Şerban George Paul Drugaş

– Mapping Ptolemaic Dacia –



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Mapping Ptolemaic Dacia

By

Şerban George Paul Drugaş

Libri Imprint

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Mapping Ptolemaic Dacia
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ISBN 978-615-81353-6-8

Libri Imprint
Responsible publisher: Teodora C. Artimon
http://trivent-publishing.eu

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First published in 2020 by Trivent Publishing

Trivent Publishing
1119 Budapest, Etele ut 59–61
Hungary

For more information, visit our website: http://trivent-publishing.eu

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Introduction

The purpose of this volume is to contribute to the cartographic calculations for the *poleis* which appear in Ptolemy regarding Dacia, in the effort to reach a better representation of Dacia, in general, and of the Roman province of Dacia, in particular.[1] The calculations done by others and the studies that I am aware of will be included in the volume.

As a member of the Balkan History Association, and author of several articles in its *Hiperboreea Journal*, I was honoured to receive the support to pursue this subject from the Association. The main purpose of this study is not to argue on any historical or archaeological grounds, but rather to estimate positions and do the calculations and only afterwards find possible archaeological matches.

Some of the *poleis* will be taken as references, since they are already clearly established. This is the case of Porolissum, for instance, for the northern array of the Ptolemaic *poleis* in Dacia.

I consider this study preliminary because the Ptolemaic values need much further attention, more than I can propose here. This book represents a necessary starting point for possible future debates, which will strengthen or, on the contrary, will question some paths opened here.

Mapping a region of the Ptolemaic map in modern coordinates is a difficult task. The local patterns can suffer secondary alterations, as already acknowledged by other studies.[2] The map of Ptolemy gathers

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[1] Csaba Szabó, "The Map of Roman Dacia in the Recent Studies," *Journal of Ancient History and Archeology* 1 (2014): 44-51.

[2] A. Stückelberger et al., *Claudius Ptolemaeus' Handbook of Geography* (Basel: Schwabe Verlag, 2009). Evangelos Livieratos, Angeliki Tsorlini, and Chryssoula Boutoura, "Coordinate analysis of Ptolemy's Geographia Europe Tabula X with respect to geographic graticule and point positioning in a Ptolemaic late 15th century map," *e-Perimetron*, Vol. 2, No. 2, Spring, 2007, 80-91, accessed May 7, 2018, https://www.researchgate.net/publication/266242744_Coordinate_analysis_of_Ptolemy's_Geographia_Europe_Tabula_X_with_respect_to_geographic_graticule_and_point_positioning_in_a_Ptolemaic_late_15_th_century_map. C.

regional "patches,"[3] so we need to approximate a suitable framework for Dacia, and find reasonable solutions. This is what I am trying to do in this study, for Dacia, in conjunction with some relevant neighbouring areas, such as the southern bank of the Danube, and some locations east of Dacia proper. This study will not reject, but invite further discussions. The strongest results in the study include, however, some remarkable matches with the archaological evidences.

I thank Mihai Dragnea, the Balkan History Association, and the editors of the *Hiperboreea Journal* for their guidings and support, which made possible the publication of this book.

The Author

Marx, "On the precision of Ptolemy's geographic coordinates in his Geographike Hyphegesis," *History of Geo- and Space Sciences* 2(1) Copernicus Publications (2011): 29-37, http://www.hist-geo-space-sci.net/2/29/2011/hgss-2-29-2011.html. Marx, "Rectification of the ancient geographic coordinates in Ptolemy's Geographike Hyphegesis," *History of Geo- and Space Sciences* 3(1) Copernicus Publications (2012): 99-112, http://www.hist-geo-space-sci.net/3/99/2012/hgss-3-99-2012.pdf. Sorin Forţiu, "The Translation of the Ptolemaic Coordinates into Modern Coordinates. Case Study: Zurobara," presented at the Symposium *Culture and Civilisation in the Historical Banat*, 21st ed., Section "Arheologie şi istorie veche," 26.05.2011. Forţiu, "Geodetic-Statistical Analysis, just a classical GIGO?!," *ArheoVest*, no. 1, *In Memoriam Liviu Măruia, Interdisciplinaritate în Arheologie şi Istorie*, Timişoara, 7 december, 2013, Vol. II, 617-643, http://arheovest.com/simpozion/arheovest1/38_617_643.pdf. I. Tupikova and K. Geus, *The Circumference of the Earth and Ptolemy's World Map* (Dresden & Berlin: Max Planck Institute for the History of Science, 2013).

[3] J. Lennart Berggren and Alexander Jones, *Ptolemy's Geography: An Annotated Translation of the Theoretical Chapters* (Princeton and Oxford: Princeton University Press, 2000). R. Darcy and W. Flynn, "Ptolemy's map of Ireland: a modern decoding," *Irish Geography* 41(1) (2008): 49-69, doi: 10.1080/00750770801909375, https://www.researchgate.net/publication/233191569_Ptolemy's_map_of_Ireland_A_modern_decoding. Abshire Corey et al., "Ptolemy's Britain and Ireland: A New Digital Reconstruction," in *Proceedings of the 2017 International Cartographic Conference*, Washington D.C., 2017, accessed 07.03.2019, 2:42 p.m., http://pervokarta.ru/wash.pdf. C. Marx and F. Neitzel. "Deformation analysis and regional adaptation of a historical geodata inventory," in *Entwicklerforum Geoinformationstechnik*, Junge Wissenschaftler forschen (Aachen: Shaker Verlag, 2007), 243-255.

Abreviations

Counties in Romania

AB	Alba
AR	Arad
AG	Argeş
BC	Bacău
BH	Bihor
BN	Bistriţa-Năsăud
BV	Braşov
BZ	Buzău
CS	Caraş-Severin
CJ	Cluj
CV	Covasna
DB	Dâmboviţa
DJ	Dolj
GR	Giurgiu
GJ	Gorj
HR	Harghita
HD	Hunedoara
IL	Ialomiţa
MH	Mehedinţi
NT	Neamţ
OT	Olt
PH	Prahova
SJ	Sălaj
SV	Suceava
TR	Teleorman
TM	Timiş
VL	Vâlcea
VR	Vrancea
VS	Vaslui

Countries

BG	Bulgaria
HU	Hungary
RO	Romania
SRB	Serbia

CHAPTER ONE

General Ptolemaic Principles

1. Notes on the editions of Ptolemy

Ptolemy's *Geography* (Γεωγραφικὴ ὑφήγησις) was written after 150 AD. During the Middle Ages, it was cited mostly by Arab scholars. Around 1295 AD, Maximus Planudes discovered a manuscript of *Geography*, which was translated into Latin by Jacopo Angeli in 1406. There are two main recensions:

> The manuscripts are presumably based on two recensions, the so called Ω and Ξ recension (…). The Ξ recension is bequeathed by only one manuscript (…) which ends in Book V, Chapter 13.[1]

Stückelberger and his collaborators[2] offer information from the Ξ recension, too, which gives valuable alternative coordinates for some places, presumably closer to the original. Manuscript X[3] (the only source

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[1] Marx,"On the precision…," 31. Citing: A. Stückelberger et al., *Ptolemy. The Handbook of Geofgraphy* (Basel: Schwabe Verlag, 2006), 27. Cf. Marx, "Rectification…". Dalché, 2009.

[2] Klaudios Ptolemaios, "Geographia," in *Klaudios Ptolemaios Handbuch der Geographie*, 2 vols., ed. Alfred Stückelberger et al. (Basel: Schwabe Verlag, 2006). Stückelberger et al., *Claudius Ptolemaeus' Handbook of Geography*.

[3] Claudius Ptolemaeus, "Geographia," in *Codex Vaticanus Palatinus Graecus* 191 (X), Greek manuscript, Biblioteca Apostolica Vaticana, ca. 1300, ff. 128v-169v. https://digi.vatlib.it/view/MSS_Vat.gr.191, accessed 21.06.2018, 11:04 p.m. Cf. http://www.philosophie.unibe.ch/index_eng.html, last accessed March 09, 2019. Description of Renate Burri, "Übersicht über die griechischen Handschriften der ptolemäischen Geographie," in Stückelberger et al., *Claudius Ptolemaeus' Handbook of Geography* (*Klaudios Ptolemaios Handbuch der Geographie*) (Ergänzungsband, Basel: Schwabe Verlag, 2009), 13: "Konstantinopel, um 1300. Papier ohne Wasserzeichen, 340 x 250 mm, 397 Bl. … f. 128v-169v; Geogr. 1: 1-2 Kolumnen, Geogr. 2-8: 4 Kolumnen. Ptolemaios, Geographie ohne Karten… Einziger reiner Vertreter der Ξ-Recenzion."

of the Ξ recension), as well as U[4] (the main source for the Ω recension) and A[5] are mentioned in the Bibliography of this volume with the on-line reference from Biblioteca Apostolica Vaticana.

An exhaustive account of the sources is discussed by different authors in the works of Stückelberger and his collaborators. This includes Renate Burri's presentation of the Greek manuscripts[6], A. Stückelberger and Florian Mittenhuber's history of the manuscript traditions[7], Florian Mittenhuber's comments on the editions dealing with map plotting,[8] and K. Geus' presentation of the Latin editions.[9] The western culture rediscovered Ptolemy's so called *Geographia* or *Cosmographia* in Latin translation:

> The Latin translation of Jacobus Angelus was also used in the following Latin editions. Even the very first print of Ptolemy's *Geographike Hyphegesis*, published by Angelus Vadius and Barnabas Picardus on November 13, 1475 in Vicenza, used his Latin translation.[10]

The 1475 edition is mentioned in this volume's bibliography with a reference to the online sources. Bibliothèque Nationale de France offers, among many others, a printed edition from 1462, the very first known until today.

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[4] Claudius Ptolemaeus, "Geographia," in *Codex Vaticanus Urbinas Graecus* 82 (U), Greek manuscript, Biblioteca Apostolica Vaticana, ca. 1300, accessed 22.06.2018, 01:47 a.m., https://digi.vatlib.it/view/MSS_Urb.gr.82. Description of Renate Burri, *Übersicht*… in Stückelberger et al., *Claudius Ptolemaeus'*…, 13: "Konstantinopel, um 1300, Pergament, 575 x 418 mm, 111 Bl., 2 Kolumnen. Ptolemaios, Geographie mit Weltkarte in der einfachen Kegelprojektion bach Buch 7 und 26 Länderkarten in Buch 8. Gehörte dem florentinischen Kaufmann und Humanisten Palla Strozzi…, der die Handschrift seinen Söhnen vererbte; später im Besitz des Frederico da Montefeltro, Herzog von Urbino."

[5] Claudius Ptolemaeus, "Geographia," in *Codex Vaticanus Palatinus graecus 388*, Biblioteca Apostolica Vaticana, 14th century, Accessed 22.06.2018, 02:33, https://digi.vatlib.it/view/MSS_Pal.gr.388.

[6] R. Burri, *Übersicht*… in Stückelberger et al., *Claudius Ptolemaeus'*…, 10-21.

[7] *Stemma-Entwurf* in *ibid*., 21-25.

[8] F. Mittenhuber, *Karten und Kartenüberlieferung*, in *ibid*., 34 sqq.

[9] K. Geus, *Lateinischer Ptolemaios*, in *ibid*., 358 sqq.

[10] *Ibid*., 358 (my translation).

Scholars gradually realized the need to search for more sources and critical editions of Ptolemy:

> The value of Jacobus' translation has been estimated very differently. While many praise Jacobus's scholarly and zest for life, Paolo dal Pozzo Toscanelli, Conrad Gesner, and Willibald Pirckheimer voiced harsh criticism. (…) The criticism of Jacobus' translation continued to be included in Ptolemy's editions of 1482 and 1486 (by Nicolaus Germanus), 1507, 1508 (by Marcus Beneventanus and Joannes Cota), 1511 (by Bernardus Sylvanus), 1513 (by Giovanni Pico de la Mirandulla), and of 1522 (by Laurentius Fries). Even before, the editions had *tabulae modernae*, documenting the increase in geographic information of that time. The first edition with parallel Greek and Latin text (edited by Petrus Montanus)[11] appeared in Amsterdam in 1605.

These and other editions are listed in the Bibliography of this study.

The sources mentioned are sufficient to define any major aspect pertaining to the research below. The Bibliography also opens the possibility to enlarge the comparison between the sources, if necessary.

2. Outlines on the Ptolemaic maze and general methodological principles

The estimation of the Ptolemaic *poleis* and other places lead to conclusions which reveal the relative and fragile nature of the Ptolemaic cartographic network, Ptolemy's map showing distortions even in well-known areas, such as Italy and parts of the Mediterranean Sea.[12] This happened, firstly, because Ptolemy based his map on a few places with certain latitude and some local strings of valid distances[13] on the

[11] *Ibid*., 358-359 (my translation).

[12] Berggren and Jones, *Ptolemy's Geography*…, 22. Cf. *CARTOGRAPHY. WEB.AUTH.gr*, last accessed March 9, 2019, http://cartography.web.auth.gr/Livieratos/fil/Ptolemy_Plus.html.

[13] Berggren and Jones, *Ptolemy's Geography*…, 16-17.

longitude (e. g., *Via Militaris*[14], *Via Egnatia*[15] etc.). For the distances in straight line between places, he often approximated, reducing the distances reported by travelers through arbitrary algorithms (e. g., reducing by one-third at one stade).[16] Following the footsteps of other great cartographers, Ptolemy did not have a sufficient and completely reliable database to include into a system which was, theoretically, correct:

> Ptolemy himself would not have claimed that the *Geography* was original in all these respects [in the astronomical principles he used, *my note*]. He tells us that the places and the arrangement in his map were mostly taken over from an earlier cartographer, Marinos of Tyre. Again, Ptolemy comprehended fully the superior value of astronomical observations over reported itineraries for determining geographical locations, but in this he was, on his own admission, anticipated by other geographers, notably Hipparchus three centuries earlier. Even so, he was too far ahead of his time in maintaining this principle to be able to follow it in practice, because he possessed reliable astronomical data for only a handful of places.[17]

The second source for errors is the inaccurate copying of the original information, in several manuscripts. Such errors can be corrected if they are compared to other sources, but even so they can pose difficulty. For instance,

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[14] *TABULA-PEUTINGERIANA.de*, last accessed March 9, 2019, https://www.tabula-peutingeriana.de/sources.html?typ=im_dx. Matthew Larnach, *All roads lead to Constantinople: Exploring the Via Militaris in the medieval Balkans, 600-1204* (Sidney: The Medieval and Early Modern Centre, University of Sydney, 2016). Forţiu, "Geodetic-Statistical Analysis…," 625: *Singidounon–Tibiskos–Danubios–Trikornion–Ouiminakion.*

[15] G. Philip Curti, "The Via Egnatia: Rome's Traverse Of A Multi-Cultural Marchland," *The Geographical Bulletin* 5 (1979): 9-15, https://gammathetaupsilon.org/the-geographical-bulletin/1970s/volume05/article3.pdf.

[16] Berggren and Jones, *Ptolemy's Geography*…, 17.

[17] *Ibid*., 3.

> From the first screening of the point placements, some obvious misprints in point-coordinates were more than evident, like e.g. Thessaloniki, which in both the Germanus and the Müller lists is given with latitude 49° 20' instead of 40° 20'.[18]

The coordinate which could benefit of a reliable determination in the time of Ptolemy was the ***latitude***. Some principles available at that time offered the possibility of a precise calculation, if some facts were known about a certain location. I quote only two of those principles, mentioned by Berggren and Jones:

> (1) "the ratios of an upright stick (*gnōmōn*) to its shadow on the longest and shortest days of the year, as well as in the equinoxes;"
> (2) "the amount by which the longest day of the year exceeds the equinoctial day (…)."[19]

The first of these principles was used by Pytheas of Massalia (ca. 330 BC) in his expedition along the Atlantic coast of Europe.[20]

Ptolemy, following the tradition before him, used the second principle to mark some reference parallels, which were eventually correlated with some very well-known places. Not using parallels with equal degrees to define the *klimata* ("inclinations," i. e., strips between two close parallels, sg. *klima*) is "awkward from a modern perspective."[21] However, Ptolemy and all the cartographers of the ancient tradition used

> "The latitudes corresponding to the regular sequence of increments in daylight," which "are not equally spaced, but become more crowded the further we get from the equator. For this reason Ptolemy uses quarter-hour increments until he reaches the parallel for which the longest day s 15½ hours, and increments of half an hour thereafter until he reaches

[18] Livieratos, Tsorlini, and Boutoura, "Coordinate analysis of Ptolemy's Geographia…," 83.
[19] Berggren and Jones, *Ptolemy's Geography*…, 9.
[20] *Ibid.*
[21] *Ibid.*, 10.

> the parallel that he believes marks the northern limit of the known world, where the longest day is twenty hours."[22]

Posidonius, Marinos, and then Ptolemy defined the major climate zones as: one "torrid" (12° N, 12° S), two "temperate" and two "frigid."[23] The *klimata* were used to define narrow strips with identical climatic features. Determining the parallel of a known location was possible in the time of Ptolemy. However, obtaining valid geo-astronomical data for a certain location was harder as that location was farther from the cartographer's point of observation. Ptolemy was not an exception in this respect, but, as mentioned before, he also had a hard time finding such valid data. Thus, sometimes he resorted to a less scientific method. For instance, he used some approximated climatic resemblances between two locations. Using such a principle to ascertain the latitude of a location points to one of the frailties of the Ptolemaic final product:

> Ptolemy occasionally makes use of the principle that climate (including) the range of plant and animal life and the appearance of the human inhabitants is dependent on latitude to deduce that localities sharing the same climate must be at approximately the same distance from the equator.[24]

Hipparchus was, according to Ptolemy, the only one who transmitted the parallels of some known places.[25] Ptolemy took most of them from Hipparchus. Since many of the reference places for parallels, drawn on intervals guided by the principle of the increment of the equinoctial day, were taken from areas known by Phoenicians and Greeks, they were also not far from Dacia. Some of these values are significant for the Ptolemaic data on Dacia. These points are, with identical values in Hipparchus: the mouth of the river Borysthenēs (16 h, 48°30', error 2½°), the mouth of the river Tanais (15½ h, 45°), Byzantion (equally as Massalia 15¼ h, error 2½° for Byzantion), Hellespont (15h, 40°55'), and Rhodes (14½ h, 36°).[26] The latitude of Rhodes was traditionally used "as the central east-west

[22] *Ibid.*, 9.
[23] *Ibid.*, 13.
[24] *Ibid.*
[25] *Ibid.*, 28.
[26] *Ibid.*, 10, 29.

axis of the known world,"[27] from which Ptolemy takes the 30° angle for the solstice sunrise / sunset (which is ca. 24° at the equator and larger towards the poles).[28] Ptolemy did not use the more accurate value of Hipparchus for Babylon (32°30'N), but rather the Babylonian tradition which gave him 35°N.[29] He did not make his own estimation with the *gnōmōn* for Alexandria, but he followed Hipparchus, with 30°58' instead of 31°13'N.[30]

Ptolemy used *the principle of time* for the ***longitude***, recommending meridians at 5°, at "intervals of a third of an equinoctial hour."[31] Although pointing to a correct principle, calculating the longitude by using this principle leads to an estimation, due to the scarcity of the accurate data:

> The only astronomical method available in antiquity for determining the interval in longitude between two places was to establish the difference in equinoctial hours between noon at the places in question by observing the local times of a lunar eclipse in both places.[32]

Ptolemy used the lunar eclipse that occurred during the battle of Gaugamela near Arbēla, when Alexander the Great defeated Darius III (30 September 331 BC), to calculate a 45°10' longitude between Carthage and Arbēla. This was, most likely, the only such data used by Ptolemy – which was inaccurate, since between Carthage and Arbēla there are ca. 45° (furthermore, a value in stades closer to reality resulted from the smaller equatorial circumference used by Ptolemy).He used the information from itineraries to approximate longitudes. Thus, the errors in longitude were much greater than those in latitude, although, as we saw, many latitudes were gross approximations, as well.[33]

The meridian zero was vaguely described by Ptolemy as passing through the Islands of the Blessed, which are most likely located in the Atlantic Ocean, near the coast of Africa. Because of the name of one of

[27] *Ibid.*, 15.
[28] *Ibid.*
[29] *Ibid.*, 29.
[30] *Ibid.*
[31] *Ibid.*, 11.
[32] *Ibid.*, 29.
[33] *Ibid.*, 29-30. Tupikova and Geus, *The Circumference of the Earth*….

the islands (Canaria), it was assumed that they were the Canary Islands.[34] However, other studies convincingly showed that both Marinos of Tyre and Claudius Ptolemaeus were aware of the islands of Cape Verde and chose them as the location to establish longitude zero, which is the modern longitude of ca. 25° W.[35] While calculating the latitudes was already done accurately in Antiquity by using the length of the shadow of a standard pole (method used by Eratosthenes, 3rd century BC), the longitude only started to be measured in the 18th century.[36] Marinos of Tyre and Ptolemy only knew a few accurate latitudes of the places in their maps, and the accurate distances between the *poleis* mainly within the Roman Empire.

The observation that scale differences are due to "Ptolemy's overestimation of the longitudinal dimension of the Ecumene (180° to the most eastern place in China instead of about 130°)"[37] affects the operation of establishing a universal reference for the longitude. The local grids are only roughly correlated to the entire *oikoumenē*.

Eratosthenes estimated that the equator's circumference would have 250,000 stades (of ca. 185 m), meaning that an equatorial degree would have 700 stades (15% too large).[38] Ptolemy reduced the equator's

[34] A. Tsorlini and E. Livieratos, "A digital approach in eliminating the higher order systematic effects in Ptolemy's Geographia longitude and latitude differences," in *XXIII International Cartographic Conference* (Moscow, 2007), accessed 14.05.2018, http://xeee.web.auth.gr/ICA-Heritage/Commission/Tsorlini_Livieratos_MOSCOW.pdf, 1. Stückelberger et al., *Claudius Ptolemaeus'*…, 240.

[35] H. Reichert,"Ptolemaeus," in *Reallexikon der Germanischen Altertumskunde*, ed. H. Beck, D. Geuenich, and H. Steuer, Vol. 23, 2nd ed. (Berlin: Walter de Gruyter, 2003). D. R. Rawlins,"The Ptolemy Geography's Secrets," *The International Journal of Scientific History* 14 (2008): 573. M. J. Ferrar, *The Text of Marinus the Tyrian and Claudius Ptolemy: "Geographia", Book 4, chapters 1,6, 7 and 8. The west coast of "Libya" explored, the Zero longitude determined and the East Coast capes located* (2009, updated April 2018), accesed 6.05.2018, http://www.cartographyunchained.com/cp4.html. Marx, "Rectification…," 100: a *better ascertained*, but *still approximated*, *assumed*, zero degree longitude of the Ptolemaic system: "− 25º10' is the modern longitude of Santa Antão, the most western island of the Cape Verde Islands."

[36] Forţiu, "Geodetic-Statistical Analysis…," 627.

[37] Marx, "Rectification…," 101.

[38] *Ibid.*, 20.

circumference at 180,000 stades, meaning an equatorial degree would have 500 stades (ca. 18% too small).[39] Both used an *oikoumenē* of a quarter of the Earth's sphere, bordered by a half of the equator and a meridian circle. Ptolemy's world map was thus plotted from 63°N to 16°S.[40]

The intrinsic margin of error given by the Ptolemaic coordinates is of 5', since the smallest subdivision of the degree he used was $\frac{1}{12}$°.[41] However, Ptolemy's coordinates of exact places on his map are affected by many other inaccuracies, different in origin from one area to another and different for the latitude than for the longitude:

> This follows from the independent and different measurement of longitudes (mainly terrestrial) and latitudes (terrestrial; Gnomon; length of the longest day) in the antiquity and Ptolemy's determination of coordinates from travel reports and itineraries, which only provided distances and no detailed directions, so that the accuracy of a determined position probably differs in longitude and latitude.[42]

We can determine if the places on Ptolemy's map were oriented by him according to a good or bad value of the reference latitude, only for clearly identified places. The longitudes are only approximated transpositions from the information of the itineraries. This is also the case for many latitudes. Thus, it is impossible to make a unitary grid for Ptolemy's locations, disregarding the local patterns. This also makes impossible any "grand calculation," of a global scale, of the Ptolemaic sites.

Christian Marx wrote, in the Introduction of one of his articles, something optimistic and in contradiction to my assumption above, about the impossibility of any "grand calculation" of the Ptolemaic coordinates:

> The following investigation is a first statistical analysis of the precision of the Ptolemaic geographic coordinates in terms

[39] *Ibid.*, 21. Cf. Sorin Forţiu, *Ziridava in Ptolemaic Context* (Brăila: Editura Sfântul Ierarh Nicolae, 2012), 106.
[40] Berggren and Jones, *Ptolemy's Geography*…, 20-22.
[41] Marx,"On the precision…," 30. Marx, "Rectification…," 101.
[42] Marx,"On the precision…," 30-31.

> of their resolution. This precision needs to be distinguished from the accuracy in terms of the actual errors (random, systematic, gross), however, the resolution and the size of the random errors are associated.[43]

Since many of Ptolemy's places on the map are unidentified with concrete sites, the author could have made his statistical calculations only based on the Ptolemaic data. Thus, he concluded that

> The most precise coordinates are to be found in Greece, Macedonia and Italy, followed by the Iberian Peninsula. Less precise are the coordinates in Southeastern and Eastern Europe, followed by the Near East, Central and Western Europe and Africa. In Asia, east of the Caspian Sea the coordinates are the least precise. This arrangement obviously reflects the sphere of control and area influence of the Roman Empire, from which we can assume, that there were more accurate measurements and more geographic information available.[44]

For the region of Dacia, in the same article, the average resolution is 25 km for the longitude and 22 km for the latitude. For Greece, the average resolution is 16–15 km. For Italy, it ia 17–16 km, while for Germany, 29-26 km.[45] This means that, *ideally*, we should find the unidentified places by using those resolutions, as well as identified places. Inaccuracies can have various and unexpected origins, as Ch. Marx realizes. Thus, working with the concrete values offered by Ptolemy for various *known* locations, many "disappointments" can appear, which cannot give too much hope for the more obscure ones. The inherent inaccuracies of the Ptolemaic data, due to the variable reliability of the data that Ptolemy obtained in different manners, add to the purely methodological inaccuracies analyzed by Ch. Marx.[46] The difficulty for Ptolemy to input enough reliable data in a relatively acceptable cartographic system makes the discrepancy between the sensation of acceptable accuracy given by the scientific principles he uses and many

[43] *Ibid*., 29.
[44] *Ibid*., 36-37.
[45] *Ibid.*
[46] *Ibid.*

gross errors even for some well known places, on which his map's network should rely (see above the example of Alexandria, Byzantion, mouth of R. Borysthenēs etc.; cf. the inaccurate orientation of Italy[47]). This explains mostly by itself the pertinence of the criticism[48] given to "geodetic-statistical analysis," undertaken by the researchers of the Institut für Geodäsie und Geoinformationstechnik, Technische Universität of Berlin, with results published by Christian Marx and Andreas Kleineberg.[49]

In a later article, Ch. Marx wrote that

> Regardless of which zero meridian is taken into account, there remain large deviations between the converted ancient and the modern longitudes. Also, ancient and modern latitudes often differ considerably. Regarding the identification of places, it is of interest whether the coordinate differences contain systematic components. If so, they can be described by a mathematical function, and the positions of unidentified places can be rectified.[50]

That article sought the "mathematical function" that would allow the corrections. Indeed, if we possessed such a formula, any Ptolemaic set of coordinates could be immediately transformed in a modern pair of coordinates. However, as expected, the article engages in many statistical analyses, finding no formula or, at least, a system of formulas, which would solve the Ptolemaic puzzle, just like the collective books to which Marx referred.[51]

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[47] Berggren and Jones, *Ptolemy's Geography*…, 20-22.

[48] Forţiu, "Geodetic-Statistical Analysis…"

[49] A. Kleineberg et al., *Germania and the Thule Island* (*Germania und die Insel Thule. Die Entschlüsselung von Ptolemaios' "Atlas der Oikumene.")* (Darmstadt: Wissenschaftliche Buchgesellschaft, 2010). A. Kleineberg, C. Marx, and D. Lelgemann, *Europe in the Geography of Ptolemy* (*Europa in der Geographie des Ptolemaios. Die Entschlüsselung des "Atlas der Oikumene": Zwischen Orkney, Gibraltar und den Dinariden)* (Darmstadt: Wissenschaftliche Buchgesellschaft, 2012). Marx, "Rectification…"

[50] Marx, "Rectification…," 100.

[51] Marx, "Rectification…," 100. Kleineberg et al., *Germania*…. Kleineberg et al., *Europe*….

Beginning the explanations of the method with Illyricum, Marx shows that

> The difference vectors $(\angle\lambda\angle\varphi)^T$ are shown in…. They have varying directions and often magnitudes of 2° to 3° in longitude and $\frac{1}{2}$° to 1° in latitude. However, there are also vectors which are similar to each other. That indicates systematic errors (distortions).[52]

The purpose of all the statistic exercises is to determine such *systematic errors*. They are the basis for finding a pattern of those distortions, at least on relatively restrained areas of the Ptolemaic map. However, all the statistics are based on *known* locations, and they cannot be used, in any statistical context, to extrapolate patterns *that can be used further*. The problem is not in finding patterns, but in explaining why they occur as they do in a certain area and in attributing a certain pattern to an unknown area. In the region of the Istrian peninsula, east of Italy, two main patterns can be noticed, one with the vector oriented eastward, and another oriented north-east, with almost the same distance of distortion. Should we like to identify an unknown Ptolemaic place there, we would not know whether we should apply one of the distortion patterns (marked here as 1) or the other (marked here as 2), the combination of their vectors, or none. Considering the arrowhead positions, from North to South, the occurrence of the two patterns is: 1-1-2-2-1-1-2, with the additional observation that a third distortion is not a typical 2-type, since it is slightly displaced towards north-east.[53] Marx points out the difference between georeferencing the historical maps in general and the endeavor to find acceptable rectification for the Ptolemaic system, enumerating the problems of the last.[54] However, he keeps the confidence that "a promising approach is a combinatorial analysis of the observations."[55] The stage of this procedure would be:

> 1. Initial solution: analysis of the precision of the coordinate values, determining approximate values for the scales, generating initial subsets of places with similar distortions;

[52] Marx, "Rectification…," 100.
[53] *Ibid.*
[54] *Ibid.*, 103.
[55] *Ibid.*

2. Modified MSS-method: searching for consistent transformation units in the initial subsets;
3. Forward-strategy: searching for the best possible merging of unassigned places with transformation units;
4. Verification of the scales: testing the suppositional scales introduced in step 1 for validity by an adjustment of scales;
5. Merging the transformation units: testing neighboring transformation units for the possibility to merge them;
6. Post processing: visually checking and manually improving of the results.[56]

In my opinion, such a method is not always enough to *identify* unknown Ptolemaic locations without the support of some external clues. The *systematic errors*, when they occur, usually cannot be translated into precise mathematic formulas of which we would be sure to work for any other unknown location in the area. Such an opportunity would be salutary, but, unfortunately, it is not the case. The *local patterns* are only *plausible indications* for the identification of a certain unknown Ptolemaic place.

Therefore, does Ptolemy's work have a scientific cartographic worth? Although its insufficient data for that time must be considered, *when the coordinates are input or kept correctly*, the Ptolemy's system manages to distribute its *poleis* and other places at good estimations *from one to another*, working *in restrained areas*. Why does it work better on *poleis* arrays, from the same area or province, or from some proximity? Ptolemy's latitudes are better than the longitudes, as expected,[57] while mainly on longitude, his local maps suffer local displacements. This happens, as explained above, because many of Ptolemy's data come from itineraries. So, if a major reference point of an east-west itinerary is displaced eastward or westward, it drags a whole net of coordinates with it in the same direction. An example of such "systematic errors" is that the whole Italian peninsula is displaced eastwards (see Fig. 1-1: a map made with Ptolemaic coordinates in one of the earliest known manuscripts).

[56] *Ibid.*

[57] Cf. also Darcy and Flynn, "Ptolemy's map of Ireland…," 52.



Fig. 1-1. The Map of Italy. Source: *Codex Vaticanus Urbinas Graecus* 82 (U).[58]

[58] Ptolemaeus, "Geographia," in *Codex Vaticanus Urbinas Graecus* 82, ff. 0071v-0072r.