Ptolemy's West Africa Reconstructed

Lyudmila M. Filatova, Dmitri A. Gusev[1] and Sergey K. Stafeyev

Abstract. We reconstructed Ptolemy's map of ancient West Africa using a modern geographic information system (GIS). Our analysis showed that the relevant information in Ptolemy's "Geography" is a compilation of data from three or more sources, including at least one version of the Periplus of Hanno, and that some of the data is apparently redundant. This finding entails more realistic estimates of chances to locate ruins of the lost ancient cities mentioned by Ptolemy. Our reconstruction improves understanding of what West Africa was like in the distant past.

Keywords. Ptolemy, ancient map, West Africa, reconstruction, GIS

1. Introduction

Reconstruction of ancient West Africa based on the data from Ptolemy's Geography [1] was attempted before; see a book by W.F.G. Lacroix [2]. We took into account some of the earlier findings. However, the researchers encountered significant difficulties. Richard Smith [3] pointed out that Claudius Ptolemy "provides an enormous mass of mostly indigestible data in the form of names and locations of peoples and places, severalfold more than all other ancient authors combined... But Ptolemy was essentially a mathematician, and his interest was in map-making rather than history, ethnography, or culture. His goal was to complete his map, which he seems to have done much better for East than West Africa. On the eastern coast his accuracy extends to below the equator; in the west, however, it begins wearing thin in southern Morocco. He has been accused of repeating and inverting names sometimes alternating between their Greek and Latin forms when he ran out of data to fill in the blank spaces." In this paper, we will demonstrate that the repetitions of names are largely due to Ptolemy's work being, in essence, a compilation. However, the reader should bear in mind that toponyms can be duplicated naturally, as people migrate and name similar objects in different places. We will divide Ptolemy's coordinate points for West Africa into several groups determined by analyzing the differences of Ptolemy's latitudes for pairs of similar toponyms. Modern coordinates will be determined or estimated both for the points believed to be "real" and the suspected redundant duplicates, just in case the latter happen to be products of natural duplication of geographic names. We will discuss some particularly interesting cases, including those traceable to the Periplus of Hanno. In the next sections of this paper, we will also describe the steps of our iterative reconstruction process.

2. Initial analysis

We selected 25 reference points located in Morocco and built a simple two-dimensional regression that yielded two equations,

$$\lambda_{\text{Modern}} = a_0 + a_1 \cdot \lambda_{\text{Ptolemy}} + a_2 \cdot \varphi_{\text{Ptolemy}} \quad (1)$$

and

$$\varphi_{\text{Modern}} = b_0 + b_1 \cdot \lambda_{\text{Ptolemy}} + b_2 \cdot \varphi_{\text{Ptolemy}}, \quad (2)$$

where a_0, a_1, a_2, b_0, b_1, and b_2 are the regression coefficients, λ_{Modern} and λ_{Ptolemy} are longitudes in the coordinate systems denoted by the subscripts, and φ_{Modern} and φ_{Ptolemy} are the corresponding

latitudes. Eqs. (1) and (2) were applied to calculate the approximate modern coordinates of the points located in Morocco and further south from it, along with those of some of the known points in Algeria and Tunisia. The model's linearity guaranteed that it was relatively safe to extrapolate with.

Once the results were plotted in a GIS, distortions became apparent. In particular, the six Beatorum islands ended up between Canary Islands and Cape Verde. Pliny the Elder [4] tells us that one of those islands, Ninguaria, is covered with snow. Hence, it is identified with Tenerife, where snow can be seen on Pico de Teide, and the island located next to it, Canaria, is identified with Gran Canaria [2]. (These islands were not among our reference points at this step.) Pico de Teide seemingly marks Ptolemy's prime meridian, as his longitude of Ninguaria is equal to 0 degrees. The difference of Ptolemy's latitudes between two islands named Junonia (one of them also allegedly known as Autolala) equals 8º35', while Pliny the Elder conveys that, according to Juba, "a second island has the name of Junonia, but that it contains nothing beyond a small temple of stone; also that in its vicinity there is another, but smaller, island of the same name, and then another called Capraria which is infested by multitudes of huge lizards... in sight of these islands is Ninguaria…" Besides, the difference of Ptolemy's latitudes between Ganaria promontory and Canaria island is equal to 9º30', and this value also seems too large. As no mountains could be found near the location where Ptolemy's "Solis mountains" were placed, we found it useful to search for this mysterious object. The search led us to a classification of points described in the next section.

3. Classification of Ptolemy's points

Herodotus [5] informs: "The coast of Libya along the sea which washes it to the north, throughout its entire length from Egypt to Cape Soloeis, which is its furthest point, is inhabited by Libyans of many distinct tribes who possess the whole tract except certain portions which belong to the Phoenicians and the Greeks." He also says, "Sataspes went down to Egypt, and there got a ship and crew, with which he set sail for the Pillars of Hercules. Having passed the Straits, he doubled the Libyan headland, known as Cape Soloeis, and proceeded southward. Following this course for many months over a vast stretch of sea, and finding that more water than he had crossed still lay ever before him, he put about, and came back to Egypt."

The Periplus of Hanno [6] says, "After passing through the Pillars we went on and sailed for two days' journey beyond, where we founded the first city, which we called Thymiaterium; it lay in the midst of a great plain. Sailing thence toward the west we came to Solois, a promontory of Libya, bristling with trees. Having set up an altar here to Neptune, we proceeded again, going toward the east for half the day, until we reached a marsh lying no great way from the sea, thickly grown with tall reeds. Here also were elephants and other wild beasts feeding, in great numbers."

According to Pliny the Elder, "The extreme promontory of Africa, which projects into the ocean, is called Ampelusia by the Greeks. There were formerly two towns, Lissa and Cotte, beyond the Pillars of Hercules; but, at the present day, we only find that of Tingi, which was formerly founded by Antaeus, and afterwards received the name of Traducta Julia, from Claudius Caesar, when he established a colony there."

From this information, we concluded that the objects named "Solis mountains" and "Soloentia promontory" by Ptolemy are, in fact, two duplicates of his "Cotes promontory" (this name is apparently related to Pliny's "Cotte" and Hanno's "Gytta"), now Cap Spartel. We preliminarily assigned the likely duplicates to three groups dubbed "Group Cotes", "Group Solis", and "Group Soloentia". Ptolemy placed his Soloentia promontory far south, and Group Soloentia is small.

This may be due to poor quality of Ptolemy's source of information for it. For the suspected pairs of duplicates, we then plotted the differences of Ptolemy's latitudes as shown in Figure 1. The latitudes are of interest, as the shoreline of West Africa is oriented roughly north-south. The points in Fig. 1 formed four clusters, with one remarkable "special case" at (13,4). Let's discuss this special case first.

The y-coordinate value of the point that represents the special case (4 Ptolemy's degrees) is the latitude difference between mouths of two rivers, Stachir and Daras. We noticed that Ptolemy's description of Stachir matches Hanno's description of a river named Chretes. Indeed, Ptolemy speaks of the "Rysadius mountains, in which the Stachir river takes its rise flowing through the Caeonia lake not far from the mountains and the Nias river." One translation of The Periplus of Hanno [6] says, "Thence, sailing by a great river whose name was Chretes, we came to a lake, which had three islands, larger than Cerne. Running a day's sail beyond these, we came to the end of the lake, above which rose great mountains, peopled by savage men wearing skins of wild beasts, who threw stones at us and prevented us from landing from our ships." The name "Caeonia" in Ptolemy's description may be a variation of "Cerne". It is worth mentioning that a different interpretation of this part of the periplus exists [7], "Sailing from there, we crossed a river called Chretes, and reached a bay, which contained three islands, bigger than Kerne. After a day's sail from here, we arrived at the end of the bay, which was overhung by some very great mountains, crowded with savages clad in animals' skins. By throwing stones, they prevented us from disembarking and drove us away." Ptolemy also mentions a river named Daratis, or Daras. This toponym survives as Draa, and "Chretes" appears to be just another form of it. Pliny the Elder mentioned that there were crocodiles in Daratis. According to K. de Smet [8], it was claimed that a relic population of crocodiles lived in the valley of Draa until the early twentieth century. Unfortunately, it is difficult to determine with certainty which of the mouths of Draa's extensive delta once corresponded to Ptolemy's Stachir (Hanno's Chretes), and whether it was the same mouth as that of Ptolemy's Daras. In fact, the mouth currently considered to be the main one of Draa used to be called "Wady Nun" in the recent past, and the modern Cap Draa used to be called "Cap Noun". The name Noun (Nun) is similar to the names of two rivers mentioned by Ptolemy, Nuius and Nias. The mouth of the former would be located 3º20' north from that of Daras (7º20' north from Stachir) in Ptolemy's coordinates, and the mouth of the latter would be found 6º south from Daras, 2º south from Stachir. If the etymology of Nuius-Nias traces to Nun, the Egyptian god of the primeval watery abyss, bearing similarity to the biblical Noah and Plato's "noos", then the name could repeat naturally.

In the same cluster as the pair *(Nuius, Nias)*, the following four other pairs of likely duplicates are found: *(Massa river, Masitholus river)*, *(Ganaria promontory, Catharum promontory)*, *(Ganaria promontory, Arsinarium promontory)*, and *(Ganaria promontory, Canaria island)*. Rather than representing true duplicates, the last pair merely contains two objects unlikely to be far away from each other, as we mentioned in Section 2. Not surprisingly, this cluster is the closest one to the Stachir-Daras point in Fig. 1.

Four pairs of Ptolemy's points form a cluster named "Group Soloentia - Group Cotes". It is remarkable how "Baba town" and "Ubrix" from Group Soloentia are shifted south relative to Baba and Vobrix from Group Cotes. Pliny the Elder says, "In the interior, at a distance of forty miles from Lixos, is Babba, surnamed Julia Campestris, another colony of Augustus…" Babba's existence was confirmed by an inscription found at Thamusida (Ptolemy's Tamusida), according to Rebuffat [9]. Its exact location remains unknown. We will describe our approximate localization technique elsewhere in this paper. It pointed to a location near the modern Moroccan town of Boured for Ptolemy's Vobrix. Considering that Thamusida is also located in Northern Morocco, we strongly believe "Baba town" and "Ubrix" to be Ptolemy's duplicates of the lost ancient cities of Babba and Vobrix. Indeed, Thamusida is apparently named after Tammuz

(Dumuzid), a popular god also worshipped under such etymologically related names as Adonis and Dionysus, whose cult once had strong presence in Northern Morocco. Perhaps, Thamusida was one of the names of a female deity related to him. The other pairs found in this cluster are *(Soloentia promontory, Cotes promontory)* and *(Ussadium promontory, Ryssadium promontory)*.

The third cluster found in Fig. 1 consists of seven points with the x-coordinate values between 20 and 28 degrees, yet only six points are seen, because two points coincide exactly. Namely, Sala city (now Sale, Morocco) is located near the mouth of the Sala river, and, similarly, Salathus town is placed at the mouth of the Salathus river. This city-river pair will repeat again in the other cluster. In this one, we also find *(Cusa river, Chusar river)*, *(Phuth river, Ophidis river)*, *(Molochath, Malachath)*, *(Benta, Byntha)*, and *(Mysocaras harbor, Bagaza town)*. It is worth noting that a river listed by Ptolemy twice, as Molochath and Malva, is the modern Oued Moulouya. As Ptolemy places the town of Galapha near it, it appears that this same river is also Chaucer's Galaphay [10], so Galapha is yet another likely duplicate of the town of Molochath. We identify Ptolemy's "Mysocaras harbor" with El Jadida (former Mazagan). John Malalas [11] mentions that a river that separates Cilicia from Syria was called Typhon, or Ophit. Chus (Cush) and Phut (Phuth) were listed among the sons of Cham in the Bible [12]. Isaac Newton [13] pointed out the similarity of Phut, Python, and Typhon.

The fourth cluster in Fig. 1 represents nine more pairs of likely duplicates. Two rivers named Sala form a pair, and the cities named "Sala city" and "Vala" form a complementary one. Ptolemy's "Rusibis port" is often claimed to be El Jadida (Mazagan), or, alternatively, a nearby village of Moulay Abdallah. Hanno's Acra apparently occurs twice, as Acrath and Oecath. Ptolemy's city of Volubilis is named "Volubilis Diourus" on the fifteenth century map by Donnus Nicholaus Germanus reproduced in [1], so we paired it with Dorath. The other pairs in this cluster are *(Cotes promontory, Solis mountains)*, *(Tamusida, Tamusiga)*, and *(Asana river, Agna river)*.

We formed two groups of reference points that corresponded to "Group Cotes" and "Group Solis". The technique described in Section 2 was then applied twice to the other points, and the results were visualized in a GIS in order to determine which group a point more likely belonged to. This allowed us to identify some of those points with modern objects, sometimes tentatively. ("Group Soloentia" is too small to use its points this way.) In other cases we applied an approximate localization technique described in the next section.

4. Approximate localization of Ptolemy's points

Even though the Earth is not exactly spherical, the problem of approximate localization of Ptolemy's points can be interpreted as that of scattered data fitting on a sphere. Multiple methods for such data fitting are known, see a paper by Fasshauer and Schumaker [14]. From the previous discussion, it can be safely concluded that local interpolation is likely to outperform the fits based on sets of reference points for larger areas. We utilized a simple technique graphically illustrated in Figure 2. Namely, whenever Ptolemy's point lies inside a triangle formed by three known reference points, its location on the modern map can be approximated as follows. The modern coordinates of each reference point are weighed by a coefficient defined as the ratio of the area of a triangle formed in Ptolemy's coordinate system by the other three points to the area of the triangle formed in Ptolemy's coordinate system by the three reference points themselves. The approximate modern coordinates of the inside point are then computed by summing up the products. In our computation of the areas in Ptolemy's coordinate systems, we applied a special *narrowing coefficient* γ to the longitudinal differences in order to account for Ptolemy's underestimation of the length of equator. J. Lennart Berggren and Alexander Jones [15] pointed out that Ptolemy's estimate of the length of equator is about 18 percent too small, so, as far as the

longitudes are concerned, "his equivalent for one degree in stades is only about 82 percent of what it should be." Furthermore, we determined that Ptolemy's underestimation is unevenly distributed. That is to say, the local value of the narrowing coefficient should be between 0.85 and 0.95 in Asia Minor, yet it is approximately 0.73 in Morocco, so we used the latter value in our computations. The actual numerically stable formulas are as follows. The area of a spherical triangle can be computed as

$$S = 4 \cdot \arctan \sqrt{\tan\left(\frac{s}{2}\right) \cdot \tan\left(\frac{s-a}{2}\right) \cdot \tan\left(\frac{s-b}{2}\right) \cdot \tan\left(\frac{s-c}{2}\right)}, \qquad (3)$$

where a, b, and c are the lengths of its sides in radians, and $s=(a+b+c)/2$. Each of the lengths of the sides of a spherical triangle was computed as a *modified great circle distance*

$$d_{1,2} = 2 \cdot \arcsin\left[\min\left\{1, \sqrt{\left(\sin\frac{|\varphi_1 - \varphi_2|}{2}\right)^2 + \cos\varphi_1 \cdot \cos\varphi_2 \cdot \left(\sin\frac{\gamma|\lambda_1 - \lambda_2|}{2}\right)^2}\right\}\right], \qquad (4)$$

where φ_1 and φ_2 are the latitudes of two vertices of the triangle, λ_1 and λ_2 are the corresponding longitudes, and γ is the narrowing coefficient. Both latitudes and longitudes are expressed in radians. The ordinary *great circle distance* can be computed using Equation 4 by setting $\gamma=1$. There seems to be no need to modify the latitude differences. In particular, the latitudinal narrowing coefficient computed for the pair *(Byzantium, Tonice)*, i.e. *(Istanbul, Tanga),* is equal to (41.0333+5.0667)/(43.0833+4.25) = 0.9739. This value is sufficiently close to 1. Indeed, ancient astronomers could measure latitudes of objects on Earth with reasonably good precision at the time of Ptolemy. This was not the case with the longitudes and longitude differences. A detailed explanation of this fact can be found in the introduction to [15].

5. The reconstruction map

Our integrated reconstruction map of Ptolemy's West Africa is shown in Plates 1 and 2. It was produced using ArcView GIS Version 3.0a. A couple of image conversions and minor corrections were subsequently made in Jasc Paint Shop Pro Version 7.04.

Only five or six points located east from the mouth of Oued Moulouya are shown. We felt that it was important to show the city of Gao. We identified it with Ptolemy's Cuphe, Nigira metropolis, and possibly Geva, shown on the eastern side of the second part of our map, in Plate 2. As the reader might have realized from the previous discussion, Ptolemy did not have sufficient information to determine the correct course of the Niger river. Not surprisingly, a few identifications in the Southern part of West Africa had to be made based on similarity between ancient and modern names. For instance, we identified Ptolemy's Thamondocana with Tombouctou. We accepted the identification of Ptolemy's Tucabath with Togba proposed by W.F.G. Lacroix [2]. Furthermore, we suspect that Ptolemy's Thupae is a duplicate of Tucabath. We identified Ptolemy's Anygath with the ancient ruins of Aoudaghast (Mauritania). Ptolemy's Thige and Pesside are identified as the present day Segou and Mpessoba (Mali), respectively.

We strongly believe that Ptolemy's Talubath corresponds to the modern oasis of Tabelbala. According to Jean-Pierre Rossie [16], its inhabitants speak a language of their own, completely different from the languages of the surrounding nomadic or settled Saharan populations. Their language is of Black African origin but influenced by Amazigh and Arabic languages. Indeed, Ptolemy calls a nearby tribe "Melanogaetuli". The Greek word "melanos" means "black".

Hanno described a volcanic eruption of a very high mountain called "Theon Ochema" (The Chariot of Gods). We believe that his description is consistent with the volcano being located on an island, in which case Ptolemy's "Theon (Ochema) mountains" should correspond to Pico de Teide, the third largest volcano on Earth after Mauna Loa and Mauna Kea. The Periplus of

Hanno appears to be somewhat garbled. In [6], we find these descriptions: “Having taken in water there, we sailed along the shore for five days, until we came to a great bay, which our interpreters said was called Horn of the West. In it there was a large island, and within the island a lake of the sea, in which there was another island… Thence, sailing along by the fiery torrents for three days, we came to a bay, called Horn of the South. In the recess of this bay there was an island, like the former one, having a lake, in which there was another island, full of savage men.” Jona Lendering [7] pointed out that both Horns had to be promontories, not bays. Furthermore, it appears to us that the “bays” and “lakes” (“lagoons” in [7]) supposedly containing other islands should also be interpreted as promontories pointing at those other islands. Perhaps, those promontories were once described dubiously as “bends”, and a subsequent translation altered the intended meaning. Having accepted this approach, we looked closely at Hanno’s description of Cerne [7]: “When we had got interpreters from the Lixites, we sailed along the desert shore for two days to the south. After sailing eastward for one day, we found in the recess of a bay a small island, which had a circumference of five stades. We left settlers there and called it Kerne.” The location of Ptolemy’s Lix is known (see Plate 1). As one Attic stade is approximately equal to 185 meters [15], it is difficult to accept that Hanno’s Cerne was Gran Canaria, as Lacroix suggested [2]. But if this “bay” is actually a promontory, then by sailing westward (not eastward) Hanno might be able to reach Selvagens Islands. Perhaps, Portuguese had good reasons to call them “the islands of savages” when they were discovered in 1438. Hansen [17] and Steiner [18] documented some archaeological work done on Selvagem Grande, the largest island of the group. We do not share Lendering’s opinion that Hanno reached Mount Cameroon.

We identified Ptolemy’s Autolala, a city of Autololes, with Aglou. A tribe named “Ahl Aglou” still lives nearby. Ptolemy’s Thuilath might correspond to the tribal area of Ida Oultite. Ptolemy’s Suriga is now called Essaouira. This city was named Souirah on an 1844 map by C.C.F. Radefeld [19]. Ptolemy’s Herpis is now called Guercif.

Perhaps, the most questionable of our assignments based on toponymic analysis is that of Ptolemy’s Iarzitha to the modern Ouarzazate. Even though this city was founded by the French in 1928, its name is of Berber origin, meaning “the calm city”, and some older kasbahs are found at that location and nearby, on an island of the lake created by the modern El Mansour dam.

6. Conclusions and future work

We reconstructed Ptolemy’s map of ancient West Africa. Our reconstruction improves understanding of what West Africa was like in the distant past. Further improvement can be achieved by means of archaeological work or via analysis of aerial and satellite photographs of the potential locations of lost ancient cities. Known ruins, such as the ancient town of Sabratah in Libya, are readily recognizable in Google Earth Plus 3.0 at high resolution. The results documented in this paper represent part of our project aimed at complete reconstruction of Ptolemy’s Oikumene (“the known world”).

Acknowledgements. The corresponding author thanks Prof. Michael A. Radin of the Rochester Institute of Technology for his help and advice.

Notes

[1] Author for correspondence. Address: 6 Sunnybrook Lane, Fairport, NY 14450, U.S.A.

References

1. Claudius Ptolemy, The Geography, Translated and edited by E.L. Stevenson, Dover Publications, Inc., New York, 1991.
2. W.F.G. Lacroix, *Africa in Antiquity: A Linguistic and Toponymic Analysis of Ptolemy's Map of Africa, Together with a Discussion of Ophir, Punt and Hanno's Voyage*, Verlag fur Enlwicklungspolitik, Saarbrucken, 1998.
3. Richard Smith, 'What Happened to the Ancient Libyans? Chasing Sources across the Sahara from Herodotus to Ibn Khaldun', *Journal of World History*, Vol. 14, No. 4, December 2003, pp. 459–500.
4. Pliny the Elder, Natural History, Books V and VI, Eds. John Bostock and H.T. Riley, Taylor and Francis, London, 1855.
5. Herodotus, The History, Books II and IV, Translated by George Rawlinson, 1858-1860.
6. Hanno, The Periplus, Translated by W.H. Schoff, Quoted in: *Paideuma: A Journal Devoted to Ezra Pound Scholarship*, Vol. 1/2, Winter 1972, pp.224-226.
7. Hanno, The Periplus, Translated by Jona Lendering, http://www.livius.org/ha-hd/hanno/hanno02.html
8. K. de Smet, 'Status of the Nile Crocodile in the Sahara Desert', *Hydrobiologia*, Vol. 391, No. 1-3, January 1998, pp. 81-86.
9. R. Rebuffat, 'Les erreurs de Pline et la position de Babba Iulia Campestris', Antiquites Africaines, Vol. 1, 1967, pp. 31-57.
10. Geoffrey Chaucer, The Knight's Tale, in: The Canterbury Tales.
11. John Malalas, The Chronicle, in: E. Jeffreys, M. Jeffreys and R. Scott, 'The Chronicle of John Malalas. A Translation', *Byzantina Australiensia*, Vol. 4, Australian Association for Byzantine Studies, Melbourne, 1986.
12. Genesis 10:6.
13. Isaac Newton, 'The Original of Religions' (manuscript, c. early 1690s), Jewish National and University Library, Jerusalem, http://www.newtonproject.ic.ac.uk/texts/yah41_n.html
14. G. E. Fasshauer and L. L. Schumaker, 'Scattered Data Fitting on the Sphere', in: M. Daehlen, T. Lyche and L. L. Schumaker (Eds.), *Mathematical Methods for Curves and Surfaces II*, 1998, pp. 117-166.
15. J. Lennart Berggren and Alexander Jones, *Ptolemy's Geography: An Annotated Translation of the Theoretical Chapters*, Princeton University Press, Princeton, NJ, 2000.
16. Jean-Pierre Rossie, *Saharan and North African Toy and Play Cultures*, Stockholm International Toy Research Centre, Stockholm, Sweden, 2003.
17. Jorg W. Hansen, 'Siedlungsspuren auf den Ilhas Selvagens (Portugal)', *Almogaren*, Vol. 32-33, 2001-2002, pp. 287-302.
18. Hartwig-E. Steiner, 'Siedlungsspuren auf den Ilhas Selvagens. Dokumentation archaologischer Fundstatten auf Selvagem Grande. Expedition mit dem Forschungsschiff 'Corvette' vom 21.-28. Mai 1999.', *Almogaren*, Vol. 31, 2000, pp. 193-206.
19. Carl Christian Franz Radefeld, 'Nordwestliches Africa oder das Sultanat Marocco' (map), in: Joseph Meyer, *Meyer's Handatlas No. 46*, Amsterdam, 1844.

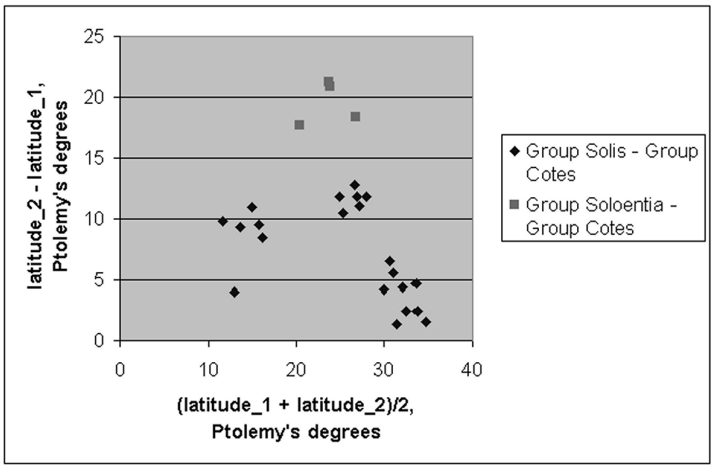

Figure 1. Differences of Ptolemy's latitudes plotted for pairs of suspected duplicates

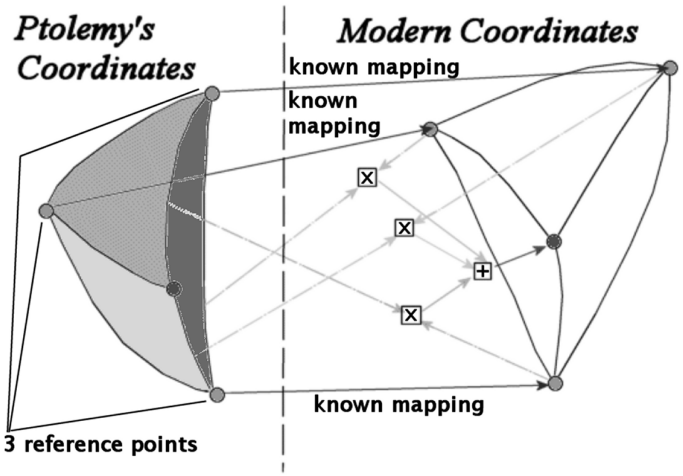

Figure 2. Approximate localization by local interpolation on a sphere

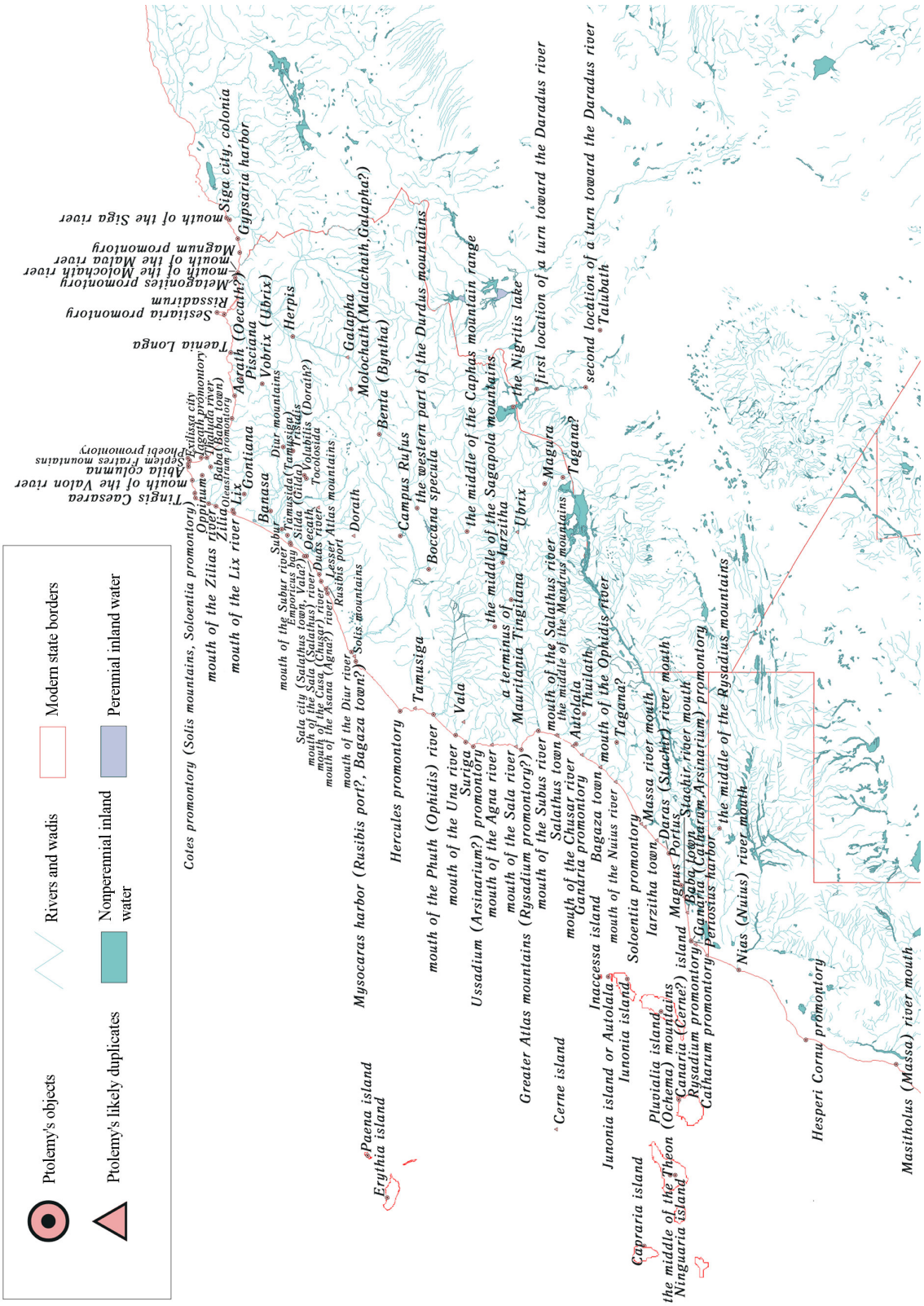

Plate 1. Our Reconstruction of Ptolemy's West Africa, Part I (North)

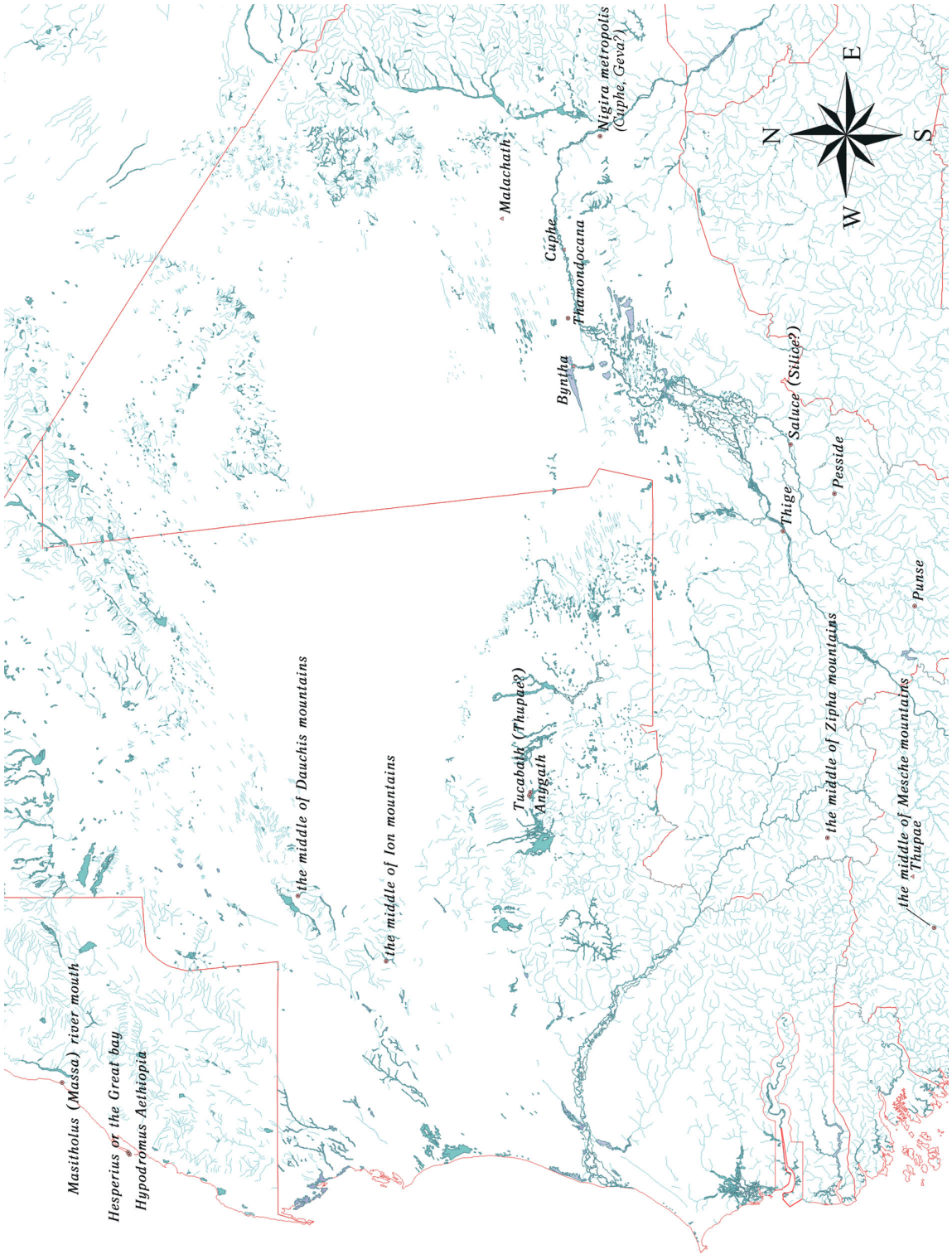

Plate 2. Our Reconstruction of Ptolemy's West Africa, Part II (South)