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## Explaining Ptolemy's Roman Britain

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# Explaining Ptolemy's Roman Britain

By ALASTAIR STRANG

If in the course of these inquiries I shall often find occasion to differ from those learned antiquaries who have engaged in this province before me, as I desire my sentiments to be no further regarded than they appear to be supported by sufficient evidence, so I hope I need make no farther apology for such dissent.  
(J. Horsley 1733, *Britannia Romana* (1974), 355)

## INTRODUCTION

Unfortunately no map of the Roman world has yet been discovered that has survived directly from Claudius Ptolemaeus' work,<sup>1</sup> conducted in Alexandria c. A.D. 120–160. However many maps have been produced from the data (8,000 geographic reference locations) contained in his monumental *Geographia* for the discovery of which we are indebted to Maximus Planudes<sup>2</sup> of Constantinople c. A.D. 1295. The *Geographia* text and these maps<sup>3</sup> vary in style from mainly Greek<sup>4</sup> and Latin manuscript sets (codices) through a variety of printed and reproduced versions from the late fifteenth century<sup>5</sup> even up to the present day.<sup>6</sup>

A typical, FIG. 1, Ptolemy's map of Roman Britain is particularly distinctive in that Scotland has been given an east–west orientation relative to England<sup>7</sup> and thus, over the last few centuries, has attracted much attention<sup>8</sup> and conjecture as to why this might have occurred. So

<sup>1</sup> A. Strang, *Ptolemy's Geography Reappraised*, unpub. Ph.D. thesis, University of Nottingham (1994), 23 for full list of Ptolemy's known work as the *Geographia* partly depends on some of his previous work.

<sup>2</sup> O.A.W. Dilke, 'Cartography in ancient Europe and the Mediterranean', in J.B. Harley and D. Woodward (eds), *The History of Cartography I* (1987), 268, apparently no maps accompanied the Greek manuscript of the *Geographia*.

<sup>3</sup> Strang, *op. cit.* (note 1), 189–202. Comprehensive lists are given of some 296 codices and their repositories. Among some 102 Greek manuscripts there are possibly 32 with maps, codices with 26/27 maps are designated the 'A' Recension and later variants with 64/65 maps the 'B' Recension.

<sup>4</sup> It is likely that most if not all of the Greek manuscripts emanated from Maximus Planudes' original, which may have been *codex Vaticanus graecus* 177 which claims him as owner. Three ancient *Geographia* manuscripts are known in Arabic (A.T. Karamustapha in J.B. Harley and D. Woodward (eds), *The History of Cartography II*, 10) but without translation and suitable research it is not known whether they could have been derived from a separate or earlier origin.

<sup>5</sup> The earliest printed maps from Ptolemy's *Geographia* appear (in Latin) to have been produced in Bologna possibly as early as 1462. Subsequently, variants proliferated throughout Europe as the art of printing rapidly spread across the Continent.

<sup>6</sup> The latest known printing of the *Geographia* is the reprint of E.L. Stevenson's *Geography of Claudius Ptolemy* (in English) in 1991. The maps of *codex latinus* VF.32, Naples, *Cosmography, Maps from Ptolemy's Geography* were recently (1990) reproduced by Magna Books, Leicester.

<sup>7</sup> FIG. 1, is reproduced (with kind permission of the authors) from B. Jones and D. Mattingly, *An Atlas of Roman Britain* (1990), 19, also see Ordnance Survey, *Map of Roman Britain* (4th edn, 1978), 15 and (3rd edn, 1956), 20.

<sup>8</sup> William Camden, *Britannia* (1599 etc.), showed early interest in Ptolemy's Britain, and Mercator had published the Ptolemy map of 1578. It was John Horsley, *Britannia Romana* (1733), who first attempted to 'rectify' this map and to seriously analyse Ptolemy's place-names of Britain. W. Roy, *Military Antiquities of the Romans in Britain* (1793), also considered Ptolemy's *Geographia* based on Mercator's map but based his place-name identities on the work of the discredited Richard of Cirencester (1747/8) so was badly misled. More recent work on Ptolemy's Britain is reviewed in Table 1 etc.

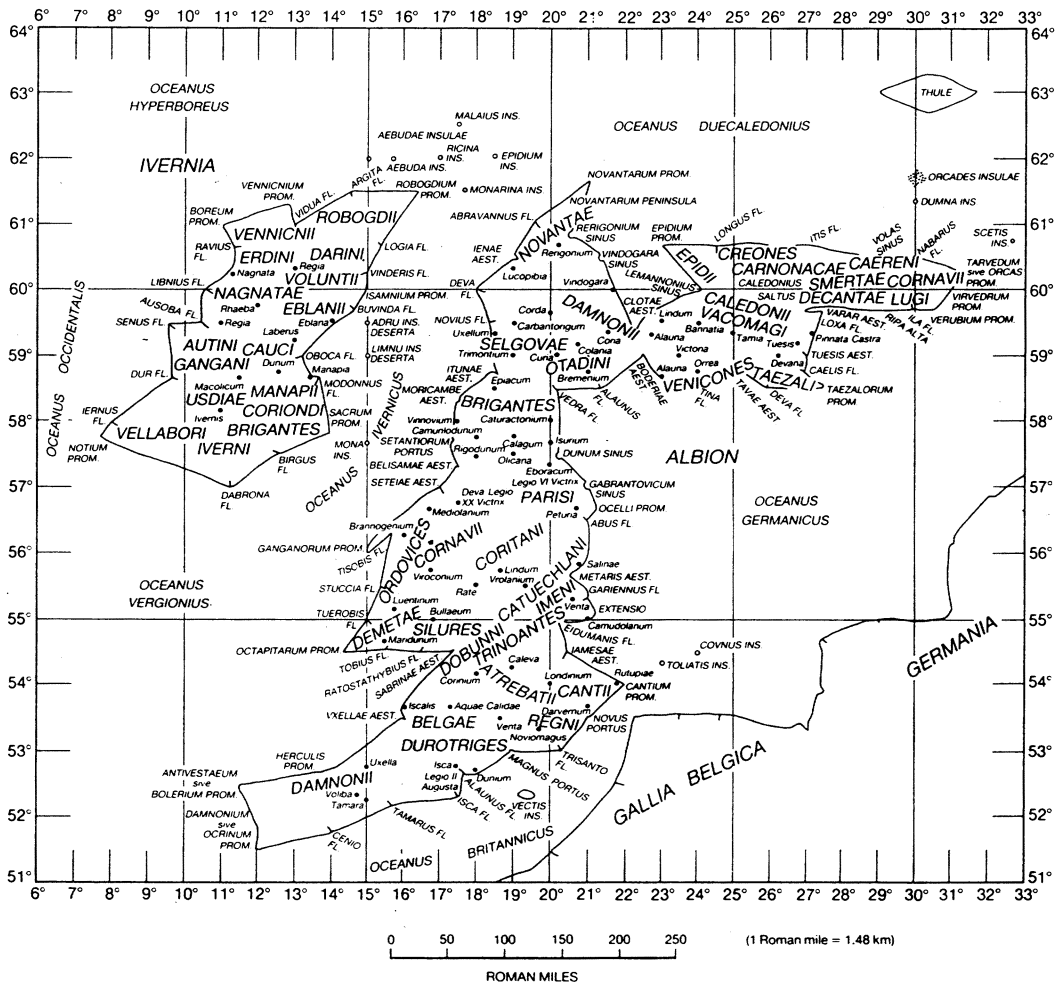


FIG. 1. Ptolemy's map of Britain (Jones and Mattingly 1990, with kind permission of the authors).

far, no reasonable explanation has been presented for Scotland's configuration. Hence the possible identity of Ptolemy's place-names<sup>9</sup> (219 total for Britain and Ireland) referenced in Scotland has not been satisfactorily resolved. A comprehensive reappraisal<sup>10</sup> of Ptolemy's geography has therefore been carried out by the author and the main methods of analysis are presented and deductions and conclusions are described. Several approaches were considered<sup>11</sup> but an empirical (as opposed to a statistical etc.) method was chosen because of uncertainty concerning the reliability of the *Geographia* data and the complex variety of distortion evident within the map of Britain derived from this data. Providing that the large majority of 'known' Ptolemy places could be satisfactorily reoriented into conformation with their actual locations

<sup>9</sup> For comprehensive consideration of place-names derived from many sources including Ptolemy's *Geographia* refer to A.L.F. Rivet and C. Smith, *The Place-Names of Roman Britain* (1979).

<sup>10</sup> Strang, op. cit. (note 1), includes reappraisal of the Roman Lower Danube region and Ptolemy's geographic methods.

<sup>11</sup> Strang, op. cit. (note 1), 59–61.

on a modern map, of uniform areal scale, then the relative locations of the remaining 'unknown' places should conform with their most likely positions on this uniform scale.

Ptolemy would have compiled the data for Britain by c. A.D. 122 and he must have drawn maps (or had them drawn) to be able to extract this data and integrate it into the spatially-related reference lists of his *Geographia*. An Agathodaimon-type<sup>12</sup> role would have been required for producing a world-map, as common boundary data were used for adjoining regional maps to ensure that compatibility was maintained within Ptolemy's world.<sup>13</sup>

Ptolemy's map of Britain embraces two distinct longitudinal, angular scales, that for England (41.67 Rm.(=Roman miles) per degree) being substantially greater than that for Scotland/Ireland (25.8 Rm. per degree). Although the latitudinal scale is common for Britain as a whole (62.5 Rm. per degree), it is misleading to apply a linear scale<sup>14</sup> (e.g. Rm. per cm) to a substantially distorted map.

Ptolemy's map was superimposed on a modified Ordnance Survey map of Britain,<sup>15</sup> with the same latitudinal scale and with London coincident. For optimum registration of 'known' places on both maps, three datum points were identified (as outlined in FIG. 7) about which regions of Ptolemy's map had been separately rotated. In bringing these 'known' (c. 84 per cent) Ptolemy place-names into register with their modern locations, the most appropriate locations for 'unknown' Ptolemy places could be determined. Several discrete sets of Ptolemy place-names were discovered to have been distorted by varying amounts (linearly and angularly) explaining the various distortions that are obvious in his map. Additionally, several anomalous locations/aberrations (e.g., Skye, East Anglia, etc.), previously unexplained, became explainable. Comparison of results was made with other ancient geographical sources including the Antonine Itinerary,<sup>16</sup> Peutinger Table,<sup>17</sup> *Notitia Dignitatum*,<sup>18</sup> Ravenna Cosmography,<sup>19</sup> and *Periplus Maris Exteri*,<sup>20</sup> as well as more modern literature on the subject.

#### TRADITIONAL REPRESENTATION OF PTOLEMY'S BRITAIN

Early manuscript maps from Ptolemy's *Geographia* were drawn on a rectangular grid-system as recommended by Ptolemy (*Geographia* II, prologue), for which he provided (*Geographia*

<sup>12</sup> See note 4, *codex Vaticanus graecus 177* (thirteenth/fourteenth-century) is also the first to record, in a colophon, Agathodaimon's claim to be 'a technician of Alexandria, who drew the whole world from the *Geographia* of Ptolemy'.

<sup>13</sup> Eratosthenes (late third/early second century B.C.) had estimated the 360 degree earth's size to be represented by 700 stades/degree (Strang, op. cit. (note 1), 46, 185), whereas the actual size is 600 stades/degree (= 75 Rm./degree) (idem, 46). Unfortunately Ptolemy followed Poseidonios, Strabo and Marinus with a value of 500 stades/degree (= 62.5 Rm./degree) making his world one sixth too small in size or effectively 31 per cent reduced in surface area. Ptolemy also adopted a 63°N latitude limit (*Geographia* I.8) imposing a further restriction on available surface area.

<sup>14</sup> Both of the first two maps in note 7 suffer from this defect which can encourage unrealistic distance measurements being made within distorted areas of the maps.

<sup>15</sup> Ordnance Survey, *Map of Roman Britain* (3rd edn, 1956), modified.

<sup>16</sup> Rivet and Smith, op. cit. (note 9), 150–80; O. Cuntz, *Itineraria Romana I* (1929); H.J. Dunkinfield Astley, 'Notes on the Ninth Iter of Antoninus', *Norfolk & Norwich Arch. Soc.* xvii (n.d.), 1–30; N. Reed, 'Pattern and purpose in the Antonine Itinerary', *American Journ. Phil.* xcix (1978), 228–54; A.L.F. Rivet and K. Jackson, *Britannia I* (1970), 34–82; W. Rodwell, *Britannia VI* (1975), 76–101, and Jones and Mattingly, op. cit. (note 7), 23–9.

<sup>17</sup> Rivet and Smith, op. cit. (note 9), 149–50; K. Müller, *Die Peutingersche Tafel* (1916).

<sup>18</sup> Rivet and Smith, op. cit. (note 9), 185–215; O. Seeck, *Notitia Dignitatum* (1876); M.W.C. Hassall, 'Britain in the Notitia', in R. Goodburn and P. Bartholomew (eds), *Aspects of the Notitia Dignitatum*, BAR Int. Ser. 15 (1976), 103–17; J. Hester Ward, 'The British sections of the *Notitia Dignitatum*', *PSAS* iv (1973), 253–63; H. von Petrikovits, 'More problems with the *Notitia Dignitatum*', *Britannia* xi (1980), 423–7; Jones and Mattingly, op. cit. (note 7), 33–7.

<sup>19</sup> Rivet and Smith, op. cit. (note 9), 185–215; M. Pinder and G. Parthey, *Ravennatis Anonymi Cosmographia et Guidionis Geographica* (1860); I.A. Richmond and O.G.S. Crawford, 'The British section of the Ravenna Cosmography', *Archaeologia* xciii (1949), 1–50; L. Dillemann, *Archaeologia* cvi (1978), 61–73; Jones and Mattingly, op. cit. (note 7), 29–33.

<sup>20</sup> Rivet and Smith, op. cit. (note 9), 73–4; C. Müller, *Geographi Graeci Minores* (1855).

VIII) mean longitude scale-values (i.e. ratios). The ratio for Britain (i.e. Europe Map I) was given as 11:20 (= 0.55). One of the earliest (thirteenth-century) manuscript maps (*codex Seragliensis 27*)<sup>21</sup> available to us, shows (PL. I) Ptolemy's Britain plotted on a rectangular grid. Even at this early date it was, obviously, severely distorted in that Scotland was rotated and much elongated relative to England.

Table I, shows a principal selection of some notable analysts and sources of Ptolemy's data for Britain.

TABLE I  
NOTABLE ANALYSTS/SOURCES OF PTOLEMY'S ROMAN BRITAIN

Date	Place names	Map	History	Text	Manuscripts
1733	HORSLEY	—————			
1807	CHALMERS	(s)			
1843				NOBBE (Diller)	—————
1883	BRADLEY	—————		MÜLLER (Fischer)	—————
1893		RYLANDS			
1894	ORPEN	(i)			
1917	FLINDERS PETRIE	—————			
1922		RICHMOND	(s)		
1926	WATSON	(s)			
1932				STEVENSON & FISCHER	—————
1948			THOMSON		
1956		O.S. 3rd Ed.			
1959		TIERNEY	(s) —————		
1964			BAGROW (Skelton)		
1967	OGILVIE & RICHMOND				
1974	—————	RIVET			
1977	—————	RIVET	(s)		
1978		O.S. 4th Ed.			
1979	—————	RIVET & SMITH	—————		
1987		SMITH	(s) —————	DILKE	—————
1990	JONES & MATTINGLY	—————			
1994	—————	STRANG	—————		

N.B. (s) = Scotland, (i) = Ireland

The work of these previous researchers and others was reviewed and, although little advance had been made in resolving Ptolemy's Britain, I regard the following as the most significant comments on their work/observations.

a. Horsley recognized<sup>22</sup> that Ptolemy's latitude scale was about 65 Rm. per degree and that a longitude scale of some 43.7 Rm. per degree should apply to his map in the South of England. This compares with an actual latitude scale of 62.5 Rm. per degree and as we shall see a determined longitude scale for England of 41.67 Rm. per degree.

<sup>21</sup> See L. Bagrow, *History of Cartography* (1964, enlarged by R. Skelton), pl. X etc. Strang (op. cit. (note 1), 67; 264) indicates that this map, drawn to a rectilinear longitude-ratio of 0.666–0.669 (c. 41.7 Rm. per degree), is significant. Britain, when drawn separately from Europe, was restricted in configuration on Ptolemy's smaller world. Hence England might well need a ratio of this order for compatibility whereas Scotland required a much smaller ratio for realism when projected in a conic or homeotheric world context.

<sup>22</sup> Horsley, op. cit. (note 8), 361: 'If a degree of longitude in any part of Britain be according to Ptolemy, 40 miles (as some affirm) it must be in the south of England where the latitude is least. Nor must we here allow them the usual length of the English computed miles. A degree of latitude, or a degree of the great circle, seems to me, according to Ptolemy, to be near enough our usual reckoning 60 computed miles' (i.e. probably c. 65 Rm. per degree latitude and c. 43.7 Rm. per degree longitude).

A. SCOTLAND - reduced

B. SCOTLAND - turned

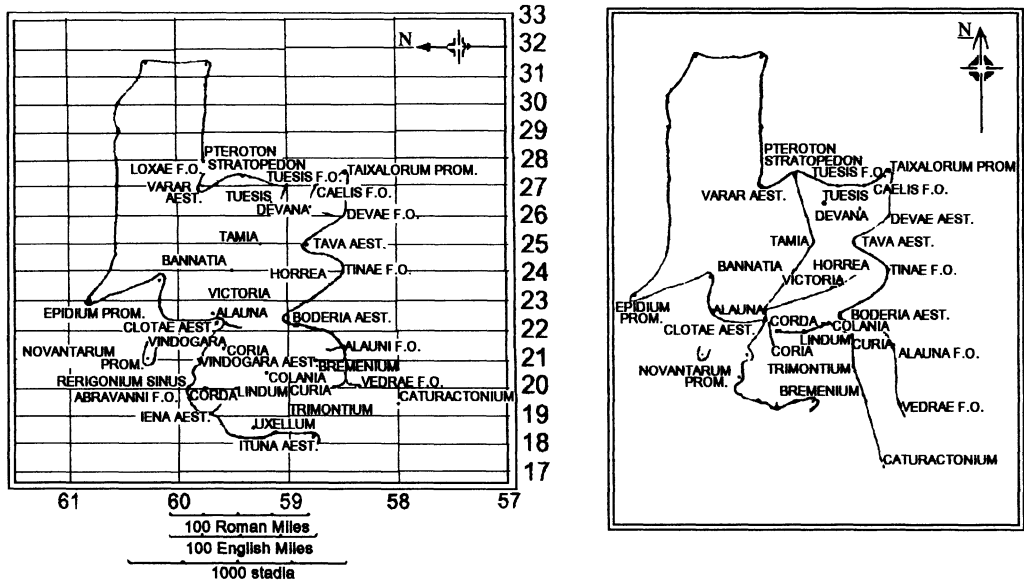


FIG. 2. Scotland reduced and turned (after Richmond 1922, 293).

- b. Bradley<sup>23</sup> did apply a rectilinear grid (ratio 0.504) to Ptolemy's Britain, whereas Mercator had used a trapezoidal<sup>24</sup> projection. Bradley does suggest that Scotland and Ireland's displacement/distortion could be explained if *separate* maps had been wrongly combined to form Britain. However he did not suggest that they could have differed in scale.
- c. Rylands<sup>25</sup> (see Strang, op. cit. (note 1), 131-4, 298-9).
- d. Tierney<sup>26</sup> (see Strang, op. cit. (note 1), 72).
- e. Richmond<sup>27</sup> was perceptive enough to feel that Ptolemy 'had access to material that might have given him an excellent picture of Roman Britain, and that might yet be unravelled if a clue upon which to work could be found'.<sup>28</sup> Also, starting with a Ptolemy map of Scotland, of rectilinear grid-ratio of 0.55, Richmond recognized a need to halve this ratio to 0.275<sup>29</sup> (FIG. 2A) to reduce the length of Scotland and he (rightly, as it turns out) chose *Vedrae*

<sup>23</sup> H. Bradley, 'Ptolemy's Geography of the British Isles', *Archaeologia* xlviii (1885), 378-96.

<sup>24</sup> See Strang, op. cit. (note 1), 20; 63-4 for analysis of Ptolemy world map projections.

<sup>25</sup> T.G. Rylands, *The Geography of Ptolemy Elucidated* (1893). Small and full-sized worlds should each revolve 360 degrees in 24 hours (i.e. 15 degrees per hour). However to cover the same longitudinal distance on the small Ptolemy world it would need to rotate 18 degrees per hour. Rylands failed to reconcile these conflicting elements in his suggestion of faulty celestial observations.

<sup>26</sup> J.J. Tierney, 'Ptolemy's map of Scotland', *JHS* lxxix (1959), 132-48. Tierney recognised that Ptolemy's co-ordinates were mainly based on land/sea measurements and directions. He discounted reliable astronomical observations and accepted that general location error could be up to 30 minutes of arc.

<sup>27</sup> I.A. Richmond, 'Ptolemaic Scotland', *PSAS* lvi (1922), 288-301.

<sup>28</sup> idem, 288. I concur wholeheartedly with Richmond and believe that the vital clue has now been found.

<sup>29</sup> The ratio 0.275 gives a longitudinal scale of 17.2 Rm./degree (cf. ultimately 25.8 Rm. per degree) for Scotland which is an over-reduction but an improvement on the often accepted value of 34.4 Rm. per degree (ratio 0.55).

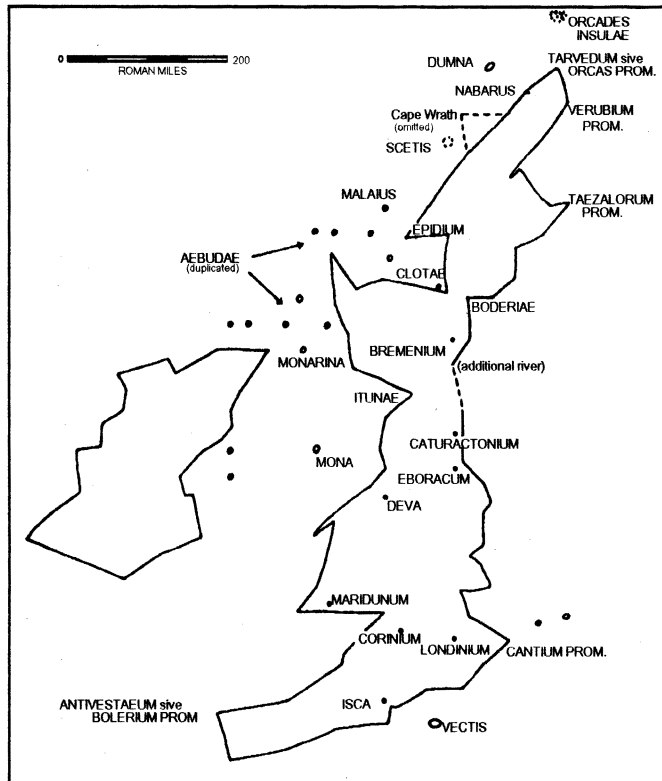


FIG. 3. Scotland turned to bring *Epidium Prom.* and *Epidium Insula* into coincidence (after Rivet and Smith 1979, 113).

*fluminis ostia* (mouth of R. Wear, FIG. 2B) about which to rotate Scotland by 90 degrees not realising that only 70 degrees relative to England was necessary.

- f. The first Ordnance Survey<sup>30</sup> Ptolemy map of Britain was drawn to a grid-ratio of 0.55 and this was adopted, together with the addition of a linear scale incorporated by Rivet<sup>31</sup> in the fourth edition of the O.S. Map, and then by Rivet and Smith as below.
- g. Rivet and Smith<sup>32</sup> made an attempt to 'turn' Scotland relative to England by about 51 degrees, FIG. 3, but used the *Itunae fluminis ostia* (mouth of R. Eden) for the pivot point, as they considered that the mouth of the R. Tyne should have been included by Ptolemy. This is invalid, as, if this had been the case in Ptolemy's rotation of Scotland, then the south-east of Scotland would have compressed the north-east of England and this has not happened. It is also rather obvious from Rivet's map-comparison in FIG. 3 that there is something far amiss with the apparent scale of the Ptolemy map, England although reasonable in length is not nearly wide enough etc. Rivet (Rivet and Smith, 123-8) also conducted an exercise of distance reconciliation on the grossly distorted map of Scotland unaware that his basis for longitudinal scale was anything but secure. His belief that 'it is possible, given a firm basis,

<sup>30</sup> Ordnance Survey, *op. cit.* (note 15), 20.

<sup>31</sup> A.L.F. Rivet, 'Some aspects of Ptolemy's geography of Britain', in R. Chevalier (ed.), *Littérature gréco-romaine et géographie historique* (1974), 56. This is the first time a linear scale was added to the severely distorted Ptolemy map of Britain.

<sup>32</sup> Rivet and Smith, *op. cit.* (note 9), 112-14.

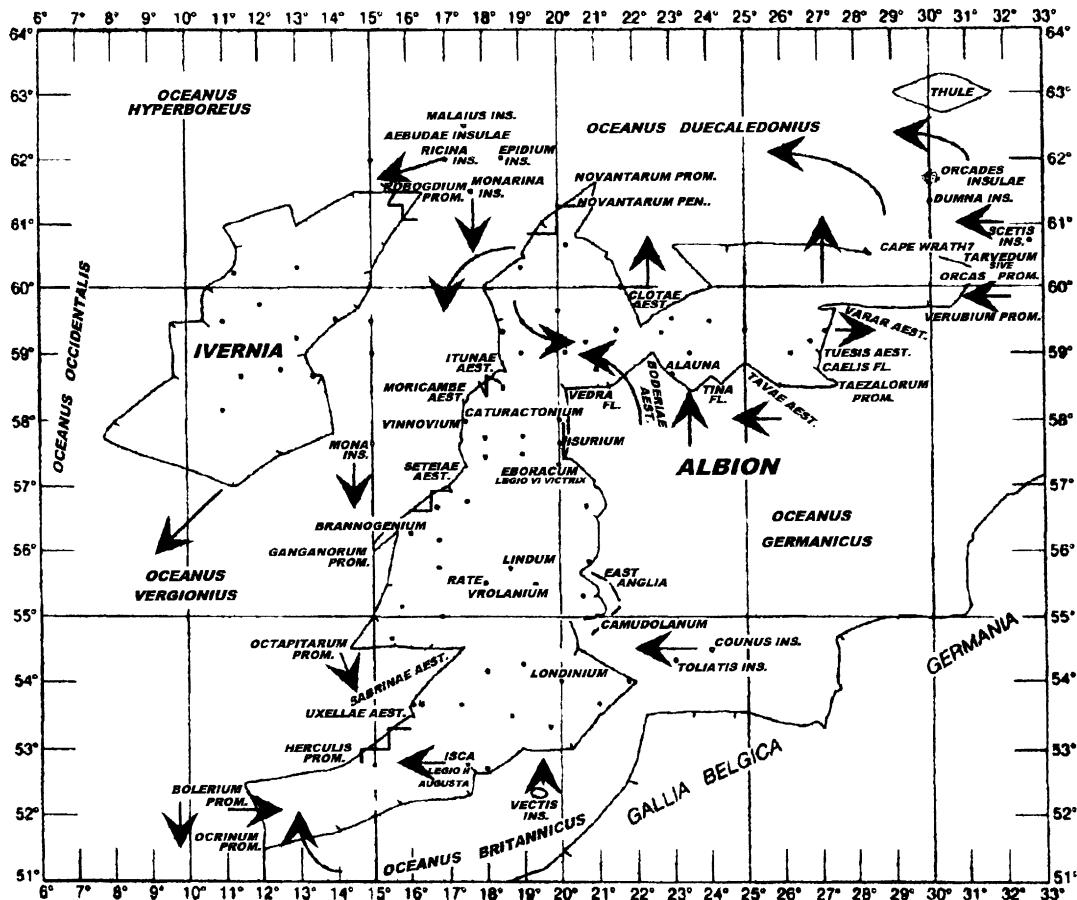


FIG. 4. Visible problems with Ptolemy's map of Roman Britain.

to make sense of Ptolemy's data by taking him at face value and applying simple measurements' was, to say the least, ill-founded.<sup>33</sup>

We can observe what appear to be some of the major geographic aberrations within FIG. 1, with the probability that the longitudinal scale varies significantly from the traditionally accepted 0.55 proportion of the latitude scale. These initial observations follow and are identified in FIG. 4.

*Apparent problems with Ptolemy's map for it to be a reasonable representation of Britain*

1. Towns: *Isca* (Exeter), *Vrolanium* (St Albans), *Brannogenium* (Leintwardine), and *Vinnovium* (Binchester) relatively out of position.
2. Land lost: Part of west and east Ireland, Cape Wrath, and East Anglia.

<sup>33</sup> Similarly, J.C. Mann's view, *PSAS* cxx (1990), 62 that, 'internally the measurements are correct, and Scotland in Ptolemy's map can be put right by a simple 90° turn to the left', is not considered a serious comment.



3. Islands: *Ivernia* (Ireland), *Ricina* (Rathlin), *Monarina* (Isle of Man), and *Mona* (Anglesey) are too far north. *Thule* (Shetland), *Orcades* (Orkneys), and *Dumna* (Lewis) need to rotate and shift north to be positioned above a repositioned Scotland. *Vectis* (Isle of Wight) is too far south and *Scetis* (Skye), *Toliatis*, and *Counus* are positioned too far to the east.
4. Seas and estuaries: The Bristol Channel is too wide and *Clotae aest.* (Clyde) is too far into Scotland. *Tavae aest.* (Tay) is relatively too far from *Tina flumen* (Eden) and *Bodotriae aest.* (Forth), *Tuesis aest.* (Spey), and *Caelis aest.* (Deveron) are displaced relative to *Varar aest.* (Beaully Firth) and *Taezalorum Prom.* (Kinnairds Head).
5. Scotland and *Albion*: Relative to England a large anticlockwise rotation is required, pivoted around *Vedra flumen* (Wearmouth), but less than 90 degrees, as *Albion* (England) requires some prior rotation to reproduce the NNE–SSW sloping profile that typifies the east coast of England. If Scotland had been rotated, with separation from *Albion* along the *Vedra/Ituna* line a large gap would have been created which appears to have been filled by clockwise rotation of the (true) South of Scotland; this requires undoing.
6. Coastal lengths: Too long between *Heracles prom.* (Hartland Point) and *Uxellae aest.* (Parrett); *Ganganorum prom.* (Braich-y-Pwll) and *Setiae aest.* (Mersey); *Morecambe prom.* (Wavermouth Bay) and *Itunae aest.* (Solway/Eden); and generally from *Itunae aest.* to *Novantarum prom.* (Mull of Galloway). The distance between *Bolerium prom.* (Land's End) and *Ocrinum prom.* (The Lizard) is too large and their relative positions too far west. *Novantarum prom.* has been elongated. The (true) west coast of Scotland appears to have been displaced inwards, the (true) northern peninsula elongated, and the Fife coast appears to have been displaced to the (true) east. The south coast of *Ivernia* appears convex as opposed to actually having a concave shape.
7. Alignment: *Caturactonium* (Catterick), *Isurium* (Aldborough), and *Eboracum* (York) are in alignment which is substantially correct but this should *not* be directly north of *Londinium* (London). Herein lies the vital clue for which Richmond had been searching in 1922.

#### THE MAP OF PTOLEMY'S BRITAIN, DRAWN TO APPROPRIATE SCALE

The latitude scale for Ptolemy's Britain is fixed at 62.5 Rm. per degree. Let us then consider what would be the appropriate longitudinal scale or scales for the various parts of Ptolemy's British Isles. It is unlikely to be singular or have the traditionally uniform and accepted ratio-value of 0.55 (i.e. 34.4 Rm. per degree). Firstly for England, we take a selection<sup>34</sup> of 'known' Ptolemy places and relate their Ptolemy angles of longitude difference from London<sup>35</sup> to their actual distance from London on a modern map. This exercise gives a first approximation for England's Ptolemy scale of 41.25 Rm. per degree. Secondly, we similarly relate actual separation distances between selected,<sup>36</sup> 'known' Ptolemy places in Scotland and Ireland to their longitude difference. Both Scotland and Ireland appear to exhibit a common longitudinal scale at 25 Rm. per degree. We may now construct a first approximation map for Ptolemy's Britain. This is defined by a double or birectangular lattice, drawn to the two appropriate longitudinal scales as shown in FIG. 5.<sup>37</sup> This first approximate map can now be compared with

<sup>34</sup> We must avoid the north of England as it has been twisted to be directly north of London and several grossly distorted or elongated regions (e.g. East Anglia, Land's End area) and some 'places' are obviously out of position.

<sup>35</sup> Strang, *op. cit.* (note 1), 76–8, for selection of London as preferred, preliminary datum for map comparison.

<sup>36</sup> *idem*, 79–80, for the rather limited selection permissible.

<sup>37</sup> Initially the two grids (at 41.25 and 25 Rm. per degree) are matched at Ptolemy's 20° (London) longitude line but with later refinement at 21° with refined (final) scales of 41.67 and 25.8 Rm. per degree respectively. By inspection and trial testing it is possible to configure the grid relationship between England and Scotland.

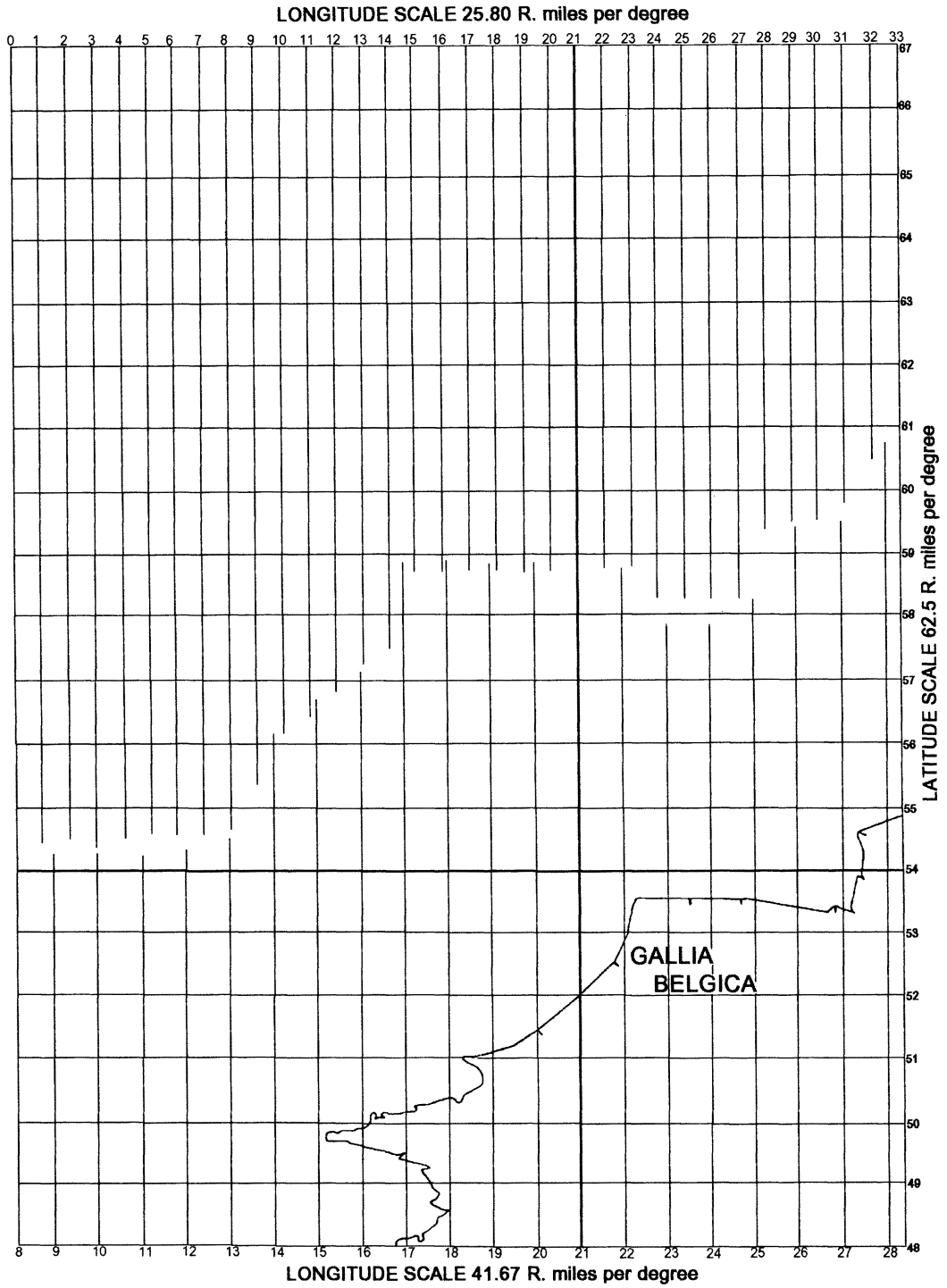


FIG. 5. Final birectangular, scalar grid for Ptolemy's map of Britain.

a modern map of Britain in order to refine these scales, optimize the grid connection and the datum for comparison and find the optimal pivot points about which a Ptolemy original map could have been rotated to arrive at the version of Ptolemy's Britain with which we have become accustomed (e.g. FIG. 1).

#### RESOLVING PTOLEMY'S MAP OF BRITAIN

For Ptolemy's smaller world surface, his representation of linear distance between places (probably from information on directly estimated distances and bearings by land and sea journeys)<sup>38</sup> will proportionately encompass more degrees of longitude or latitude angle than is the case on a normal world representation. However, providing the correct scales are applied to the Ptolemy map it should be directly comparable with a modern map of Britain providing both maps are drawn to the same linear scale in the latitude direction (i.e. converted to the same Rm. per cm from the basis of 62.5 and 75 Rm. per degree respectively). The modern map, chosen as the master for the comparison, is a modified version of the O.S. Map of Roman Britain (see note 15), with the Orkneys and Shetlands repositioned to their appropriate locations north of Scotland. A transparent copy of a newly prepared Ptolemy map, plotted on a birectangular grid was then superimposed on the master map with initial coincidence at London.<sup>39</sup>

FIG. 6. shows on an outline map the vitally important, true line A–A, as the alignment of Catterick, Aldborough, and York, which also happens to pass through Colchester.

#### ROTATIONAL DISPLACEMENT

##### England

It is clear that, to bring the Ptolemy line that passes through *Caturactonium*, *Isurium*, *Eboracum* (which also passes through *Londinium* and not *Camudolanum*) into register with the line A–A it will be necessary to rotate the Ptolemy map anticlockwise, around a pivot position on the line A–A and somewhere north of London. To find this point we connect several selected<sup>40</sup> 'known' places on the new Ptolemy map to their respective locations on the master map. The orthogonal bisectors of these lines, irrespective of rotational direction or angle all meet at a common point on A–A if Ptolemy's England(/Scotland) has been the subject of a single rotational exercise, even if this has been applied differentially across the land. The common pivot point, Pt1, found, coincides with Long Melford but no significance attaches to this village. As it happens, this is a secondary consequence of Ptolemy's manipulations of Scotland, and of the fact that the present analysis has to be conducted in reverse to get the map back to where Ptolemy started from. The superimposed Ptolemy map can now be rotated around Pt1, and it is soon discovered that all the places for England fall into several specific rotational groups. This is on the assumption that all Ptolemy places<sup>41</sup> are subject to small positional

<sup>38</sup> See Strang, op. cit. (note 1), 55–6 and 76–8, for convenient comparison between the Ptolemy world and the real world. Previous methods of map comparison/analysis are also discussed and the conclusion reached that for Ptolemy's highly distorted map, superimposition would be most effective using Ptolemy isopleths only, so that distances represented by the modern master map are indicated at their actual magnitude, in any direction. This is a novel approach and the reverse of applying modern isopleths to ancient maps (e.g. W.R. Tobler, 'Medieval distortions; the projections of ancient maps', *Annals of the Association of American Geographers* (1966), 365) which only emphasises the variability of scale of the ancient map and does not give true linear scale between isopleths.

<sup>39</sup> Strang, op. cit. (note 1), 76–8, 272.

<sup>40</sup> 'Known' places are chosen in England only, that are not obviously, drastically out of relative position or too close to the pivot point. For FIG. 6, *Ituna* (Solway/Eden), *Vedra* (R. Wear), *Ganganorum prom.* (Braith-y-Pwll), *Maridunum* (Carmarthen), and *Tamarus fl.* (R. Tamar) are for example shown connected to their real locations.

<sup>41</sup> See Strang, op. cit. (note 1), Appendix 1, and later for definition and explanation of positional error associated with Ptolemy places.

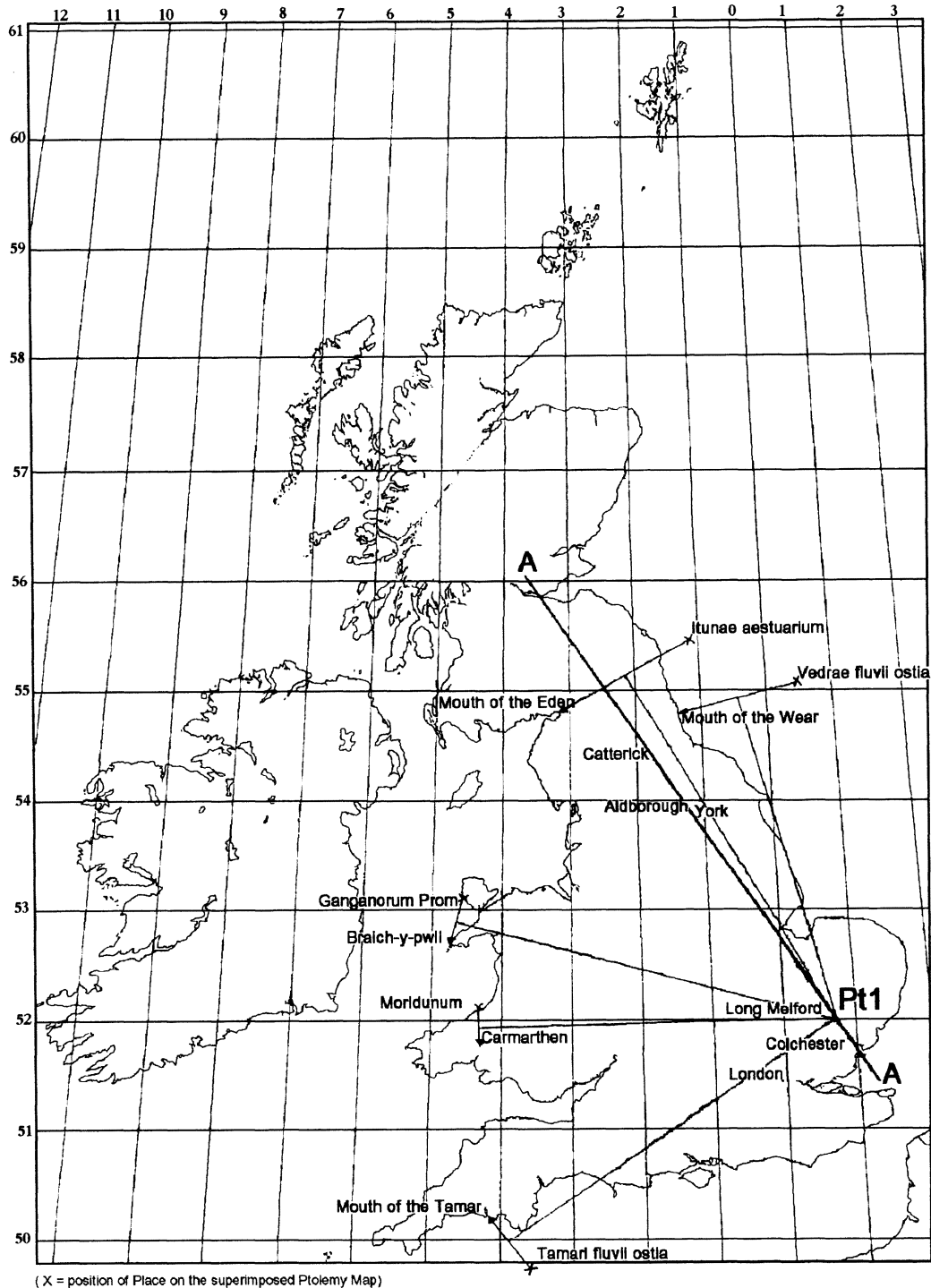


FIG. 6. *Eburacum* to *Caturactonium* extended line A-A and a selection of Ptolemy 'place' displacements from their true positions.

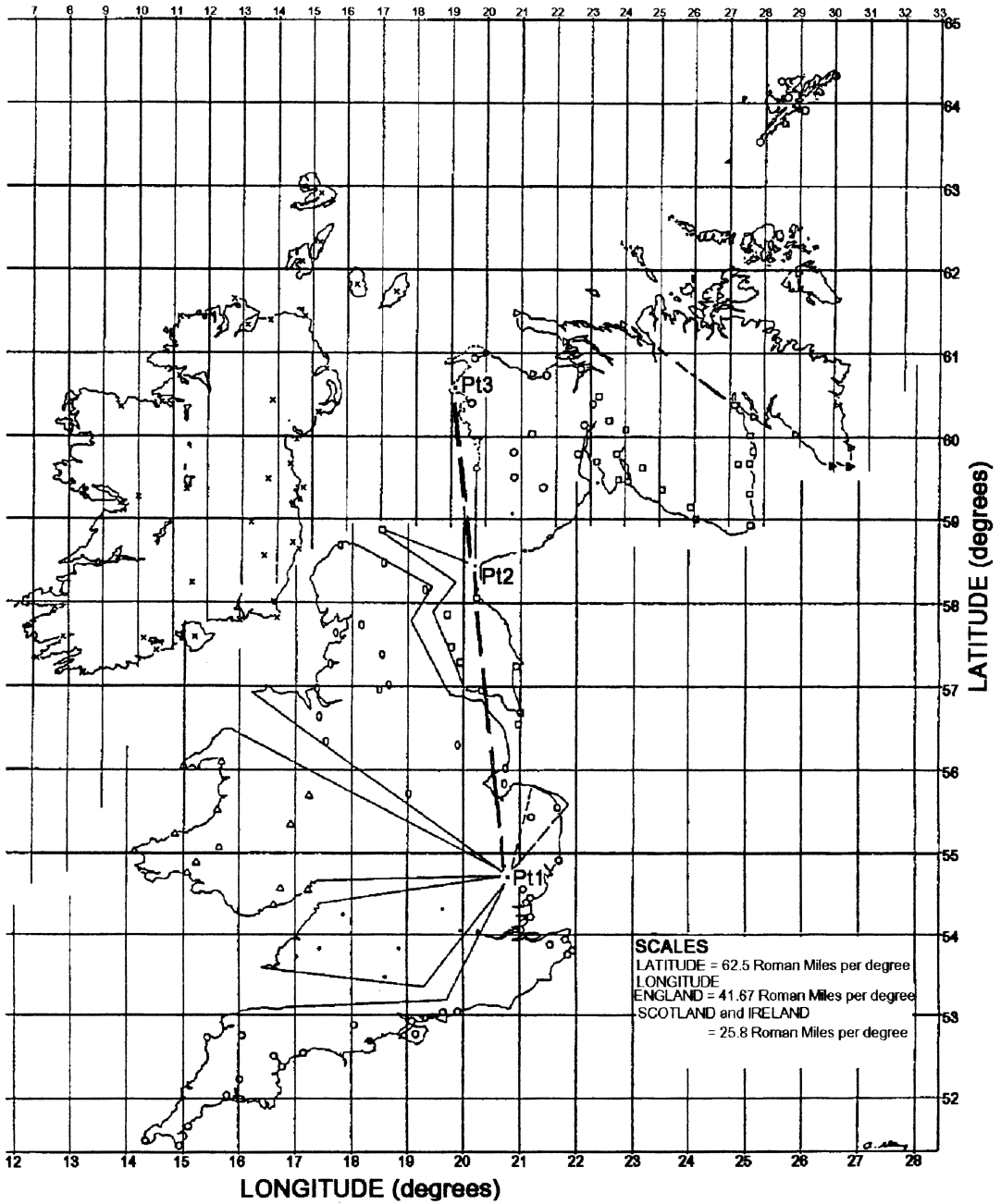


FIG. 7. Ptolemy's dissociation of England, rotation of Scotland, and lateral shift of Ireland.

inaccuracies and that some will require a degree or so of lateral shift in order to achieve registration with their locations on the master map.

Where geographically associated groups of places are subject to an identical lateral shift, this unquestionably has been deliberately applied by Ptolemy. However, where individual places require an isolated shift (often of whole degrees), with no group-association and for no apparent purpose, this has been regarded as 'transcription error', caused through translation, miscopying, misplotting, misreading, or transcribing Ptolemy's original co-ordinates over the centuries. Hence the *Geographia* co-ordinate has accordingly been adjusted to its more appropriate value by removing such a 'step-error'.

The rotational groups identified in England, with their associated angle of rotation are basically:

East Anglia and South Coast	- 10° (i.e. anticlockwise)
London to Severn	0°
Wales and Midlands	7° 30'
North-west	15°
North-east and East Coast	20°

FIG. 7 shows this rotational dissociation of England. It has become obvious that Ptolemy's map incorporates bands of territory that do not exist and that in East Anglia land has actually disappeared, hence my rejection of previous work on the Ptolemy problem based on simple map-distance between places and of Ptolemy maps with linear scales attached.

### Scotland

In effectively turning England through 20°, Scotland moved through the same angle. To achieve realistic positioning it is now necessary to rotate Scotland through a further 70°, but around a new pivot point, Pt2, while England remains stationary. Now, Pt2 should be at Wearmouth as explained with respect to the Richmond and Rivet choice of pivot points. South-west Scotland has obviously separated from England during Ptolemy's rotation, so that he was then obliged to rejoin the coastline to *Ituna* whose location remained in association with England, (we will return to this feature later). When Scotland was turned around Pt2, Ptolemy dropped off the larger islands at convenient places; *Thule*<sup>42</sup> at 35° and the *Orcades* at 55°, trying to maintain some sort of visual integrity in their relative positions above Scotland. He further subjected *Thule* to a rotation of 40° so that it lay along the 64°N parallel.

### South of Scotland

An enlarged view of the south of Scotland is shown in FIG. 8A and fortunately two of Ptolemy's places are known, *Trimontium* (Newstead) and *Colania* (Camelon most probably). To locate the pivot point for this area, it is necessary to perform a similar exercise to that which was done in England to locate Pt1: *Trimontium* is joined to Newstead and the line bisected at right angles and similarly for *Colania*. It is found that the two bisecting lines intersect near Whithorn, and thus define pivot position Pt3. It is also discovered that the rotational angle about Pt3 is 45 degrees. When this is applied to the other relevant Ptolemy places they fall into the locations shown. *Clotae aest.* appears to have been included with the ten southern Scottish places. *Clotae aest.*, *Vindogara*, and *Rerigonium* move exactly to their anticipated positions whereas the five unknown *poleis* move to positions which have not previously been expected or suggested. It was only at this stage of the analysis that the unexpected arrangement of Pt 3, Pt2, and Pt1 in a

<sup>42</sup> Pytheas' *Thule* is well argued by C.F.C. Hawkes, *Pytheas: Europe and the Greek Explorers* (1975), 35 and R. Selkirk, *The Piecebridge Formula* (1983), 173–4, to identify with Iceland whereas the *Thule* of Agricola (Tacitus, *Agricola* 10.6) and of Ptolemy (O.A.W. Dilke, *Greek and Roman Maps* (1985), 136) undoubtedly refers to Shetland.

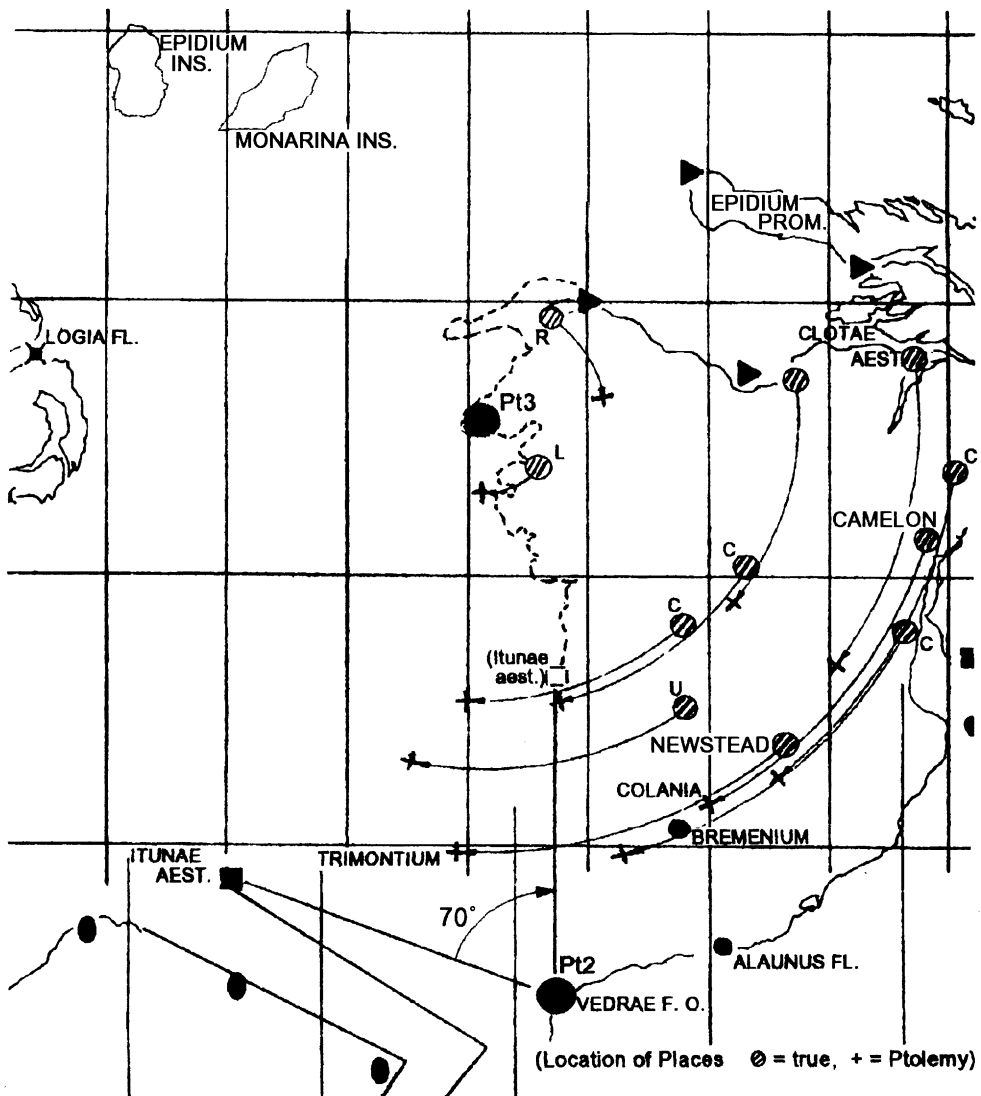


FIG. 8A. South of Scotland, Ptolemy map rotated by 45 degrees about Pt3 so that *Trimontium* and *Colania* coincide with *Newstead* and *Camelon*.

straight line was appreciated. Of course, the Ptolemy sequence would have been Pt2 then Pt3 and the extension of their connecting line would have intersected the *Caturactonium–Camudolanum* line at Long Melford (i.e. Pt1).<sup>43</sup> Once Ptolemy had rearranged these places into the gap created by rotating Scotland by 70 degrees relative to England, he had to stretch and reconnect the coastline back to *Ituna*, FIG. 8B. This appears probably to have been done freehand, as the coastal features do not seem to move in a consistent pattern, from *Ituna*

<sup>43</sup> This would seem to support somewhat the basis, method, and assumptions of the analytical exercise.

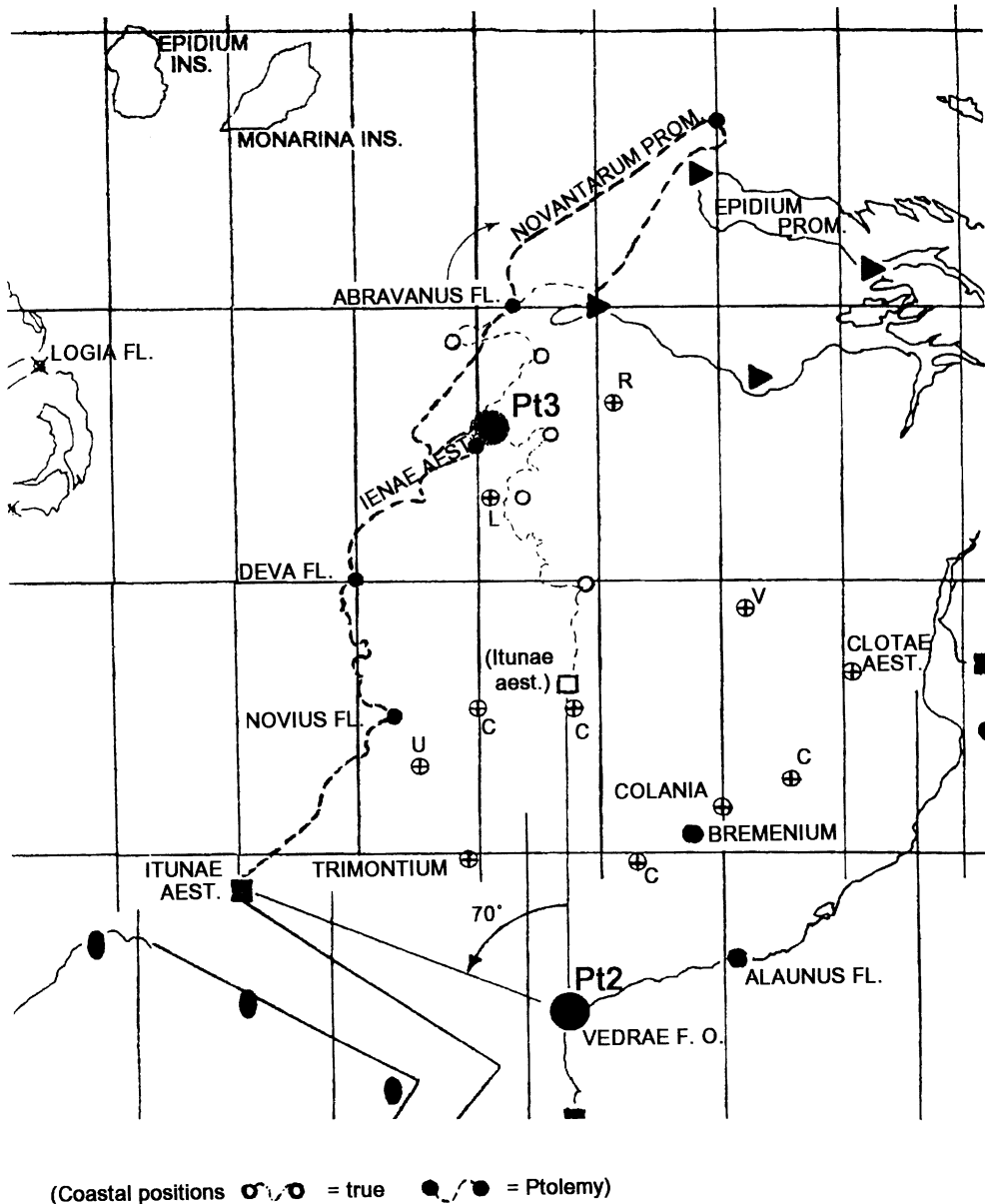


FIG. 8B. South of Scotland with Ptolemy coastline.

outwards, creating a longer coastline and giving a rather irregular relationship between the Ptolemy river-mouths. However, when *Novantarum prom.* (Mull of Galloway) is reached, it must then have been realized that *Monarina Ins.* (Isle of Man) was plotted in a position directly to the west of *Epidium prom.* Hence it must have been thought as more realistic, through clockwise rotation, to interpose an elongated *Novantarum Pen.* (Rhins of Galloway) between these two last features, as shown in FIG. 8B.



## LATERAL DISPLACEMENT

Inspection of FIG. 7 shows that Ireland has been subjected not to rotation, but to major lateral movement ( $6^\circ$  east and  $3^\circ$  north), to bring it into relative proximity with the South of Scotland. *Mona Ins.* (Anglesey), on the larger scalar grid, has been moved  $1^\circ 30'$  directly north, whereas *Monarina Ins.* (on the smaller grid) has the same relative movement plus the associated movement of Ireland to give  $6^\circ$  east and  $4^\circ 30'$  north. Additionally, many localized areas of the map, particularly in Scotland, have been subjected (often in groups) to small lateral and vertical displacements; these may generally be seen to be the result of perceivable aims.

It is probably most revealing to summarize these as shown in FIGS 9A–B.

*Differential shift — longitude* (FIG. 9A)

The whole of the (real) west of Scotland (note, not along the Great Glen) beyond *Lemannonius Sinus* (Loch Fyne as it turns out) to *Ripa Alta* (Hill of Nigg) has been slid to the east, presumably to reduce the sea distance to Europe.<sup>44</sup> Places in mid-Scotland have been moved west, possibly to compensate somewhat for places already rotated into the South. These are followed by some (all if non-Müller<sup>45</sup> co-ordinates are included) places on the Moray Firth.<sup>46</sup> Once *Scetis Ins.* (Skye) was moved  $1\frac{1}{2}^\circ$  to the east it registered  $28^\circ 15'$  on the small grid scale: it is suspected that this was subsequently plotted on the larger scale, since this would explain exactly the *Geographia* longitude of  $32^\circ 40'$  for *Scetis*, on the smaller scale, and its otherwise apparently inexplicable position on the Ptolemy map.

*Maleus* (Mull) and *Epidium Ins.* (Arran) have been moved closer to Scotland and were followed by *Ricina* (Rathlin). This also necessitated the moving eastward of *Robogdium prom.* (Fair Head) by the same amount. The south-east Irish coast, above *Sacrum prom.* (Carnsore Point), has approached too closely to the Welsh coast and appears to have been adjusted, as Ptolemy would have been aware of *Hibernia's* position relative to Britain in Pliny's *Natural History*.<sup>47</sup> In south-west England, all places west of *Tamarus Fl.* (Tamar) have been moved  $1^\circ$  to the west, with an additional  $2^\circ$  movement given to Land's End and the Lizard. To the east of *Tamarus Fl.*, *Isca*, and *Isca Fl.* (R. Exe) have conversely been moved  $1^\circ$  to the east but *Alauna Fl.* (R. Axe) only half a degree to the east. In East Anglia, repositioning has taken place to compensate for the loss of land here and the two islands, *Counus* and *Toliatis*, move away from the coast. This would appear to be a simple transcription error from the original *Geographia* text. *Counnus* longitude  $24^\circ = \bar{\kappa}\delta'$  probably was  $\bar{\kappa}\delta' = 20^\circ 15'$  and *Toliatis* longitude  $23^\circ = \bar{\kappa}\gamma'$  probably was  $\bar{\kappa}\gamma' = 20^\circ 20'$ .

*Differential shift — latitude* (FIG. 9B)

This figure shows these longitudinal, deliberate adjustments effected and the pattern of accompanying latitudinal movements. For Scotland, Ptolemy could now move *Thule* onto  $63^\circ$  latitude and adjust some of the islands of Scotland, including Mull, to compensate.<sup>48</sup> The

<sup>44</sup> This sea crossing would have been an important (known) feature for early voyagers, unable to hug the coast (see Strabo, *Geography* IV.3.4, IV.5.1–5 and in Rivet and Smith, op. cit. (note 9), 91–2).

<sup>45</sup> C. Müller, *Claudii Ptolemaei Geographia* (1883).

<sup>46</sup> I suspect that *Verubium prom.* (Noss Head) and *Virvedrum prom.* (Duncansby Head) also followed, having previously moved  $1^\circ$  east rather than  $\frac{1}{2}^\circ$ , as shown.

<sup>47</sup> 'This [Hibernia] lies above it, 30 miles from the tribe of the Silures by the shortest crossing' (Pliny the Elder, *Natural History* IV.102–4; written in the A.D. 70s, see Rivet and Smith, op. cit. (note 9), 80 and J.C. Mann and R.G. Penman, *Lactor* xi (1985), 14).

<sup>48</sup> The apparent deletion of Cape Wrath prevents its interposition between *Orcades* and *Orcas prom.*

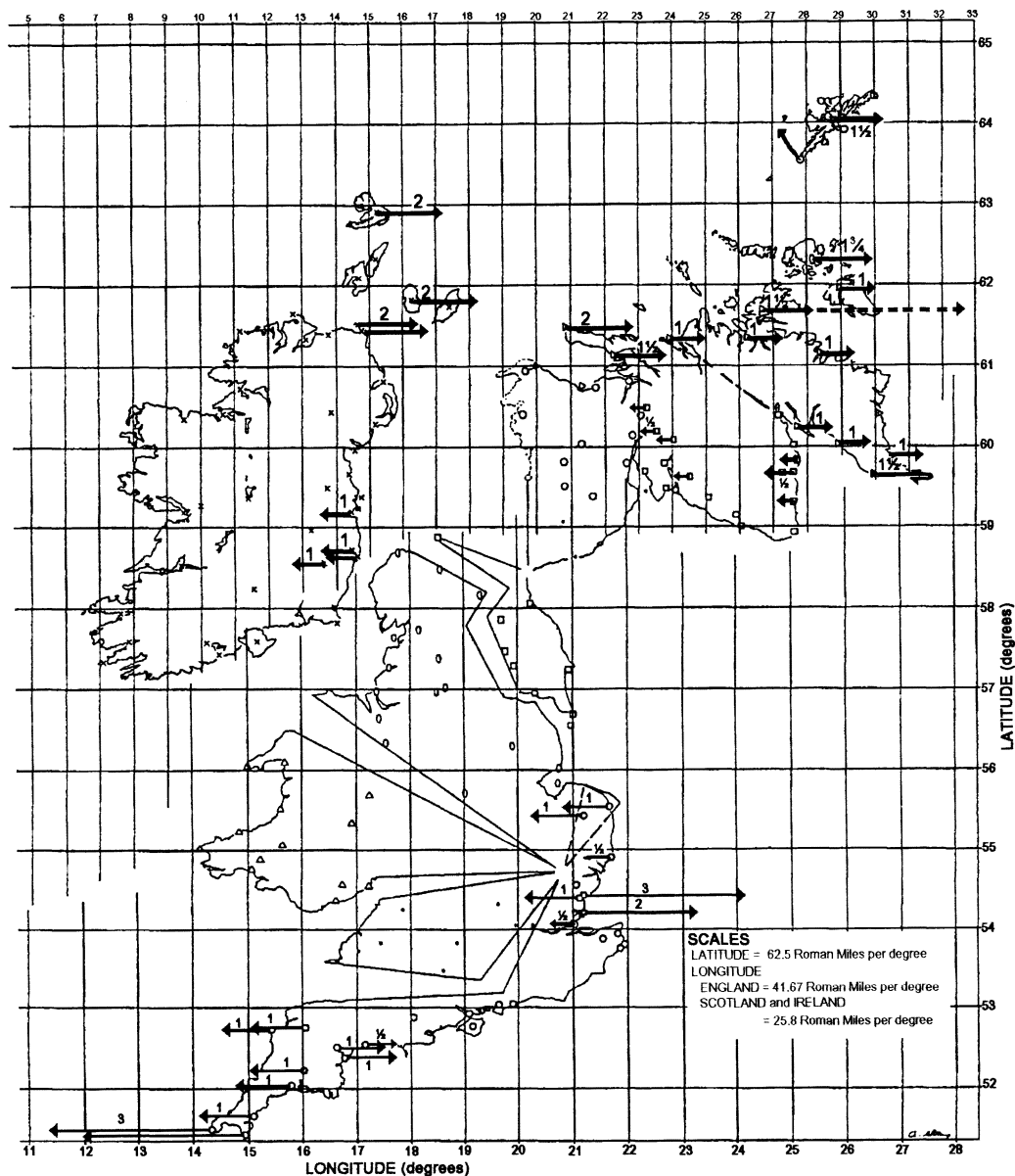


FIG. 9A. Differential shift — longitude.

(real) west coast of Scotland is moved forward by two-thirds of a degree and the north and north-east somewhat less. *Clotae Aest.* has been rotated considerably, *Lemannonius Sinus* appears to have been moved one degree to try and preserve its relationship with this Clyde movement. Fife moves similarly and the central places seem to retain (a compromise)

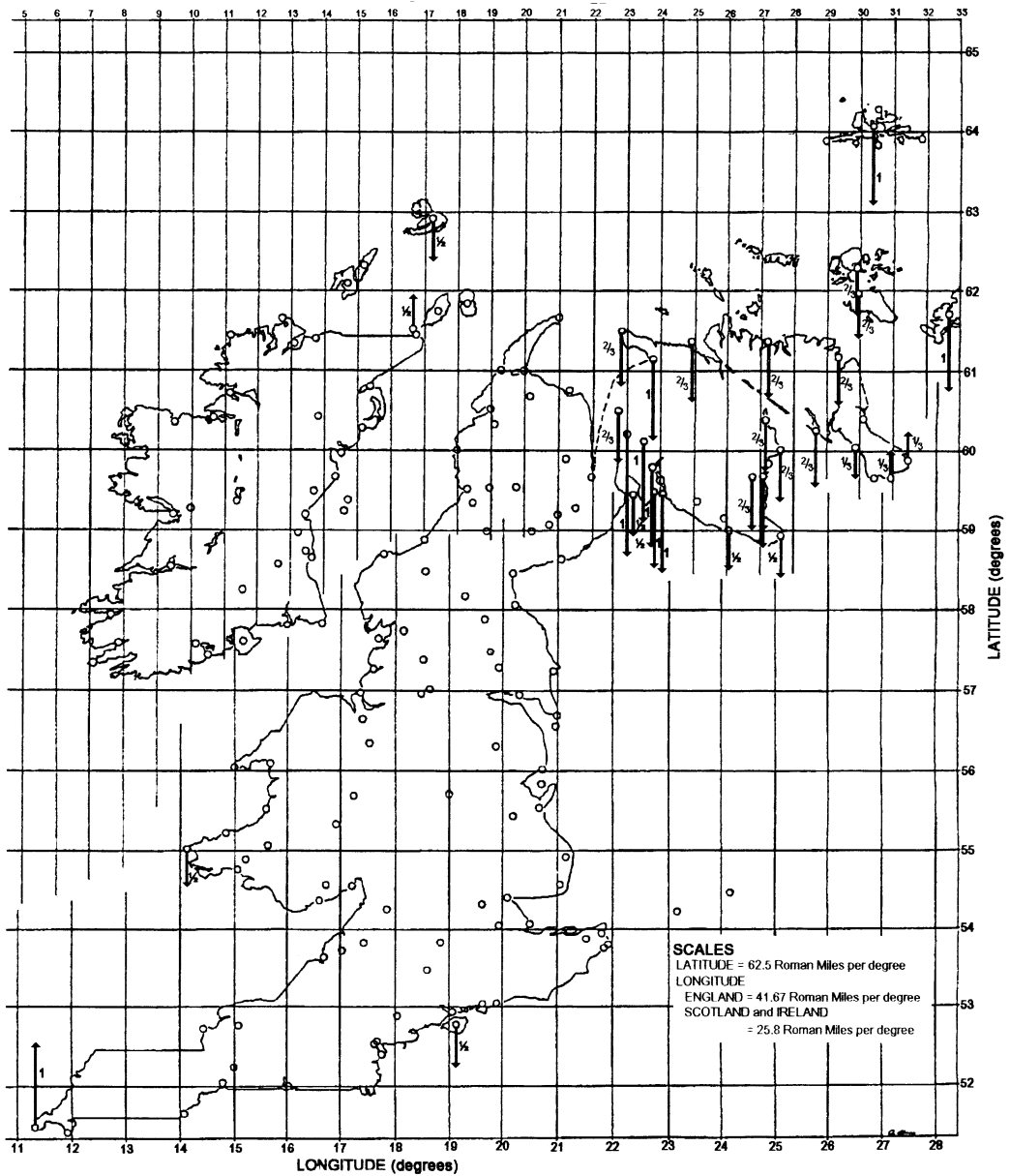


FIG. 9B. Differential shift — latitude.

relationship with the west and north. Little adjustment is made in England other than an apparent narrowing of the Bristol Channel, possibly so that the crossing distance from Lands End to St David's Head could be relatively maintained.

## QUANTIFYING THE EMPIRICAL ANALYSIS

If we consider that every Ptolemy place plotted from the *Geographia* will be in error, longitudinally and latitudinally, to a greater or lesser extent, providing that these errors can be explicitly defined, their magnitude may then be resolved.

In the *Geographia*, for over half the British co-ordinates,<sup>49</sup> part degrees are at 0' or 30' and a further quarter at 20' or 40' so it can be expected that any small positional errors will be less than 30'. Also for Britain,<sup>50</sup> the identification of 55 per cent of Ptolemy places is certain, 14 per cent virtually certain, 15 per cent most likely, and 16 per cent unknown. Hence if we can register the 'known' 84 per cent, within quantifiable tolerances, the 'unknown' 16 per cent should locate at their most likely positions within similar tolerance, which on average will be much less than 30' of arc in both longitude and latitude directions.

## DEFINITION OF ERROR CATEGORIES

1. Background noise. Inadvertent small errors in location of all Ptolemy places, which is assumed to exhibit a uniform randomness throughout the map of Britain and which cumulatively should not exhibit preferential bias between east–west or north–south.
2. Datum offset. Providing that cumulative 'noise' has been minimized, then any residual error, in either of the cardinal directions, may be reduced by slight compensation in the co-ordinates of the initial datum chosen.
3. Inadvertent linear error. Ptolemy's text contains isolated co-ordinates exhibiting a 'step' error (e.g. 1°), these can become increasingly obvious within a map, in relation to adjacent places or to the sequences contained in the text itself or in comparison with other sources (e.g. Peutinger Table etc.). These are most probably the result of transcription errors.
4. Deliberate linear and/or angular error. These are intentional changes introduced by Ptolemy (or his colleagues) to achieve specific aims. For Britain they normally seem to apply to groups of places, adjusted to a pattern, or to features relatively displaced (e.g. Ireland relative to Scotland).
5. Scalar error. This error can exist locally or extensively throughout a Ptolemy map and surprisingly is not confined to longitude scale.

If these errors can be recognized, evaluated, and compensated for or eliminated, either instantly or gradually, for Ptolemy 'known' places then his 'unknown' places can be brought into registration with their most likely, true locations over the O.S. map. The latter, of course, represents true scale as opposed to positional separation on the Ptolemy map which locally, may not be either a true or uniform representation of distance.

## EVALUATION METHOD AND CONTROL FEATURES

Ptolemy's co-ordinates for Britain in the *Geographia*, are arranged in the following groups: islands near Ireland; west then south then east coasts of Britain; peoples and places in southern then northern Scotland, then in northern England, and then in northern Wales and mid-England. Peoples and places are then listed for south Wales and England and finally the islands off Britain are given. However it is very obvious that these are the result of just listing places from an existing map in a methodical, sequential manner. The Ptolemy map is, however,

<sup>49</sup> Strang, *op. cit.* (note 1), 91.

<sup>50</sup> *idem*, 275.

distorted by displacement of quite different groups of places from those just enumerated. These latter groups behave as families of places sometimes subjected to more than one lateral or angular displacement or a combination of these. Also a group within a family can be subjected to additional movement. Hence the first priority is to facilitate the easy rearrangement of places into new families and groups within families that are more geographically related and that are being similarly displaced (i.e. do not register with their true positions to the same angular and/or lateral extent). This is readily achieved by computer 'sorting' with each place being allocated easily adjustable 'group' and 'order within group' identities.<sup>51</sup> Each 'known' place, in order to register with its true position on the O.S. map, had its specific errors evaluated (i.e. a combination of any deliberate lateral and angular shifts required, any obvious inadvertent 'step' deviations, any fine (less than 30') 'noise' errors and any overall adjustments required due to comparison-datum inaccuracies). This exercise<sup>52</sup> was conducted four times (i.e. iterations) each time refining Ptolemy's two longitude scales to improved values. A continuous cumulative record of 'noise', in the four cardinal directions, was maintained to ensure that minimum was applied and that there was a lack of bias. The net directional noise was thus gradually reduced (to an insignificant value) by a combination of, (1) east/west and north/south (London) datum position,<sup>53</sup> (2) east/west (initially at 20°E) common meridian scale-match,<sup>54</sup> and (3) the improved longitude scales.<sup>55</sup> Simultaneous recording of distance between 'known' places and their pivot point (Pt) allowed complete monitoring of longitude scales and their improvement at each iteration<sup>56</sup> to give the 25.8 (initially 25) Rm./degree and 41.67 (initially 41.25) Rm./degree values. With these scales, 80 per cent of Ptolemy places needed less than 0.25° adjustment for noise and average 'noise' was 0.08° (i.e. 4.8'). As 7 per cent of 'known' places required adjustment for inadvertent error, then of the 30 'unknown' Ptolemy places in Britain two can be expected to require similar correction, but which two is not known.<sup>57</sup> Also as 62 per cent of places are coastal and only 38 per cent inland any uncertainty for positioning (e.g. *Salinae*) should recognize this likelihood. It also becomes evident, just from inspection of the *Geographia* text, that Ptolemy place listing is not directly the result of collecting or acquiring data from *itineraria*, *periploi* etc.<sup>58</sup> but has been copied from a 'map' showing spatial and directional relationships e.g. tribal displacement (east, above etc.) and coastal lists extending beyond tribal or territorial boundaries. Significant variances in the place-order within the *Geographia* listings and known identities in the Ptolemy map of Britain allow us to make or assume (as most likely) some justifiable adjustments<sup>59</sup> in order to register the following place-locations: *Brannogenium* (Leintwardine), *Mediolanum* (Whit-church), *Voliba* (unknown), *Darvernum* (Canterbury), *Urolanium* (St Albans), *Lindum* (Lincoln), *Ratae* (Leicester), *Vinnovium* (Binchester), *Camunlodunum* (Slack?), *Rigodunum* (unknown), *Alauna Votadini* (Learchild), and *Caleva* (Silchester). *Lindum/Alauna Damnonii* need to have interchanged co-ordinates if either is to identify with Malling/Ardoch respectively.

<sup>51</sup> *idem*, 92–4; Appendix 7, Table A.

<sup>52</sup> *idem*, 93, Appendix 8 and fig. M.

<sup>53</sup> During the analysis some bias was experienced, necessitating the original datum (London) being adjusted by 1/32° east and 1/16° north.

<sup>54</sup> The birectangular scale-match was optimised at 21°E rather than the initial choice of 20°E.

<sup>55</sup> Strang, *op. cit.* (note 1), 93–4, Table 10.

<sup>56</sup> *idem*, Appendix 8, Table B.

<sup>57</sup> *idem*, Appendix 9.

<sup>58</sup> *idem*, 152–5, this is particularly evident in Ptolemy's Map IX of Europe (lower Danube region of the Roman Empire).

<sup>59</sup> *idem*, 118–20, 293–4.

## THE EFFECT OF MAP REARRANGEMENT ON PTOLEMY PLACE LOCATION

**Southern Scotland**

When Ptolemy's Southern Scotland is rotated 45° anticlockwise (plus 70° anticlockwise with Scotland as a whole with respect to England) the places moved maintain their existing group relationship but take up new positions relative to the rest of Scottish and English places and assume the following probable identities:

*Uxellum* should be situated in Upper Teviotdale. A notable site there (in a prominent 'lofty' position but somewhat to the east) is the native site of Ruberslaw. There is certainly evidence of a Roman presence here from the (unexplained) incorporation of numerous dressed Roman stone blocks<sup>60</sup> in the native ramparts. Ward Law as a coastal identity, is unlikely to satisfy a 'high or noble' meaning but was probably selected by Rivet and Smith<sup>61</sup> from the rather arbitrary representation of a coastline applied to the Ptolemy map.

*Lucopibia* should be situated at Gatehouse of Fleet, Roman fortlet.<sup>62</sup> *Glenloch*<sup>63</sup> would appear to be too far east for a match.

*Rerigonium* suspected as close to *Rerigonium Sinus* (Loch Ryan), now positioned near Stranraer; evidence of a more southerly Roman site is confirmed by aerial photography.<sup>64</sup>

*Curia Votadini* now registers near Cramond. For some time Robertson<sup>65</sup> has been convinced (from coin evidence) that Cramond was a Flavian site. This locality would seem to satisfy a *Votadini* assembly area against attack from the North (see Postscript).

*Corda Selgovae* registers near Crawford. If *Corda* like *Curia*, *Coria*, can be interpreted as a 'gathering place'<sup>66</sup> then is Crawford more appropriate than Castledykes?

*Carbantorigum* now locates near Raeburnfoot. Rivet and Smith<sup>67</sup> suggest Easter Happlew for the time of Ptolemy's information, and a derivation of 'wagon or chariot ford'. It would certainly appear from Richmond<sup>68</sup> and Graham<sup>69</sup> that the Roman roads approaching Raeburnfoot, had been cut down through the peat to obtain a firm base, so could well have been awash.

*Vindogara* locates near Irvine.

*Clotae Aest.* locates in Firth of Clyde near Greenock.

*Trimontium* at Newstead.

*Colania* at Camelon.

*Coria Damnonii* locates in the junction of upper-Strathendrick, upper-Strathcarron in the vicinity of Balgair.<sup>70</sup> As Ptolemy tribes have only one *Coria*, *Curia*, *Corda*, (*Cibra*—Ravenna 107<sub>56</sub>) it is suspected that this is more than just a 'hosting' or central place of a tribe<sup>71</sup> and is more likely to be a recognized marshalling, assembly, or gathering-place for military purposes. If the *Damnonii* regarded their greatest threat from the marauding North, rather than from their warlike *Selgovae* neighbours then the muir areas in the vicinity of Balgair

<sup>60</sup> A. Curle 'Description of the fortifications on Ruberslaw etc.', *PSAS* xxxix (1904–5), 225–6.

<sup>61</sup> Rivet and Smith, op. cit. (note 9), 484.

<sup>62</sup> J.K.S. St Joseph in B.R. Hartley and J.S. Wachter (eds), *Rome and Her Northern Provinces* (1983), 222–34.

<sup>63</sup> Rivet and Smith, op. cit. (note 9), 390.

<sup>64</sup> G.S. Maxwell, *Ptolemy and the Map of Roman Britain*, lecture at University of Leeds, 4 February 1994.

<sup>65</sup> A.S. Robertson, 'Roman coins found in Scotland, 1971–82', *PSAS* cxliii (1983), 421.

<sup>66</sup> Rivet and Smith, op. cit. (note 9), 316–17.

<sup>67</sup> idem, 301.

<sup>68</sup> I.A. Richmond, 'A new Roman mountain road in Dumfriesshire and Roxburgshire', *PSAS* lxxx–lxxxi (1946), 103–17.

<sup>69</sup> A. Graham, 'The Roman road to Raeburnfoot', *PSAS* lxxxii (1948), 231–4.

<sup>70</sup> Strang, op. cit. (note 1), 124–5, 295.

<sup>71</sup> This would certainly not be the capital place, *civitas* of a tribe (e.g. this would have been Traprain Law for the *Votadini* and possibly Eildon Hill North for the *Selgovae*).

(somewhat protected from the north by difficult army-terrain) could well have provided a suitable offensive or defensive mustering point, hence this could well be the location of *Coria Damnonii*.

## Greater Scotland

*Victoria* locates at Fendoch. Rivet and Smith<sup>72</sup> suggest that the name relates to the *Victrix* title of the Twentieth Legion, so prefer Inchtuthil as an identity. They discount Ogilvie and Richmond's<sup>73</sup> suggestion of the Ninth Legion's rescue by Agricola, possibly at Strageath. Could this have actually taken place at or near Fendoch?

*Orrea*. Carpow? Although there does not appear to be evidence for pre-Hadrianic occupation at this site<sup>74</sup> perhaps it has yet to be found. Rivet and Smith<sup>75</sup> suggest Monifieth, north of the Tay; this would mean that the *Venicones* occupied Angus as well as Fife which is considered unlikely.

*Tameia* registers with Stracathro. Rivet and Smith<sup>76</sup> give Cardean and suggest the site should be derived from a single river name. However Cardean is at the confluence of two rivers whereas Stracathro is situated only on the West Water of the River Esk.

*Devana* most likely associated with the River Dee rather than the Don (*Devona?*); if so, then Normandykes (although only a camp) is the preferred or maybe the only identity possible.

*Tuesis* should be located on the *Tuesis Fl.* (R. Spey), possibly at Newlands near Rothes.<sup>77</sup>

*Pinnata Castra* locates just to the east of Burghead.<sup>78</sup>

*Bannatia* registers with Cardean. On inspection, the site is low-lying but fits well with a 'horn' description.<sup>79</sup>

*Alauna Damnonii*. Ardoch?

*Lindum*. Malling?<sup>80</sup>

The two *Aebudae Ins.* coincide with Islay and Jura whilst *Epidium Ins.* matches Arran. Round the Scottish coast *Lemannonius Sinus* coincides with Loch Fyne, *Ingus Fl.* with Firth of Lorn, *Eitis Fl.* with (a river in) Sound of Sleat, *Volas Sinus* with Loch Broom, *Ripa Alta* with Hill of Nigg, *Loxa Fl.* with R. Findhorn (not Lossie), and *Tavae Aest.* (Tacitus, *Taum*) with R. Tay.

<sup>72</sup> Rivet and Smith, op. cit. (note 9), 499.

<sup>73</sup> R.M. Ogilvie and I.A. Richmond, *Cornelii Taciti de vita Agricolae* (1967), 243–4.

<sup>74</sup> J.D. Leach and J.J. Wilkes, 'The Roman military base at Carpow', in *Limes, Akten des XI Limeskongresses* (1977), 47–61.

<sup>75</sup> Rivet and Smith, op. cit. (note 9), 373.

<sup>76</sup> idem, 465.

<sup>77</sup> Strang, op. cit. (note 1), Appendix 10.

<sup>78</sup> idem, 123 and Appendix 10 for relationship with *Fl. Loxa*, identified as the Findhorn and not the Lossie which has been the traditional preference. Also see D.J. Breeze, 'Agricola in the Highlands?', *PSAS* cxx (1990), 56–8; J. Macdonald in *Arch. Journ.* (1891), 48, 361–95; J.C. Mann, *Roman Northern Frontier Seminar*, unpub. typescript, Dept. of Archaeology, University of Newcastle on Tyne (1970) I, 14–17; and D.H. Sellars (ed.), *Moray: Province and People* (1993), 47–74.

<sup>79</sup> Derivation of the root *Banna* is given by Rivet and Smith, op. cit. (note 9), 261–2, and there seems to have been a tendency for meaning of 'peak' rather than 'horn' to be preferred. However, if we consider the pre-Hadrianic promontory site of Birdoswald (*Banna*, *RIB* 1905, Rudge Cup, Amiens patera, Ravenna Cosmography 107<sub>28</sub>, and Hassall, op. cit. (note 18), 113), which was little more than a Roman signal station then (P. Howard, *Birdoswald Fort on Hadrian's Wall* (1969), 9, 21), it admirably suits the description of 'horn or tongue' from its situation within the sharp sweep of the Irthing river. Secondly if we now consider Horncastle (*Bannovallum*, Ravenna 106<sub>55</sub>) described by Rivet and Smith, op. cit. (note 9), 265, as on the 'spur' at the junction of the river Bain and another, this fits a similar interpretation. Similarly, Whilton Lodge (*Bannaventa*, Antonine Itinerary 470<sub>5</sub>) is described by B. Dix and S. Taylor, 'Excavations at *Bannaventa* 1970–1', *Britannia* xix (1988), 299 as 'market on the spur'. Ptolemy's *Bannatia* seems to coincide with the Roman site at Cardean and G.S. Maxwell in *The Romans in Scotland* (1989), 109, describes the Cardean fort as 'at the confluence of the Isla and the Dean'.

<sup>80</sup> Strang, op. cit. (note 1), 120; Appendix 10.

## England

*Maglone* at Whitley Castle? *Epiacum* is uncertain.<sup>81</sup> *Dunium* is definitely Hod Hill, *Salinae* is definitely near Skegness,<sup>82</sup> and *Extensio* is more likely to be in the position of Orford Ness than Walton Castle. The Thames estuary islands appear to have preferred identity of West Mersea (*Counus*) and Foulness (*Toliatis*), somewhat supported by Ptolemy's statement of both being 'beside the Trinovantes'. *Tamara*, *Uxella*, and *Voliba* appear to have likely locations near Tavistock, Barnstaple (Alverdiscot?), and Liskeard respectively.

## Ireland

Places in Ireland were initially based on the suggestions of Orpen,<sup>83</sup> any new preferred identities are discussed in Strang.<sup>84</sup>

### COMPOSITE MAP OF PTOLEMY'S BRITAIN AND HIS TRIBAL CONFIGURATION

The Ptolemy map of Britain (cf. FIGS 1 and 7) is unrealistic in surface area, due to distortion, and places related to tribes are out of their true positions so that true geographical relationships cannot be derived from the map directly. Hence we must resort to a total transformation of the Ptolemy map onto the real O.S. map of Britain. This is shown in FIG. 10 where the two Ptolemy scalar grids have been distorted backwards to relate directly to the real map of Britain and Ireland so that oceans, places, and tribes can exhibit their true relationships.

### OCEANS

Of Ptolemy's seven oceans only *Oceanus Duecaledonius* is uncertain, but on the transformed map its optimum position would be through The Minches, separating the Outer Hebrides from the Inner Hebrides and Ireland.

### TRIBES

For Ireland and Scotland we can insert Ptolemy's tribes in their displaced map-positions (FIG. 11B) but prior to subsequent land distortions. England on the other hand, for realism, must have its tribes introduced onto the fully transformed map, FIG. 11A. Tentative boundaries between tribes are based on topographical features depending on whether it was considered that a river or a watershed was the most likely separating feature. Tribal boundaries for England, are generally as described in the book-series 'Peoples of Roman Britain', except where those proposed could not apply.

## England (FIG. 11A)

The *Carvetii*,<sup>85</sup> who are identified in later Roman times, have been introduced to assist in determining the likely extent of the *Setanti*, both being subject to the *Brigantes*.<sup>86</sup> The *Gabrantovices* have been indicated as one of the four<sup>87</sup> possible sub-tribes of the *Parisi*.<sup>88</sup> The *Catuvellauni*<sup>89</sup> have been extended to encompass *Salinae*, which had already been anticipated

<sup>81</sup> idem, 224, also see *RIB* 899 and Hassall, op. cit. (note 18), 111.

<sup>82</sup> There is no justification for removing Ptolemy's *Salinae* to a Droitwich identity as in Rivet and Smith, op. cit. (note 9), 120, 451.

<sup>83</sup> G.H. Orpen, *PRIA* xxiv (1894), 115–28 and *PRIA* xxxii, c3 (1913), 41–57.

<sup>84</sup> Strang, op. cit. (note 1), Appendix 7.

<sup>85</sup> N. Higham and B. Jones, *The Carvetii* (1985).

<sup>86</sup> B. Hartley and L. Fitts, *The Brigantes* (1988).

<sup>87</sup> Rivet and Smith, op. cit. (note 9), 437.

<sup>88</sup> H. Ramm, *The Parisi* (1978).

<sup>89</sup> K. Branigan, *The Catuvellauni* (1987).



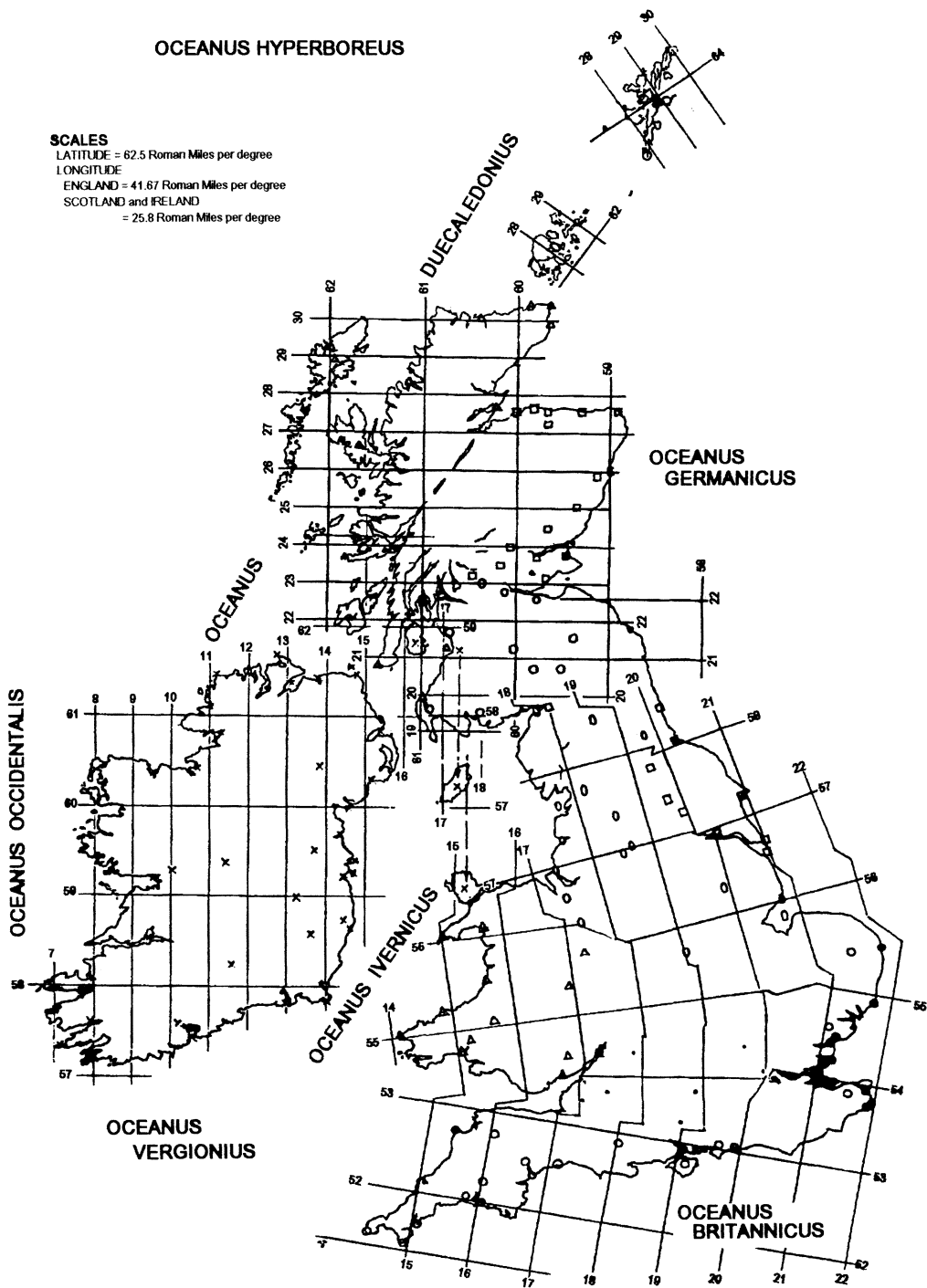


FIG. 10. Composite map of Ptolemy's Britain and Ireland.

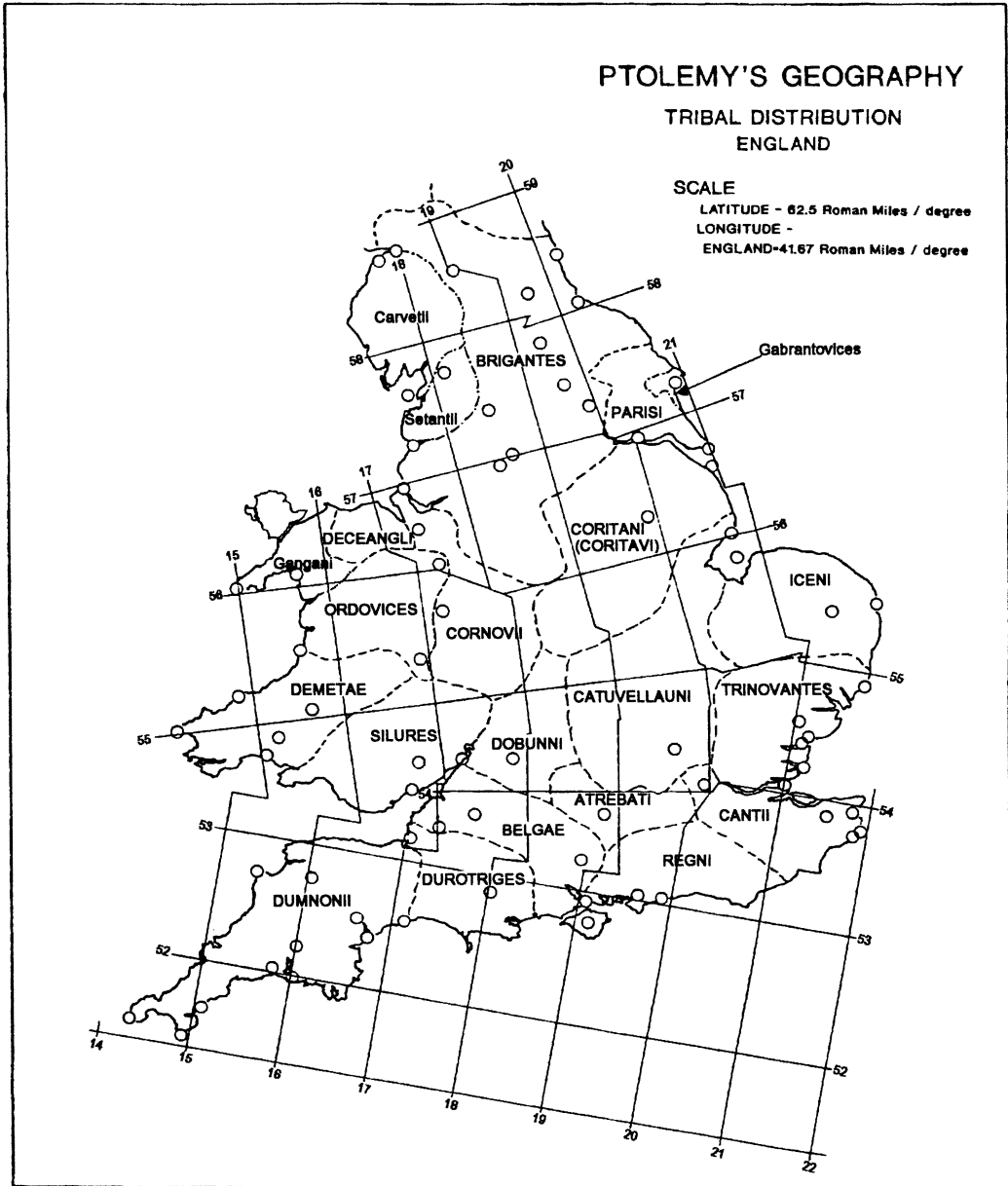


FIG. II.A Ptolemy's tribes — England.

by Todd<sup>90</sup> in his work on the *Coritani* (*Corieltauvi* (Hassall and Tomlin<sup>91</sup> and Tomlin<sup>92</sup>) and variant *Coritavi* in Ptolemy's *Geographia*). With *Londinium* being north of the Thames, but

<sup>90</sup> M. Todd, *The Coritani* (1973).

<sup>91</sup> M.W.C. Hassall and R.S.O. Tomlin, 'Thorpe in the Glebe. Lead sealing', *Britannia* xiv (1993), 318.

<sup>92</sup> R.S.O. Tomlin 'Non *Coritani* sed *Corieltauvi*', *Antiq. Journ.* lxxiii (1983), 353-5.

belonging to the *Cantiaci*,<sup>93</sup> the likely boundaries with *Catuvellauni*, *Atrebatii*, and *Regni*<sup>94</sup> are very uncertain, whereas that with the *Trinovantes*<sup>95</sup> should be the R. Lea. Because *Deva* and *Viroconium* belong to the *Cornovii*, while *Mediolanum* and *Brannogenium* belong to the *Ordovices*; the territory that I have ascribed to the *Cornovii* is somewhat different from that allocated by Webster.<sup>96</sup> Rivet and Smith<sup>97</sup> do suggest that *Mediolanum* might be attributed to the *Cornovii* instead of the *Ordovices*, but I have retained Ptolemy's attribution.

### Ireland (FIG. 11B)

Unfortunately Ptolemy did not ascribe all towns to particular tribes so some tentative allotment has been attempted. Tribes in 'lower-case' lettering are subjects of a neighbouring tribe. If Ireland was depressed by 3° to its true location, the *Brigantes* tribe would be at 55°N. Ptolemy's statement on the situation, in the *Almagest* (22nd parallel), presumably applies to Ireland, as the lowest latitude for the *Brigantes* in England would be greater than 56°.

### Scotland (FIG. 11B)

It is obvious from the *Geographia* text that Scotland must have been in an east–west orientation when Ptolemy described the tribal arrangement. Ptolemy does not mention a tribal boundary between the *Smertae* and the *Cornovii* so it must be minimal compared to that mentioned with the *Lugi* whom he says are below the *Smertae*. Also the *Lugi* march with the *Demetae*, so the *Smertae* are inferred to occupy the area shown in FIG. 11B.<sup>98</sup> With Scotland at its full thickness the *Caledonii* can extend from *Lemannonius Sinus* to *Varar Aest.* and the *Caledonius Saltus* (Caledonian Forest) can be mainly located below the Great Glen, which has been a difficulty in a thin Scotland. The *Vacomagi* have been extended from Moray down into Angus avoiding the Dee and Don valleys which were most likely occupied by the *Taexali*. The *Caledonii* have also been allowed to occupy the territory containing Schiehallion, Rohallion, and Dunkeld<sup>99</sup> although this brings them very close to Inchtuthil (which may explain its siting) with Fendoch and the Gask Ridge to the south. The *Venicones* can occupy the whole of Fife, as intrusion by *Alauna Votadini* was a *Geographia* error. In the south, now that places can be located, the territories of the *Damnonii*, *Votadini*, and *Selgovae* can be realistically arranged; the boundary with England being projected as that of the *Brigantes*, along the Tyne to the Annan and encompassing Birrens, which is very probable from the (altar) inscription<sup>100</sup> found there.

### COMPLEMENTARY SOURCES

Ptolemy's *Geographia* data have been compared with other available, ancient historical sources with respect to place-names and the configuration of Britain in Roman times. The Antonine Itinerary, Peutinger Table, and *Notitia Dignitatum* although providing some useful comparisons do not significantly assist in illuminating Ptolemy's 'unknowns' for Britain.<sup>101</sup> Conversely the present analysis, if anything, may contribute to clarifying some of the Ravenna

<sup>93</sup> A. Detsicas, *The Cantiaci* (1983).

<sup>94</sup> B. Cunliffe, *The Regni* (1973).

<sup>95</sup> R. Dunnett, *The Trinovantes* (1975).

<sup>96</sup> G. Webster, *The Cornovii* (1975), 7.

<sup>97</sup> Rivet and Smith, op. cit. (note 9), 121.

<sup>98</sup> To be compatible with W.J. Watson's *The History of the Celtic Place Names of Scotland* (1926), 17, which suggested relationship to Carn Smear, the *Smertae* would have to be encircled by the *Lugi*. Also it is probably more reasonable to have named a burial place in an enemy's territory in any case.

<sup>99</sup> *ibid.*, 21.

<sup>100</sup> *RIB* 2091, see also D.J. Woolliscroft, 'The outpost system of Hadrian's Wall', *Brit. Archaeology* vi (1988), 25.

<sup>101</sup> Strang, op. cit. (note 1), 105–11.

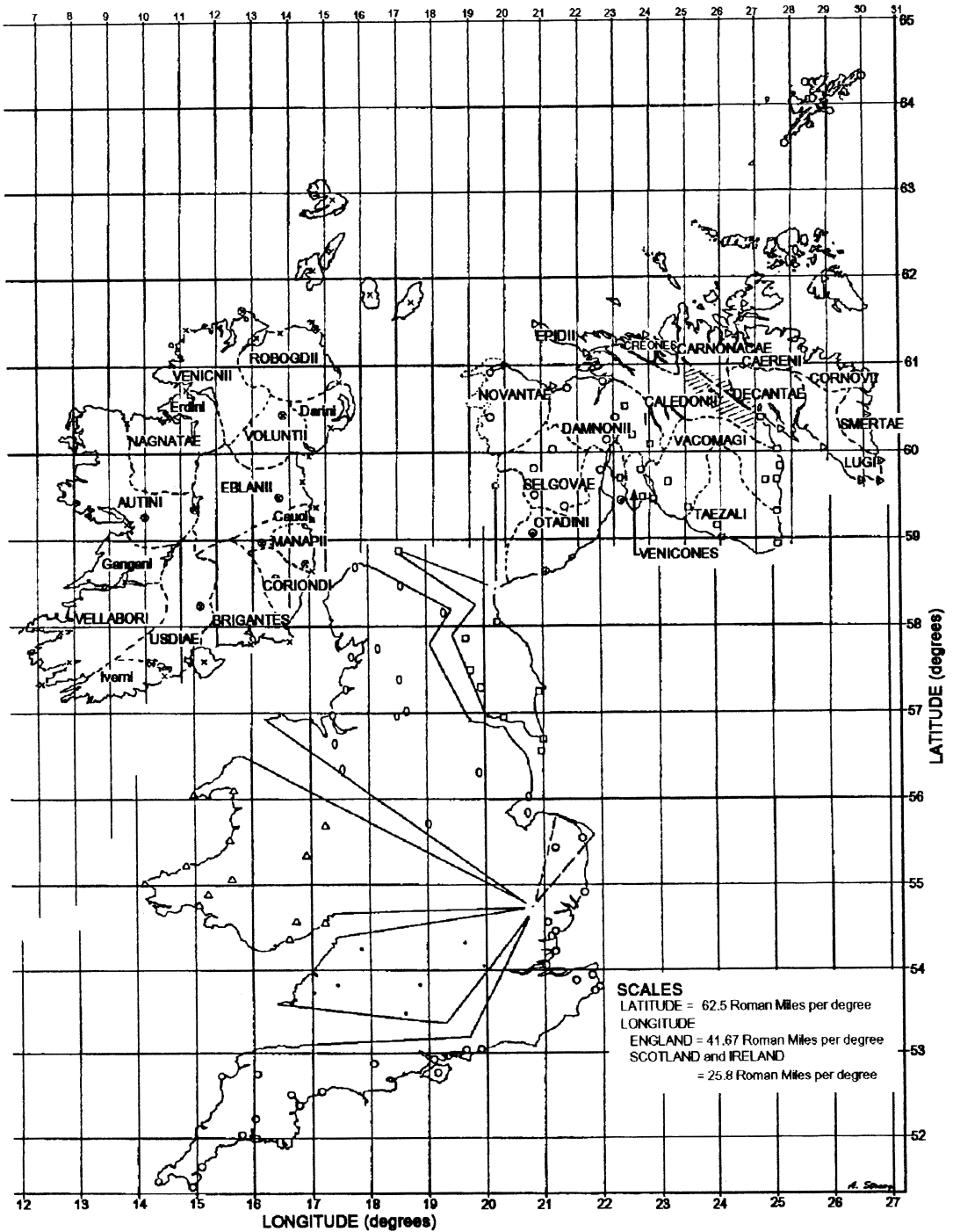


FIG. 11.B Ptolemy's tribes — Scotland and Ireland.

Cosmography identities.<sup>102</sup> The Rudge Cup, Amiens patera, and the *Velunia* inscription<sup>103</sup> provide information which generally post-dates that of *Geographia*. It is interesting to note that Marcianus Heracleensis's (c. A.D. 400) positioning of Ptolemy's Britain appears to have been derived directly from the *Geographia* or (more likely) from a Ptolemy map. Using the birectangular-grid scales it has been shown that sense can be made of Marcian's distances applying to Britain in its world context.<sup>104</sup>

#### PTOLEMY'S ACTUAL MAP OF ROMAN BRITAIN

Having defined the optimum birectangular longitude scales to suit the data of Ptolemy's *Geographia* and identified preferred locations of some place-names, tribes etc. as these may have appeared in Ptolemy's archetype, this allows Ptolemy's map of Roman Britain to be depicted (FIG. 12) as it may have appeared in the second century A.D.

#### CONCLUSION

Ptolemy's map of Britain and Ireland has been reconstructed by relating his majority of 'known' *poleis* with their true locations on a real map of the British Isles at appropriate scales to those initially estimated from inspection of the Ordnance Survey map of Ptolemy's Britain. Ptolemy's map requires a birectangular grid for longitude to latitude, to be compatible with his *Geographia* co-ordinates. These scales appear to be supported by east–west distances, for Ptolemy's location and configuration of Britain, recorded by Marcian Heracleensis c. A.D. 400. The south of Scotland requires special attention as Ptolemy had rotated places to new positions in order to fill in territorial space that he generated when he 'turned' Scotland 70 degrees relative to England and was then obliged to reconnect an extended southern Scottish coastline. Reversing the Ptolemy procedures to contain Britain on his severely restricted surface area of his smaller Roman world, I have been able to ascertain the most likely positioning of so far 'unknown' Ptolemy places, within certain tolerances. The final Ptolemy map provides explanation for previously unexplained anomalies (e.g. Skye etc.). Also, by reverting to either the transform map or locally undistorted, intermediate versions of this map, realism can be imparted to the ocean and tribal distribution which would otherwise be unreliable if derived from a distorted map. The Scottish sites, certainly beyond the Forth, are of Agricolan or Flavian date but it is somewhat surprising that the legionary fortress of Inchtuthil was not included. In the south-west of England it would appear that Ptolemy's information is of earlier vintage, as *Isca*, the fortress of Legion II Augusta, had been changed from its Exeter location to Caerleon by c. A.D. 75.<sup>105</sup> Conversely Ptolemy was aware that Legion VI Victrix was at *Eboracum* (York) and this legion did not arrive until A.D. 122.<sup>106</sup> However there is no indication of knowledge of Hadrian's Wall<sup>107</sup> or the earlier Trajanic Stanegate sites. Most-likely locations are provided for Ptolemy's 'unknown' places in Scotland and, wherever possible, positive identities are suggested. Some (*Clotae Aest.*, *Vindogara*, *Rerigonium*, *Alauna* (*Votadini*), *Trimontium*, *Colania*, and *Bremenium*) have identities which were expected. Other 'places' reviewed resulted in new dispositions and possibly unexpected locations. *Lucopibia*

<sup>102</sup> idem, 110–17, 290–2.

<sup>103</sup> I.A. Richmond and K.A. Steer, 'Castellum Veluniate and civilians on a Roman frontier', *PSAS* xc (1956), 1–6.

<sup>104</sup> Strang, op. cit. (note 1), 127–30, 297.

<sup>105</sup> M.G. Jarrett, 'Legio II Augusta in Britain', *Arch. Camb.* cxiii (1964), 52; P.T. Bidwell, *Roman Exeter; Fortress and Town* (1980), 56; and R.J.A. Wilson, *A Guide to the Roman Remains in Britain* (1988), 190.

<sup>106</sup> A.R. Birley in R.M. Butler (ed.), *Soldier and Civilian in Roman Yorkshire* (1971), 82 and Wilson, op. cit. (note 105), 227.

<sup>107</sup> Military diploma July A.D. 112, D.J. Breeze and B. Dobson, *Hadrian's Wall* (3d edn, 1987), 62–4 and M.C. Greenstock (ed.), *Lactor* iv (1971), 32.

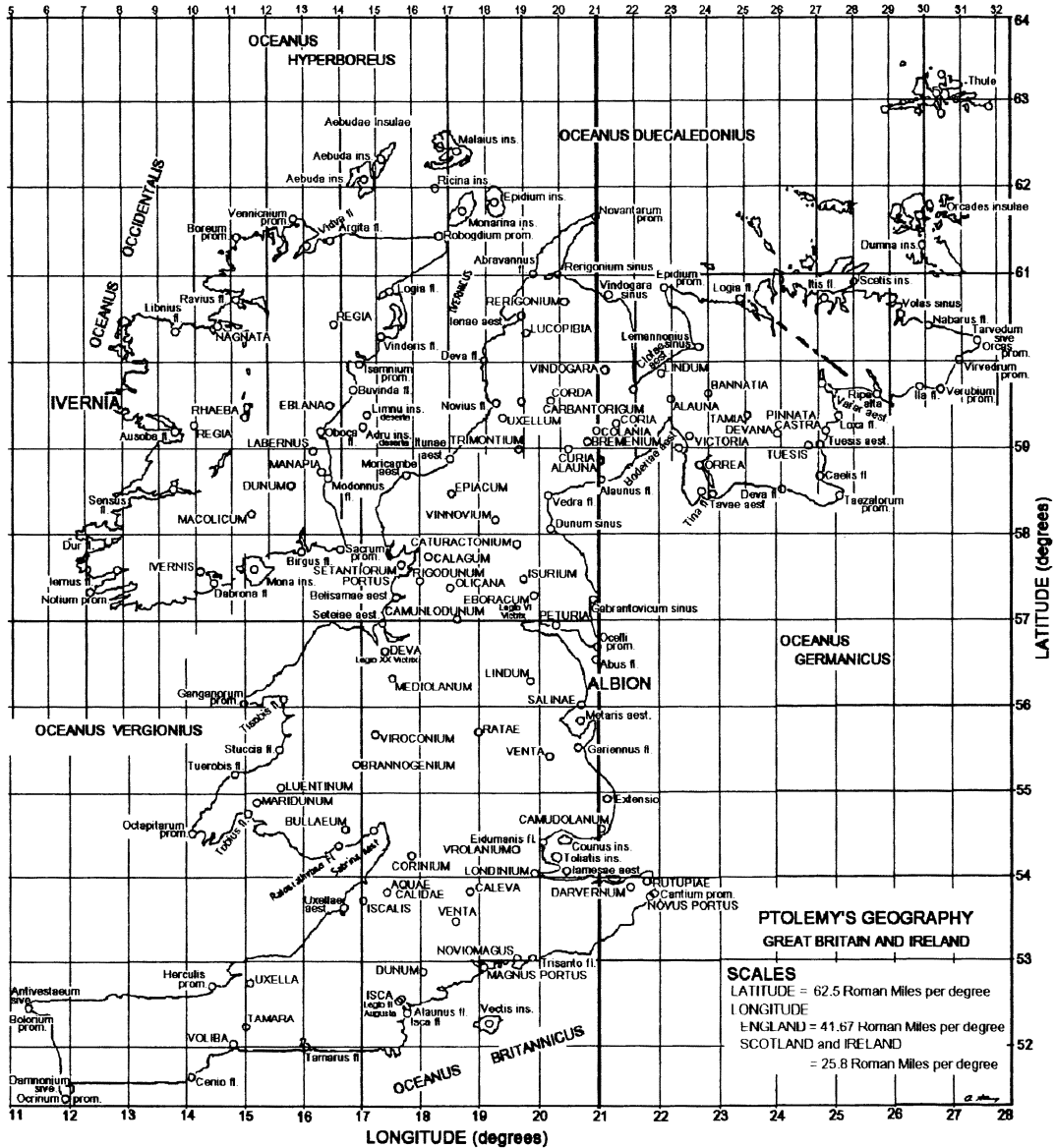


FIG. 12. Ptolemy's map of Roman Britain and Ireland.

(Gatehouse of Fleet), *Uxellum* (Ruberslaw?), *Corda* (Crawford?), *Carbantorigum* (Raeburn-foot?), *Curia* (Cramond/Corbridge), *Coria* (Balgair?), *Lindum* (Malling?), *Alauna* (Ardoch?), *Orrea* (Carpow?), *Victoria* (Fendoch?), *Bannatia* (Cardean?), *Tameia* (Stracathro?), *Devana* (Normandykes?), *Tuesis* (Newlands?), *Pinnata Castra* (near Burghead?), *Aebudae Ins.* (Islay and Jura?), *Epidium Ins.* (Arran?), *Lemannonius Sinus*, (Loch Fyne?), *Longus Fl.* (Firth of Lorn?), *Eitis Fl.* (in Sound of Sleat?), *Volas Sinus* (Loch Broom?), *Ripa Alta* (Hill of Nigg?), *Loxa Fl.* (R. Findhorn?), and *Tavae Aest.* (Tay estuary?). For England, there are the following

identities *Dunium* (Hod Hill), *Extensio* (Orford Ness?), *Counus* Ins. (West Mersea?), *Toliatis* Ins. (Foulness?), and *Salinae* (near Skegness). *Epiacum*, *Maglone*, and *Rigodunum* are doubtful and *Tamara*, *Uxella*, and *Voliba* appear to be near Tavistock, Barnstaple, and Liskeard respectively. In addition the systematic and deductive techniques adopted, although empirically based, have provided rather remarkable results in elucidating virtually every anomalous aspect of Ptolemy's configuration of Roman Britain that we have been so accustomed to seeing in previous maps.

When the sun rises,  
 All the sheen of the stars is covered  
 And the moon forthwith, draws back its ray of light  
 So this *Geographia*, now rediscovered  
 Shades on earlier ones, a veil of night.  
 (Maximus Planudes c. 1295)

*Bramcote, Nottingham*

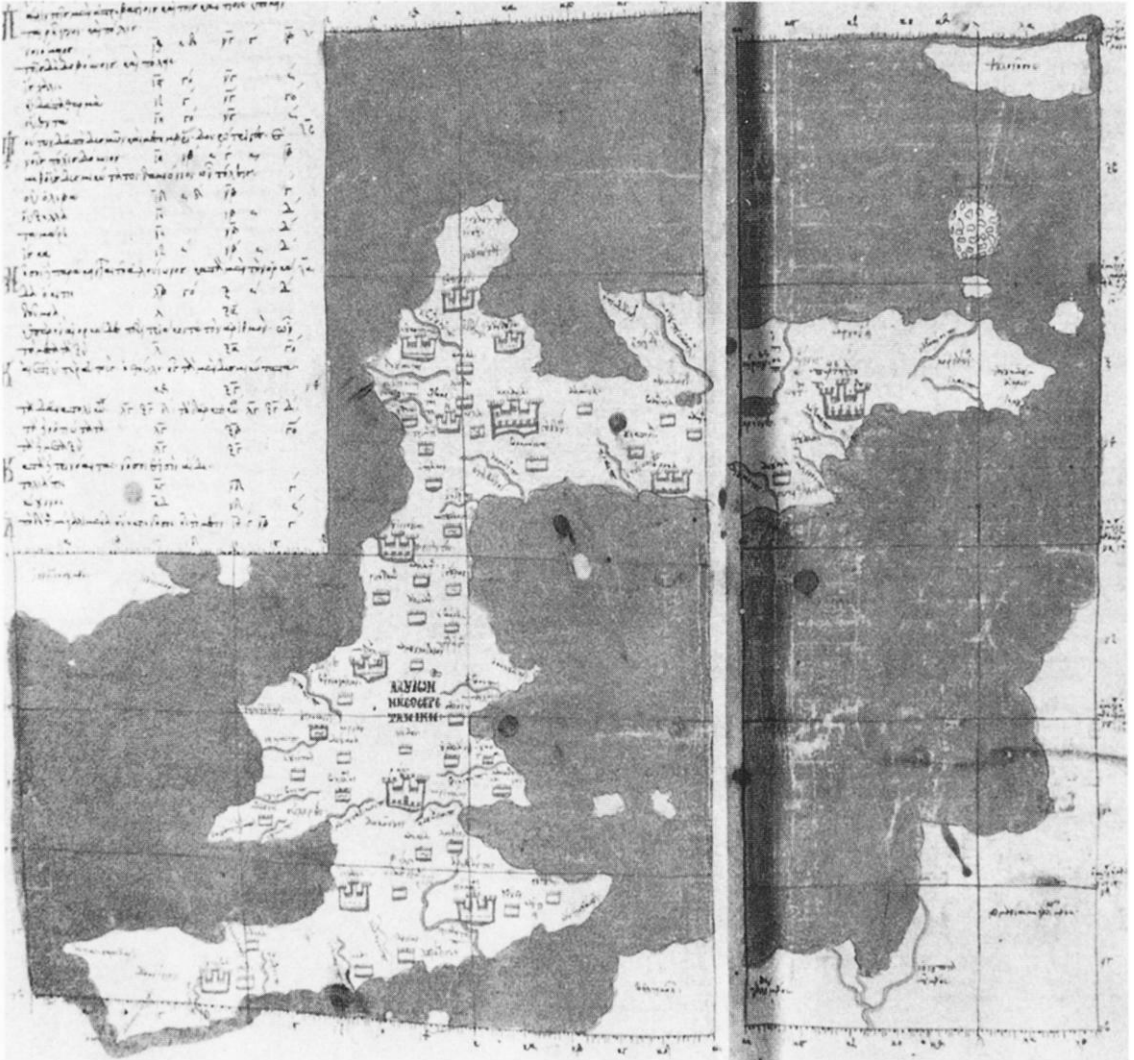
#### POSTSCRIPT

Initially. *Alauna Votadini*, as referenced by the *Geographia*, was situated in the (*Venicones*?) territory of Fifeshire with no obvious justification for its registration with Learchild on the *Alauna flumen*. However, subsequent to complementary consideration of Ptolemy's Lower Danube region<sup>108</sup> where analysis of the sequencing of places in the *Geographia* proved highly significant, this process was also applied to the data for Britain. By a simple 2 degree (longitude) step-adjustment to accommodate *Alauna Votadini* onto the larger birectangular grid-scale, the registration above was convincingly effected. It was recognized later that the last remaining Ptolemy place of the *Votadini*, i.e. *Curia*, should also have been included on this same scale and not with the main South of Scotland group (FIG. 8A, B), which became subject to further rotational displacement. Hence, relationship with Cramond is invalid as *Curia* actually registers with a position some 25 Rm. south-east of *Bremenium* (High Rochester) corresponding to the early Roman site at Red Houses, Corbridge.<sup>109</sup>

<sup>108</sup> A. Strang, 'Ptolemy's Geography of the Lower Danube region', *JRA* (1998, forthcoming).

<sup>109</sup> J.G.F. Hind, 'The Romano-British name for Corbridge', *Britannia* v (1980), 165-71; A.K. Bowman, *Life and Letters on the Roman Frontier* (1994), 22.

PLATE I



Thirteenth-century manuscript map of Ptolemy's Britain on rectilinear grid (*codex Seragliensis 27*, Topkapi Saray Museum, Istanbul). (p. 4)