Note: Taprobane [*GD* 8.28] is the last map in the *GD*, though [given its location] it should obviously have been covered before the *GD* listings get to China. I.e., we have here yet another symptom of a late add-on.)

[39] Following the revolt's suppression, Judaea was re-named "Syria Palestine" and Rome henceforth (c.135) eliminated the term "Judaea". The fact that it is retained in both the body (G2-G7) and Book 8 of the *GD*, taken together with the re-naming of Jerusalem leaves us with a bracket-argument in favor of dating Marinos to about 135, which is indeed of Ptolemy's time — as he said.

[40] The "Siatoutanda" goof reminds one of St.Philomena, of whose "life" whole books used to be written (DR possesses a copy of one), though she never existed: "Philomena" turned out to be just an

all-too usual in the ancient-science community, Müller's novel and obviously valid discovery has been doubted on grounds so tenuous (in comparison to the compelling evidence in its favor) as to make one wonder whether anything ever gets resolved in this field, no matter[41] the power of relative evidence. Against Müller, it has been argued (see sources cited at B&J p.28 n.34) that Tacitus *Ann* was published in 116 AD, which is after the (inexplicably-widely-believed) upper-limit date (110 AD) for Marinos. (But the 110 date is so far from firmly established that one should reverse[42] the situation: instead of using the date to exclude H.Müller's finding, use the HM finding to help establish a lower limit for Marinos' date.) So we recognize that H.Müller's discovery contributes importantly to the evidence suggesting that conventional wisdom on Marinos' date is suspect, and thus that there is little trustworthy evidence against our proposal that Marinos was much nearer Ptolemy's contemporary than is now generally understood.

J Tyre: Missing Home-City of Book 8's Once-Supposed Source

J1 The most peculiar coincidence in the history of ancient geography will turn out to be a lucky break for scholars of the *GD*: incredibly, Marinos' native Tyre is absent[43] from *GD* 8. (Curiously, this telling point has been overlooked in the literature.) And, in a context of questionable authorship, we must likewise notice (§E4) that Ptolemy's alleged home-city (Alexandria) is missing from *GD* 1.

J2 Marinos is clearly identified as of-Tyre (*GD* 1.6.1). Indeed, Tyre (Phoenicia) is cited doubly and with accurate latitude — highly exceptional on each count — at *GD* 5.15.5&27: 67° E of Blest Isles, 33° 1/3 N of Equator. (The latitude is correct [see similarly at §K11] if we account for refraction of pole-star light and 5′ rounding.)

J3 Thus, we conclude that *GD* 8 (in the form we have it) was not compiled by Marinos.

over-imaginative later mis-read of a fragmentary ancient stone inscription (found in the catacombs of Rome on 1802/5/25): "LUMEN PAX TECUM FI", which was "restored" as a reference to FILUMEN or Philomena. This was enough to launch (starting c.1805 in the super-religious Kingdom of Naples) a cult, special novenas, the usual "miracles", and (from devotees' revelations) a detailed biography of her life & martyrdom. The Roman church creditably removed her from the list of saints about a 1/2 century ago.

[41] What says this about the field? See *DIO 7.1* [1997] ‡5 fn 40 [p.33] (www.dioi.org/vols/w71.pdf). Note the Velikovskian context.

[42] Similarly, when (1999/10/1) dim atmosphere proponent B.Schaefer imparted to DR his intention of testing the Ancient Star Catalog's authorship by assuming 0.23 mags/atm opacity, DR immediately suggested that it would be far more fruitful to use Hipparchos' authorship (which had by then been obvious to serious astronomers for centuries) to test for ancient atmospheric opacity. BS didn't listen, so this important and revealing project — proving beyond any question that man (not nature) is the prime cause of present atmospheric opacities ominously higher than ancient skies' — was instead masterfully and independently established by Pickering 2002A §§D2-D5 [pp.11-12].

[43] Tyre's absence from *GD* 8 has several non-neatnesses. While Tyre is also missing from the Important Cities lists in late copies of Ptolemy's *Handy Tables* (Halma ed.), Tyre does reside in two 9th century copies (published in Honigmann 1929), which are far older than our earliest mss of the *GD*, and each contains (fn 17) c.100 more sites (than *GD* 8): Tyre is city #307 in Vat 1291, #160a in Leid.LXXVIII. In the latter ms, Tyre is counted secondarily; which suggests that, if paring occurred, Tyre was expendable. The superficially attractive interpretation is to wonder if *GD* 8 is a Byzantine-era add-on, which reflected a shrinking of the number of sites from nearly 500 to just 360.
The problem with that theory is format: *GD* 8 differs generically (from all other surviving Important Cities lists, which uniformly are in longitude degrees east of the Blest Isles and latitude degrees north of the Equator) by: [1] using Alexandria (fn 14) as prime meridian (astrologer Ptolemy's preference); and [2] providing data entirely in hours, *just* as ancient astrologers preferred (§G2 [a]). This argues strongly that *GD* 8 goes back in time at least as far as Ptolemy.

K Landlubber Ho! Wrapped China Negates the Pacific

K1 It is well-known that the farthest-east region of the *GD*, China, portrays a non-existent continuous roughly-north-to-south coast (blocking any route to the Pacific) beyond the South China Sea, near longitude 180° ($12^{\rm h}$) east of the Blest Isles or 120° ($8^{\rm h}$) east of Alexandria, stretching from near the Tropic of Cancer, all the way south to Kattigara at 8° 1/2 S. latitude — effectively wrapping China around the Indian Ocean's eastern outlet. Latitude-longitude coords for 18 China sites are found in *GD* 7.3 (Renou 1925 pp.62-65).

K2 But, according to the previously-broached §D1 theory, all of this geography hinges upon the underlying grid-network: *GD* 8 and-or its kin. If we look at the *GD* 8.27.11-14 China data, we find that the situation of all China hinges upon just 3 cities' hour-data (longest day & longitude east of Alexandria, according to Diller 1984's XZ mss): Aspithra [D354] ($13^{\rm h}$1/8, $7^{\rm h}$2/3), Thinai [D355] ($12^{\rm h}$5/8, $8^{\rm h}$), Kattigara [D356] ($12^{\rm h}$1/2, $7^{\rm h}$3/4). Anything wrong with *GD*'s China is wrong in this trio.

K3 For Thinai (D355), *GD* 7.3.6's latitude (3°S) jars with *GD* 8.27.12's longest-day $12^{\rm h}$3/4 north, which would be correct for about latitude 12° 1/2 N.

K4 Fortunately, Vat 1291's Important Cities (fn 17) lists the same 3 cities (only) for China. (Honigmann 1929 p.206: cities #443-#445; no China listings in Leid.LXXVIII.) And on Thinai, it provides confirmation of *GD* 8 (not *GD* 7), listing Thinai at 13°N. Which suggests that the 3°S of *GD* 7 is either a scribal error (missing the *iota* for ten) or perhaps is differential: 3° south of Aspithra (16° 1/4N). Either way, it seems that 13°N is correct, as listed by Vat 1291.[44] (S&G 2:734 for Thinai has *GD* 7.3.6's 13° latitude.)

K5 Finally, we observe that Kattigara's latitude in degrees is the same in both Vat 1291 and *GD* 7.3.3 — but in the former it is *north* latitude (which makes way more sense for a Chinese city), correctly contradicting the impossible southern latitude of both *GD* 7.3.3 & *GD* 8.27.14. The matter gets even more interesting when we check our latitudinally-corrected position for Kattigara: 177°E (of the Blest Isles) & 8° 1/2 N — that is precisely the *GD* 7.3.2 position of Rhabana. Therefore (not for the 1st time: §H5), the *GD* may have used two (or more) names for the same place.

K6 Thus, when we examine the underlying-grid trio for China, the two negative (southern) latitudes both appear so shaky that we can dispense with all negative signs for China — which eliminates the above-cited fantastic N-S coastal-bar to the Pacific.

K7 There is a disturbing pattern to the *GD* 7 latitudes of the only four cities in the Southeast Asia region which are listed in *GD* 8 (in order N-to-S): Aspithra, Thinai, Kattigara, Zabai. These cities' *GD* 7.2-3 latitudes are, resp, about equal to: 16° 1/4, 13°, 8° 1/2, 4° 3/4 — which are suspiciously close (though not exactly equal) to what one would compute indoors via sph trig (eq.1) from a quarter-hour-interval klimata table: Aspithra (D354) $13^{\rm h}$, Thinai (D355) $12^{\rm h}$3/4, Kattigara (D356) $12^{\rm h}$1/2, Zabai (D348) $12^{\rm h}$1/4. (And, indeed, these are the values Diller found in *GD* 8's UNK mss-tradition.) This looks even fishier when one recalls (above) that these are the only four SE Asia cities east of the Golden Peninsula which are listed in *GD* 8, where only longest-days (the stuff of klimata-tables) are provided for N-S position. (Even the precise $13^{\rm h}$1/8 variant discussed in fn 44 for Aspithra, perfectly matched what may [*idem*] have been merely a scribal error: 18° 1/4.) Obviously assuming exactly-correct latitudes here is risky when dealing with such rounded data. Conclusion: we must also use verbal descriptions, if we wish to have any chance of solving this section of the *GD*.

[44] The same Vat 1291 list gives 18° 1/4 N latitude for Aspithra (not the 16° 1/4 N latitude of *GD* 7.3.2, corresponding to longest-day $13^{\rm h}$1/8 (§K7), the very Aspithra longest-day value listed in Diller's XZ-tradition mss. (One is tempted to ask if 18° 1/4 latitude [*idem*] was the true original latitude — or was later forced to agree with $M = 13^{\rm h}1/8$? But it could have just come from a scribal error.) In Nobbe, *GD* 8 lists Aspithra at longest-day "about" $13^{\rm h}$, which corresponds to latitude 16°+, agreeing with the *GD* 7.3.5 Aspithra latitude in Nobbe and Renou: 16° and 16° 1/4 N, respectively.

K8 *GD* 7.3.3 refers to Kattigara (which has a 1st syllable like Cathay's) as a Chinese harbor, near walled cities and mountains. So it is on the Asian mainland.
[Note: The rest of this explicitly speculative reconstruction was nontrivially re-analysed & revised in 2009. See *DIO 5* fn 68 for numerous SE Asia site-identifications.]
Our interpretation of *GD* 1.13.9 (B&J p.75): Marinos is saying that an ancient sea voyage from Malay's Sabara-Tamala region (Phuket, Malay) to the Golden Peninsula (Sumatra's NW tip) is roughly 200 mi, which is about right. (Marinos' sailing direction [c.SE] is ignored here, since based on his distorted map.) *GD* 1.14 says the rest of the trip to Zabai (Singapore) takes 20^{d}. Going around Sumatra (instead of sailing between Malay&Sumatra) would require c.20^{d}. (Speed c.100mi/day: already established at B&J p.76 via *GD* 1.14.4: Aromata to Prason. Made more exact by checking Phuket-to-Singapore.) The original report is due to "Alexandros" (geographer? explorer? admiral?) who says the trip from Zabai across to Kattigara (Saigon) takes merely "some days" (*GD* 1.14.1-3), roughly consistent with the c.6^{d} it would've taken at the previous speed.
K9 The *GD*'s supposed direction to Kattigara (left [east] of south) is obviously confused. I suspect that the ancient cause was a common land-lubber misinterpretation: "south wind" (which means wind *from* the south) was taken as *towards* the south — thus, the report of going somewhat east of a "south wind" (*GD* 1.14.1; B&J p.75) was mis-taken[45] (at *GD* 1.14.6) to mean sailing with a wind blowing southward. (Compare to B&J p.76.)
K10 Kattigara (D356) was probably about where resides the harbor long called Saigon. (Re-named Ho Chi Minh City. For now.) The real Saigon's latitude is just north of 10°N, so the *GD* is off by c.2°, which is about as big an error as one will find caused (§D5) in this region by computing latitudes (eq.1) from $1^{h}/4$-interval klimata. Whoever originally cubby-holed Saigon so found that its L didn't fall exactly on a klima: the nearest such klima for rounded $L = 10°$ would in a region rounding to 1°/4 put L at 8°1/2. This, in microcosm, is the secret of why the *GD*'s mean latitude error is so poor: ordmag 1° (§D5), despite contemporary astronomers' achievement of knowing their latitudes ordmag 100 times more accurately. (See citations: Rawlins 1982G, Rawlins 1982C, Rawlins 1985G.)
K11 For the four above-cited SE Asia cities with klima-afflicted latitudes, our tentative identifications follow. Barely-inland Aspithra (D354, L: 16°1/4) = Thailand Gulf's Chanthaburi (real L: 12°.7). more deeply inland Thinai (D355, L: 13°) = Cambodia's Phnom Penh (real L: 11°.6). Kattigara (D356, L: 8°1/2) = Saigon (real L: 10°.8). Zabai (D348, L: 4°3/4) = Singapore (real L: 1°.3). The *GD*'s failure to notice prominent Hainan Island (which nearly blocks off the east side of the broad Tonkin Gulf) suggests that the report Marinos used did not extend beyond Saigon (which is in fact the farthest point of Alexandros' narrative), so Alexandros & thus the *GD* never reached Hanoi or Hong Kong.

[45] Would linguistic problems (in the babel of antiquity) have contributed to these errors? (Marinos likely wrote in Greek; otherwise, Ptolemy could not have used him for a whole book.) For Ptolemy, it probably wouldn't have been the 1st time. He appears to have sloppily misordered (*GD* 1.4.2) simple, well-known data regarding the famous lunar eclipse that occurred shortly before the Battle of Arbela (D261 [modern Irbil, lately a north Iraq hot-spot]) also seen at Carthage (D131), by (www.dioi.org/cot.htm#xptx) screwing-up Latin text of (or like) Pliny's accurate description of that −330/9/20 event, thereby attaching Arbela's eclipse-time to Carthage! Despite lunar eclipse after lunar eclipse occurring in Ptolemy's lifetime (three recorded at Alexandria in under 3^{y} at *Almajest* 4.6: 133-136 AD), this antique record was his sole example (!) of how to determine longitude astronomically. (See fn 25.) Further suggestion of patch-workery (also §L1): the Ptolemy account of these eclipses is in gross disagreement with not just the real sky but *just as grossly with his own luni-solar tables*. See similar situations for Polaris at fn 31 and for Venus at Rawlins 2002V §B3 (p.74). And his solar fakes also show the same propensity to swift-simple, not-even-tabular fraud and plagiarism. (Anyone researching Ptolemy should keep ever in mind that he was shamelessly capable of every brand of deceit. See, e.g., fn 8; also Thurston 1998A ‡1 ⊙2 [p.14].) This eclipse was so famous that one would suppose it was widely-written-of. Thus, it is doubly weird that Ptolemy could make such an error. The suggestion here is that, as an astrologer for a Serapic temple, he was isolated from real scientists. (As perhaps Hipparchos had also been: §B1.)

L Brief Comments & Hypotheses on Several Subjects

L1 Parts of the *GD* show familiarity with the Euphrates River by name. (E.g., *GD* 1.12.5, 5.20.1-3&6.) So: why does *GD* 5.20.6 refer to Babylon as merely being "on the river that goes through Babylonia"? This appears to be just an unconsidered quick-info-transplant from an uncited source — and yet another (see §D3, etc) hint of patch-workery.
L2 B&J p.44 notes that from *GD* 5.13 on, the most trustworthy ms (X) bears no coordinate data. Since the dataless lands were acquired late (after 100 BC) if at all by the Roman Empire, one might wonder if this oddity reflects dependence of the *GD*'s data (up to that point) upon early Greco-Roman lists, maps, or globes. Perhaps of Hipparchos' epoch.
L3 Marinos' *ekumene* was overbroad: a 225°-wide known-world, 5/8 of a wrap. This was justly revised at *GD* 1.12-14 to a smaller and much more accurate half-wrap breadth of 180° (see fn 48 or *GD* 1.14.10), though B&J n.53 (p.76) rightly note the over-roundness here: Ptolemy aimed to get 180° — "by hook or by crook".
Had Marinos-Ptolemy not implicitly trusted (‡1 §J4; Rawlins 1985G n.14) E-W stade-measures over eclipse-measures of longitude (contra priority promo-announced at *GD* 1.4) and thus altered all degree-longitudes by a constant Earth-size-shift factor (fnn 13&25; Rawlins 1985G p.264) when switching from 700 stades/degree (§L6) to 500 stades/degree, then the known-world's *GD* breadth in degrees would have been quite close to the truth — as was Ptolemy's breadth in distance (error merely ordmag 10% high): 90000 stades = 9000 nmi from BlestIsles-W.Europe to Java-E.China-Vietnam.
L4 Thus, strangely (since latitudes were much easier for the ancients to measure accurately: §D6), the Ptolemy *ekumene* (Fig.1) *longitudinal stades-distance-across is not less trustworthy than his latitudinal stades-distance-across*.
L5 We met a similar surprise earlier in finding (§D6 [2]) original longitude error-noise not worse than that in latitude. The upshot of both findings is an important broad insight: the merits of the *GD* are more geographical than astrographical.
L6 Some scholars aver that an ambiguous discussion at Strabo 2.1.34-35 shows that Hipparchos knew Babylon's true latitude, 32°1/2. But the argument is vitiated by the high sensitivity of its key triangles' north-south sides, to slight uncertainties of ordmag 100 stades in other sides. Confirmatorily lethal: Strabo's very next paragraph (*ibid* 2.1.36) unambiguously, unsensitively reports that Hipparchos placed Babylon over 2500 stades north of Pelusium (D150), which was well-known (in reality [31°01′N] & at *GD* 4.5.11 [31°1/4]) to be near the same 31° parallel as Alexandria (*GD* 4.5.9). (Opposite sides of the Nile Delta: Alexandria-Canopus on the west, Pelusium on the east. Contiguous entries in *GD* 8.15: items 10&11 = D149&150, respectively.) At Hipparchos' 700/1° scale (Strabo 2.5.34), this puts Babylon (D256) rather north of 31°1/4 + 2500 stades/(700 stades/1°) = 34°5/6-plus — i.e., at 35°N, just the grossly erroneous value we find at *GD* 5.20.6 and (effectively) at *GD* 8.20.27 (fn 16) and on all other extant ancient *Greek* Important-City lists.[46] More germane to the present investigation: this finding leaves still-uncontradicted our proposal (Rawlins 1985G p.261) that Hipparchos was (fn 10) the ultimate source of the corrupt state of the *GD*'s network's key latitudes.[47]

[46] A consideration which alone could serve to gut the entire long-orthodox Neugebauer-group fantasy (§D4) that high or even low Greek math-astronomy was derived from Babylon. Note that the same Strabo passage shows that Eratosthenes' latitude for Babylon was as erroneous as Hipparchos' but in the other direction. I.e., the entire Greek tradition had no accurate idea of where Babylon was, despite by-then long-standing contacts that had transmitted, e.g., invaluable Babylonian eclipse records. (Dicks 1960 p.134 notes that Babylon had no interest in geographical latitude, not even its own.)
[47] It has been remarked that the Strabo 2.5.34 intro to his discussion of Hipparchos' klimata appears to state that Hipparchos was computing celestial phenomena every 700 stades (i.e., every degree) north of the Equator. But since the lengthy klimata data immediately following are instead almost entirely spaced at quarter-hour and half-hour intervals, DR presumes that the original (of the material Strabo was digesting) said that Hipparchos was providing latitudes (for each klima) in stades according to a *scale* of 700 stades/degree, a key attestation that Hipparchos had adopted Eratosthenes' scale.

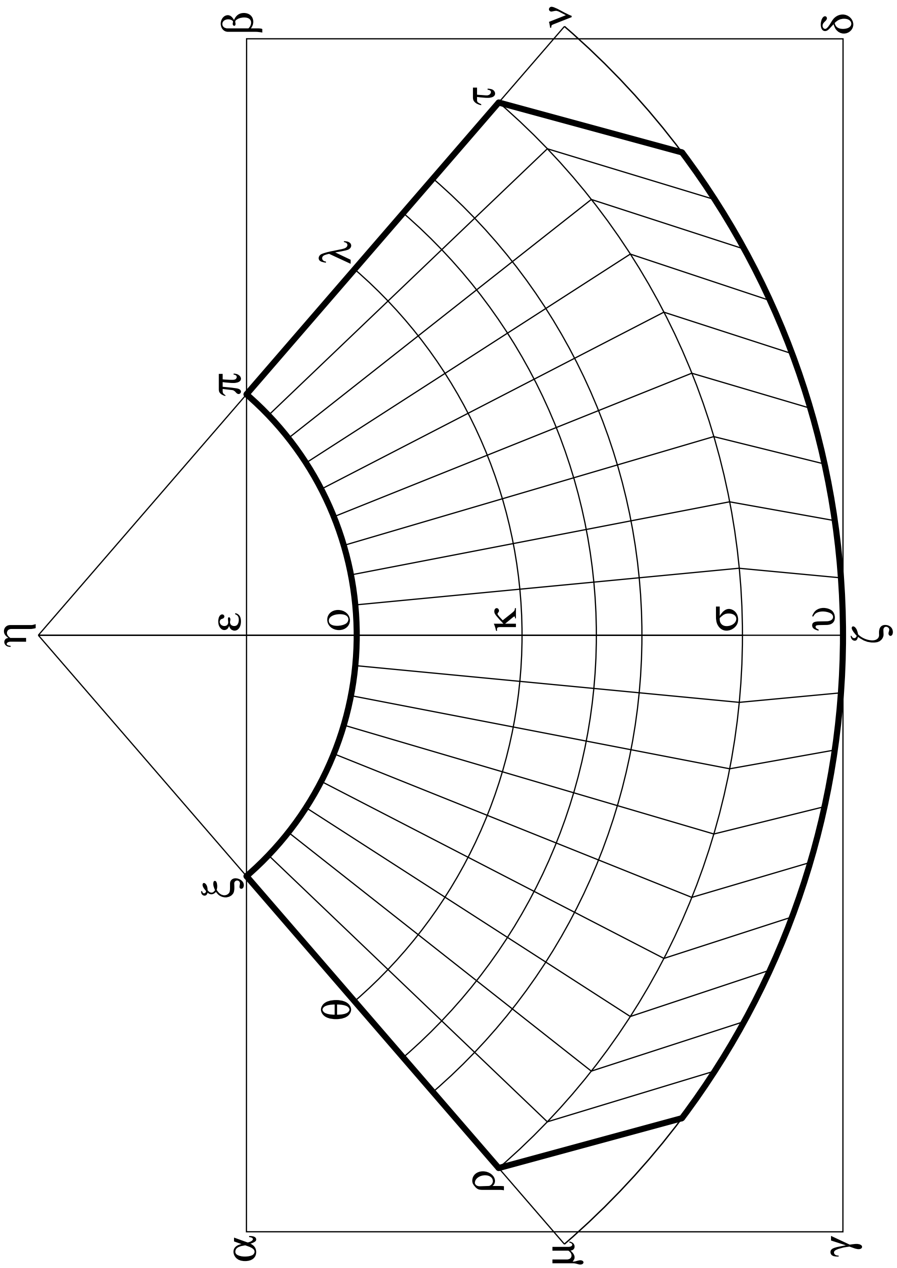

Figure 1: Ptolemy's 1st projection. *Ekumene* demarcated by dark bound. Proceeding south, we successively encounter arcs representing the *ekumene* portions of six latitudinal circles: Thule $= \xi$-o-π, Rhodos $= \theta$-κ-λ, N.Tropic, Meroë, Equator $= \rho$-σ-τ, anti-Meroë $= \mu$-ζ-ν.

M Ptolemy's 1st Planar World-Map Projection

From Where-in-the-World Arrived That 34-Unit Vertical Strut from Its Top (ε) to Its "North Pole" (η)? Ancient Averaging. And Weights?

M1 In *GD* 1.24, Ptolemy twice attempts to design a planar portrayal of a broad spherical geographical segment, representing the known world — the *ekumene* — covering 180° of longitude from the Blest Isles (0° longitude) to easternmost China-Vietnam (180°E. longitude)[48] and 79°5/12 (*GD* 1.10.1) of latitude from Thule [Shetlands (Mainland)] (63°N. latitude) to anti-Meroë (16°5/12 S. latitude, a klima as far south of the Equator as Meroë is north of the Equator). It is the 1st of his two projections (*GD* 1.24.1-9) which will concern us, since it involves a hitherto-unsolved mystery. This projection (page opposite: Figure 1) is a fan, opened slightly more than a right angle: c.98° (§N11). Thus, all north-latitude *ekumene* semi-circles are represented by 98° arcs. (Versus fn 51.) The fan is fairly neatly placed within a rectangle about twice (fn 55) as wide as high, as we see from Fig.1, where the four corners of the rectangle are (clockwise from upper left) points α, β, δ, γ.

M2 For the 1st Projection's conversion of the spherical-segment *ekumene* to planarity, the degree-distance $T = 63°$ from Equator to Thule is made (§M4) into $T = 63$ linear units; likewise for the $S = 16°5/12$ from Equator to anti-Meroë, etc. In Fig.1, representations of several latitude-semi-circles are depicted as Ptolemy's source intended (fn 54):
the Thule semi-circle (latitude 63°N) $= \xi$-o-π;
the Rhodos (§M6) semi-circle (latitude 36°N) $= \theta$-κ-λ;
the semiEquator (latitude 0°) $= \rho$-σ-τ;
the anti-Meroë semi-circle (latitude 16°5/12 S) $= \mu$-ζ-ν.
(Repeating §M1: though each arc in Fig.1 is only c.98°, it represents 180° of longitude in the Ptolemy world-projection.)

M3 Beyond the Equator, instead of continuing to extend the radiating meridians of his fan-projection, Ptolemy decides to bend all meridians inward — resulting in the oddly-shaped, dark-bounded *ekumene* of Fig.1. This kink-step enables Ptolemy to force (*GD* 1.24.7) the length of the anti-Meroë parallel (south of the Equator: latitude $-16°5/12$) to be exactly[49] as long as its northern equivalent, the Meroë parallel (latitude $+16°5/12$).

M4 Ptolemy's angular↔linear duality here is effected by two rough expedients:
[a] Defining the fan's units by forcing the distance T from Equator to Thule circle — 63 *degrees of latitude* — to be 63 *units of space*.
($T = 63$ is henceforth both a distance and an angle-in-degrees.)
[b] Making the distance H, from the Thule circle to the fan's pseudo-N.Pole (point η in Fig.1) proportional to cos 63° — i.e., equal to cos 63° in units of R, the fan's radius from "N.Pole" (point η) to Equator. Simply put:

$$\frac{H}{R} = \cos\ 63° \tag{4}$$

These conditions produce $T = R - H = R - R\cos T = R(1 - \cos T)$. Thus:

$$R = \frac{T}{1-\cos T} = \frac{63}{1-\cos 63°} \doteq 115.38\ldots \approx 115 \tag{5}$$

(The rounding is Ptolemy's.) Which produces the radius H of the Thule latitude-circle (centered at the pseudo-N.Pole η):

$$H = R - T = 115 - 63 = 52 \tag{6}$$

[48] Ptolemy rightly scaled-down (§L3) Marinos' eastern limit from c.225° (15^{h} = 5/8 of circle) to 180° (12^{h} = 1/2 of circle); southern limit, from c.24° (Tropic of Capricorn) to 16°5/12 (anti-Meroë).

[49] This length-fidelity (perfectly reflected in our Fig.1 — and creating the absolute magnitude in eq.8) renders all other southern parallels of the *GD ekumene* virtually equivalent (in length, though not radius) to their northern counterparts.

Letting $S =$ the south latitude of anti-Meroë, Ptolemy further defines

$$E = R + S = 115 + 16\ 5/12 = 131\ 5/12 \tag{7}$$

This establishes all the fan's dimensions.[50] We next turn to the more puzzling question of how wide-open the fan will be.

M5 The openness of the fan is immediately determined when Ptolemy states (*GD* 1.24.2) that he will choose a vertical strut $Y = 34$ units, extending from ϵ (the top of the rectangle bounding the fan) to the pseudo-N.Pole η, which is the fan's radiating center. And then — a very strange step appears.

M6 Since Ptolemy follows Hipparchos and (*GD* 1.20.5) Marinos in taking the Rhodos latitude (36°) or klima ($14^{h}1/2$) as canonical for the mid-*ekumene*, he chooses (*GD* 1.24.3) the Rhodos parallel at latitude 36°N as the one along which he will (allegedly) adjust longitudinal distances precisely, just so that this parallel's curved length (***west→east*** arc) has the correct proportion (4:5 $\approx \cos 36°$: *GD* 1.20.5 & 24.3) to the fan's already-determined ***north→south*** radial distances (§M4).

M7 That step is odd because, when he earlier (§M5) established $Y = 34$ units, this rigidly fixed the fan's openness, and thus the proportion along the Rhodos parallel — i.e., ***there is no fan-openness flexibility left***, once Y is set at 34 units.

M8 Well, you may suppose: Ptolemy must have chosen $Y = 34$ with this very point in mind — this of course has to be the precise value for Y which will ensure proper Rhodos-parallel proportionality. But, no. He didn't, and it isn't. We can tell so by just doing the math.

M9 If we let L be the latitude of Rhodos or any other place, the following equation finds that value of Y which will guarantee the desired proportionality at the given L's parallel:

$$Y = H \cos \frac{16200 \cos L}{\pi(R - |L|)} \tag{8}$$

(L's sign-insensitivity in this equation is due to Ptolemy's kink-step: §M3.)

M10 But the truth swiftly reveals itself when we substitute Rhodos' L (36°) into this equation: we get $Y \doteq 31$ units[51] (nearly 32 without Ptolemy's eq.5 rounding) — not 34 units. But $Y = 31$ corresponds to fan-spread 106° (not the 98° of §M1), since

$$F = \text{Fan-Spread} = 2 \arccos(Y/H) = 32400 \cos L/[\pi(R - L)] \tag{9}$$

so for $L = 36°$, $F = 32400 \cos 36°/79\pi \doteq 106°$.

[50] A list for ready reference. If we go up the mid-vertical of Fig.1, we find:
o-η is of length $H = 52$ (as is ξ-η);
σ-o is of length $T = 63$ (as is ρ-ξ);
σ-η is of length $R = 115$ (as is ρ-η);
ζ-σ is of length $S = 16\ 5/12$ (as is μ-ρ);
ζ-η is of length $E = 131\ 5/12$ (as is μ-η).
We recall that ϵ-η is of length Y. Note that ζ-ϵ is of length Z (§N3), as are the sides of the 2-1 rectangle: γ-α & δ-β; also equal to Z are: α-ϵ, ϵ-β, γ-ζ, ζ-δ.

[51] This accounts for the non-fitting & unintended aggravation that points ξ & π lie above the top (α-β) of the rectangle in several modern depictions of the situation. (The discrepancy has long been recognized; see, e.g., Wilberg & Grashof 1838-1845 p.78.) The screwup is not by the drafters but by Ptolemy, who did not realize (§M12) that $Y = 34$ units is not for the Rhodos parallel (corresponding via eq.9 to the 106° fan-spread used by the non-fitting diagrams just cited) but was designed as an average fit (§M14) to all *ekumene* parallels L. Note that for $L = 0°$ (Equator) or 63° (Thule), fan-spread F would be 90° by eq.9 ($Y \doteq 37$ by eq.8). The average of 106° & 90° is 98°, which fits $Y = 34$ (the average of 31&37: §M13).

M11 Two obvious questions now arise:
[a] Why didn't Ptolemy know the origin of $Y = 34$?
[b] What, then, is the true origin of his choice (§M5) of $Y = 34$?

M12 The answers are:
[a] Because as usual Ptolemy plagiarized (fn 45) math he didn't understand the origin of.
[b] We get a clue to the actual origin when we substitute other latitudes L into the foregoing equation: we find that Y reaches a minimum very near Rhodos — and is considerably higher near the Tropics or the Arctic. The Y for Thule ($L = T = 63°$) is the same as for the Equator ($L = 0°$), since substituting either of these two L-values into the general equation (eq.8) reduces it to:

$$Y = H \cos[16200/(\pi R)] \doteq 37 \tag{10}$$

M13 Noting that the mean of our last two results is (31 + 37)/2 = 34, we may now commence our solution-reconstruction (§M14) of the insights of the actual designer of the fan-map Ptolemy swiped.

M14 The 1st thing the true originator presumably noticed was that, in order to arrive at a meaningful averaged Y-value, it made no sense to use (as Ptolemy claims to: §M6) a mid-*ekumene* parallel (Rhodos: §A2) — since the solutions for Y did not increase linearly or even monotonically in the latitude-range under consideration. Instead, if we go south: the values for the Y that are apt (i.e., produce correct longitudinal proportion: §M6) start at $Y \approx 37$ for Thule, dip to a minimum of about 31 almost exactly at Rhodos, and then double right back up to 37 for the Equator. So the obvious crude solution was to average 31 and 37, yielding 34.

M15 Better: a mean Y for all *ekumene* latitudes also = 34. With or without eq.5 rounding. If we go on to a truly proper solution and use weightings by area (since tropical latitude-intervals contain more area than non-tropical), we still find that mean $Y \doteq 34$. (Again: with or without rounding.)[52] I.e., the result is a firm one, encouraging the hypothesis that we have here successfully induced the true origin of Ptolemy's strut-length: $Y = 34$, an origin of which he was (§M14) evidently unaware. Moreover, the result is consistent with (though it does not prove) ancient mathematical mappers' competent attention to proportional preservation of areas (even if but imperfectly), a consideration for which no evidence has previously been in hand.[53]

[52] If we eliminate the southern latitudes, we yet find $Y \doteq 34$, except for the non-weighted average with rounding, where $Y \doteq 33\ 1/3$ instead.

[53] See, e.g., B&J p.38.

N Impossible Dream: Symmetric-Rectangle-Bounded *Ekumene* Fan

N1 There is an attractive alternate theory of the origin of $Y = 34$: the suggestion (§N6) that the 2-1 rectangle (§M1) bounding Ptolemy's *ekumene* influenced the openness of the fan (Fig.1): "The length of 34 units . . . seems to have been empirically chosen to accommodate the largest map in the given [2-1] rectangle without truncation of the corners [ρ&τ]." (B&J p.86 n.68.) We will now explore this theory, which takes us in a very different (but equally fascinating) direction from the previous section, §M.

N2 Ptolemy says his projection nearly (§N6) fits neatly into a 2-1 landscape-oriented rectangle: see Fig.1.

Since the fan-projection is symmetric about the mid-vertical (ϵ-ζ), the rectangular condition can be equated with fitting the left or right half of the *ekumene* into a split-off square. (Splitting the rectangle into halves, we will use the left square during the following analysis). Fitting the half-*ekumene* into a square will henceforth be referred to here as: the split-constraint or just The Split.

N3 Having arranged that each half of Fig.1's rectangular bound is a perfect square[54] of side Z (fn 50), we take half of the horizontal straight line between ρ & τ and call it B. Note: if The Split-condition is met, then B should equal half of the rectangle's top border (α-β). But it obviously does not, for reasons to be seen: §N7.

Our aim is to (as closely as possible: §N21) meet the Split-condition, which can be expressed simply as:

$$Z = B \tag{11}$$

N4 We then search for the value of Y which ensures that Ptolemy's *ekumene*-fan will satisfy The Split. The equation is (using the inputs already defined):

$$Y = \frac{E + (R/H)\sqrt{R^2 + H^2 - E^2}}{(R/H)^2 + 1} \tag{12}$$

N5 Ptolemy starts (§M5) by assuming that the meridian-radiating center of the fan (the pseudo-N.pole: point η in Fig.1) is $Y = 34$ units (*GD* 1.24.2) above the top of the rectangle that he proposes to contain his *ekumene* projection. (To repeat, we are saying that in Fig.1 the distance from η to $\epsilon = 34$ units.)

[54] Notice to those checking-via-ruler the rectangle of the Nobbe 1843-5 p.47 illustration of Ptolemy's 1st projection (reproduced at www.dioi.org/gad.htm#nobm, with the *ekumene* bounded in green): its halves are accidentally drawn not quite square, though very close. Also, many modern diagrams have failed along the anti-Meroë parallel. Creditable exceptions are those of Wilberg & Grashof 1838-1845 Fig.8 [p.96c2], B&J p.36, S&G 1:122-123, 2:748-749. The present illustration (our Fig.1) is perhaps the 1st rigorously accurate illustration of the anonymous ancient cartographer's full intended map-rectangle concept. (Where compatible choice of $Y = 34$ and fan-spread 98° allows meaned area-proportionality while ξ & π lie on line α-β: §§M14-M15.) Fig.1 is designed in pure Postscript (as was ‡1's Fig.1).

Figure 2: Left: Trajan aureus, Vienna Kunsthistorisches Museum.
Right: Antoninus Pius aureus (minted during Ptolemy's lifetime), DIO Collection.

N6 Ptolemy admits (*GD* 1.24.1) that his 2-1 rectangle isn't quite exact (§N2): the rectangle's width is only nearly [εγγιστα] two-fold[55] its height. But: why only *approximately* twice as wide? Why not adjust Y such as to make the ratio exact? — since the priority here is suspected (§N10) to be The Split: a symmetric 2-1 rectangularly-bounded fan, for reasons either aesthetic (symmetry) or practical. (A portable map that is conveniently square after one protective fold?)

N7 The hitherto-unrecognized answer is that, given Ptolemy's specs for the projection's essentials ($T = 63$ and $S = 16$ 5/12), the 2-1 rectangle-bound condition (§N2) for the fan *cannot* be met. Mathematically speaking: for the cited Ptolemaic values of T&S, the only solutions for Y that can result from eq.12 are not real. This surprise finding will now lead us onto unexpected paths.

N8 I.e., the *ekumene*-fan as Ptolemy ultimately constructed it cannot fit into a 2-1 rectangle, no matter how widely or narrowly the Thule-bounded *ekumene*-fan is fanned out, so long as $S = 16$ 5/12. Try it for yourself. As S is increased, we find (from eq.12) that the maximum *ekumene* southern-limit S that allows $Y = 34$ and satisfies the symmetry of The Split is about $S = 6$.

[55] For the 2nd projection, there is no such qualifier (*GD* 1.24.17), even though there might as well have been — since for both projections the 2-1 rectangular bound is slightly wider than necessary. But for the 2nd projection, there is no appearance that an adjustment might render the *ekumene* exactly twice as wide as high. Its definition is quite different from the 1st, and results in a fan opened only about 61° (vs the 1st projection's 98°: §M1), with a pseudo-north-pole c.180 units above the Equator (vs the 1st's 115 units: eq.5).

N9 When the Fan Fit The Split
So the 2-1 theory has exploded in disaster: ***no choice*** of Y will satisfy Ptolemy's $S = 16\ 5/12$ and allow the fan-projection to fit the symmetric 2-1 rectangle. Indeed, the maximum S that will permit satisfaction of The Split (for *any* choice of Y) is found via the equation:

$$S_{\max} = T\frac{\sqrt{1+\cos^2 T}-1}{1-\cos T} \tag{13}$$

which for $T = 63$ (fan's north bound at Thule) yields $S_{\max} \doteq 11\ 1/3$.
N10 Things get even more intriguing if we assume (as some non-adamantly have: §N1) that $Y = 34$ was an empirical adjustment to The Split (the 2-1 rectangle condition: eq.11). We can test the theory by finding (§N21) the value of Y which *best* satisfies The Split. Answer: $Y \doteq 21$ — a value not even close to 34.
$Y \doteq 21$ satisfies The Split to within 5%: that is, $Z/B < 1.05$. But Ptolemy's $Y = 34$ cannot satisfy the 2-1 rectangle condition to better than 11%, i.e., $Z/B > 1.11$.
N11 However, let's keep exploring the theory that the 34 was chosen for The Split. (If Ptolemy was seeking any other type of symmetry, the obvious and nearby alternative would have been to make the fan-spread angle [ξ-η-π] equal to exactly 90° — not the seemingly pointless and peculiar [roughly 98°] spread we actually find: see fn 55 or Fig.1.) A 90° spread would make all longitude slices neatly 1/2 their real angular thickness.[56]
N12 Our math for an attempted Split-inspired reconstruction of the process behind $Y = 34$ will, up to a point, be the same as Ptolemy's — only simpler.
We round $R = 115.4$ to 115 (just as in eq.5 or *GD* 1.24.4) but then use a simple fan — i.e., *without*[57] Ptolemy's equatorial kink.
N13 Once we dispense with Ptolemy's clever kinky-projection scheme, we may easily find the S that produces $Y = 34$:

$$S = H^2\frac{\sqrt{1-(Y/H)^2}+1}{Y} - R \tag{14}$$

Substituting Ptolemy's values, $Y = 34$ (§M5 or *GD* 1.24.2) and $R = 115$ & $H = 52$ (eqs.5&6 or *GD* 1.24.4), we find:

$$S = 24.7 \tag{15}$$

A provocative result, since that is virtually right on the southern tropic (24°).
N14 However, as noted: $S = 24°$ is Marinos' value — according to Ptolemy himself (*GD* 1.7.1-2 & 9.6). Thus, we have found a potentially fruitful alterate-possibility for the source of the problematic $Y = 34$: a non-kinked fan-*ekumene*, with Marinos' latitudinal breadth of the known world, though Marinos is said (§N17) not to have used a fan-projection.
N15 Having thus found an S that could have led to *GD* 1.24.2's $Y = 34$, we may simply invert the process to follow in the hypothetical math-footsteps of the hypothetical ancient scholar who hypothetically deduced said Y. If we also dispense with intermediate variables, to show dependence purely upon the *ekumene*'s northern & southern limits (T & S, resp), the inverse of the previous equation gives us what we need:

$$Y = 2\frac{S+T/(1-\cos T)}{1+[\frac{1+S[1-\cos T]/T}{\cos T}]^2} \tag{16}$$

[56] The corresponding $Y = H/\sqrt{2} = 37$, obviously not Ptolemy's choice.
[57] That is, we do not immediately follow Ptolemy in suddenly bending all meridians inward after southward-crossing the Equator. That step eliminated (for Ptolemy: §M3) the extreme-outside points μ&ν. But we instead (§N13) keep it simple by letting lines η-ρ and η-τ in Fig.1 extend right straight out to μ and ν, respectively — and leave them be (i.e., no kink) — just as these two points are shown (slightly outside the 2-1 rectangle in Fig.1).

N16 Substituting (into the above equation) $T = 63$ (Thule) and $S = 24$ (southern tropic), the hypothetical ancient computer (of the Y that has come through to us) found

$$Y = 34 \tag{17}$$

(Barely less than 34 1/2 without Ptolemy's rounding [eq.5] of R to 115; or about 34 1/8, if that rounding is adopted.)
N17 But *GD* 1.24.4-5 denies that Marinos used the fan-scheme. If this report is to be trusted and if the Split-hypothesis is valid, then: at an early stage in the history of the development of the fan-approach, a scholar (working sometime between Marinos and the final version of *GD* 1.24) tried out a simple (no-kink) fan using Marinos' southern limit ($S = 24$).
N18 However, had he adopted $S = 16\ 5/12$ without[58] kinking his projection, he could easily have found (using eq.16) that for this case the appropriate $Y = 36$, which would in fact effect a perfect-Split circumscription of the (non-kinked) fan by the preferred symmetric 2-1 rectangle.
N19 So, if the Split-theory is valid, Y must have been frozen at 34 before any steps were taken to abandon either
[1] assumption of $S = 24$ (Marinos: fn 48), or
[2] the simple non-kinked fan-scheme.
N20 If Ptolemy adopted $Y = 16\ 5/12$ before kinking his fan, then he could easily have arrived at $Y = 36$ by the same means that 34 was arrived at. (As already shown above: §N18.) Since 36 is not what survived, it would follow that Ptolemy instead kinked his fan before bringing his southern boundary from $Y = 24$ up to 16 5/12.
N21 However, either way, he at some point would be faced with the problem of finding out what Y would most closely effect The Split if the kinked version of his *ekumene* projection were adopted. For this search, he had best be aware that the eq.11 Split-ratio (Z/B) is extremal when (on Fig.1) a line drawn from ζ to ξ is perpendicular to the radial line η-μ. Thus, the best fit to The Split occurs when:

$$Y = \frac{H^2}{E} \tag{18}$$

For $S = 16\ 5/12$, this equation yields, as noted previously (§N10), $Y \doteq 21$, which corresponds (eq.9) to fan-spread 132°. For $S = 24$, $Y \doteq 20$ — corresponding to fan-spread $F = 135°$.
N22 Even if the foregoing Split-theory isn't historical (and the prior §M development — much-preferred by DR — obviously assumes that it is not), the mathematical development of it here has been thoroughly enjoyable.

[58] B&J p.87 n.69 point out the oddity that the *GD* 1.24 discussion refers only to pt.υ not pt.ζ, though they are identical. (Both are shown in Fig.1.) This would appear to indicate that, at some moment during drafting, before arrival at the final version of the first projection, pts.υ&ζ were separate. This could have happened during experiments ere the kink (when the 2-1 rectangle touched pts.μ&ν) or ones where the projection's southern parallel was the Equator (§I2) or the Tropic of Capricorn (fn 48).

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Aubrey Diller is generally acknowledged to have been the 20th century's leading authority on ancient geographical mss. We will be ever grateful that he in 1984 bequeathed to DR his final work: 1st establishment of the text of crucial Book 8 of Ptolemy's *Geography*.

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