PTOLEMY'S MAP OF SCOTLAND

IT has long been recognised as a puzzling fact that in Ptolemy's map of the British Isles Great Britain is turned abruptly to the east from about latitude 55° north (corresponding roughly to the area of Scotland) so as to make a right angle approximately with the southern part of the country. It may be of interest to review briefly various tentative explanations of this peculiar fact which have been advanced during the last three-quarters of a century, and to add yet another to the list.[1]

In 1885 H. Bradley suggested that either Ptolemy or one of his predecessors had before him three sectional maps representing respectively England, Scotland, and Ireland, and that in fitting the three maps together Ptolemy or his predecessor fell into the mistake of turning the oblong map of Scotland the wrong way. T. G. Rylands next put forward his view that the error was due to a faulty observation of a lunar eclipse at Duncansby Head causing an error of longitude, together with a faulty gnomonic observation at the same place causing an error of latitude.[2] In 1894 H. Kiepert was clearly getting nearer the truth when he wrote: 'The only coherent, though often deficient source for the knowledge of the [British] islands that has come down to us from the most flourishing period of the Empire, is the map of Ptolemy, the result of a combination of the lines of roads and of the coasting expeditions during the first century of Roman occupation. One great fault, however, has crept into the map by his having made use also of a totally different source, namely the astronomical fixations of latitude executed by Pytheas in the time of the earliest Greek mercantile expeditions to these regions of high latitudes.' In a footnote to this observation he added: 'These fixations stop at a borderline at the highest point reached in the north, which according to the itinerary sources would have been crossed in a northward direction, and thus the Alexandrian scholar was forced to give the northern half of the island a bend towards the east, the only possible direction, in consequence of which all the localities of Caledonia have been shifted from their proper positions by about a quarter of a circle.'

At about the same time Hugo Berger, in his *Geschichte der wissenschaftlichen Erdkunde der Griechen* 631, stated what is in my view the real reason, but merely as a possibility: 'The northern part of Britain, however, is twisted at right angles towards the east in a remarkable fashion, and the Orkades islands and the island of Thule lie over its most easterly end. Mannert suspects, not without reason, that this occurred because an extension of the country would have led to too high latitudes, but it is also possible that in his [Ptolemy's] sketch

[1] I append a list of the chief modern works quoted, to which I refer merely by the name of the author, except where he has written more than one work:

Anderson, J. G. C., *Tacitus, Agricola* (1922).

Berger, H., (1) *Die geographischen Fragmente des Hipparch* (Leipzig 1869); (2) *Die geographischen Fragmente des Eratosthenes* (Leipzig 1880); (3) *Geschichte der wissenschaftlichen Erdkunde der Griechen*, 2nd ed. (1903); (4) *Berichte der Verh. der Ges. der Wiss.*, Leipzig Phil.-Hist. xlix.

Bradley, H., *Archaeologia* xlviii (1885).

Cuntz, O., *Die Geographie des Ptolemaios* (1923).

Fischer, J., *Cl. Ptolemaei Geographiae Cod. Urb. Gr.* 82, *Tomus Prodromus, Pars* i (1932).

Flinders Petrie, *Proc. Soc. Ant. Scotland* lii (1917–1918).

Honigmann, E., *RE* iv A (1931).

Kiepert, H., *Formae Orbis Antiqui*; commentary on Map xxvi: *Insulae Britannicae.*

Kubitschek, W., *RE* x (1919).

Mette, H. J., *Pytheas von Massalia* (1952).

Ramsay, W. M., *The Historical Geography of Asia Minor; Royal Geographical Soc. Suppl. Papers* iv (1890).

Richmond, I. A., *Proc. Soc. Ant. Scotland* lvi (1922).

Rylands, T. G., *The Geography of Ptolemy Elucidated* (Dublin 1893).

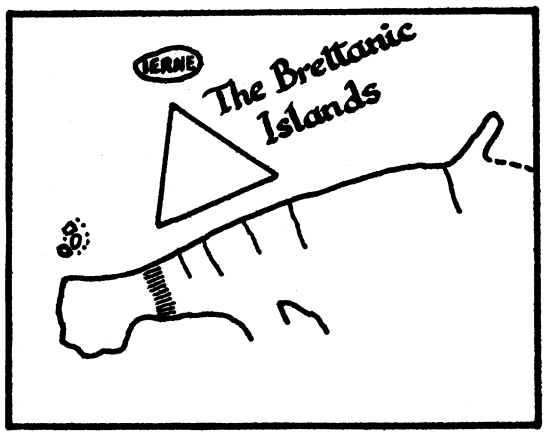
Schnabel, P., *S.B. Ber. Ak. Phil.-Hist.* (1930).

Schütte, G., *Scottish Geographical Review* xxx (1914) 57–77, 294–8, 617–24; xxxi (1915) 371–81, 580–9.

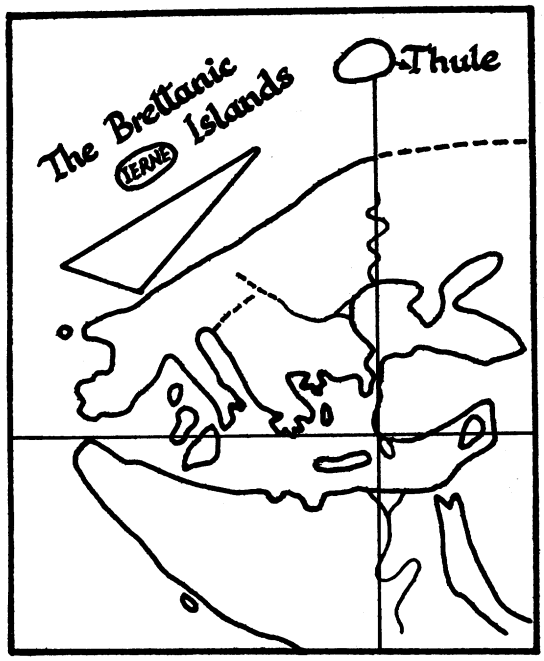
Thomson, J. O., *Hist. of Anc. Geography* (1948).

Zimmer, H., *Abh. Ber. Ak.* (1909, 1910).

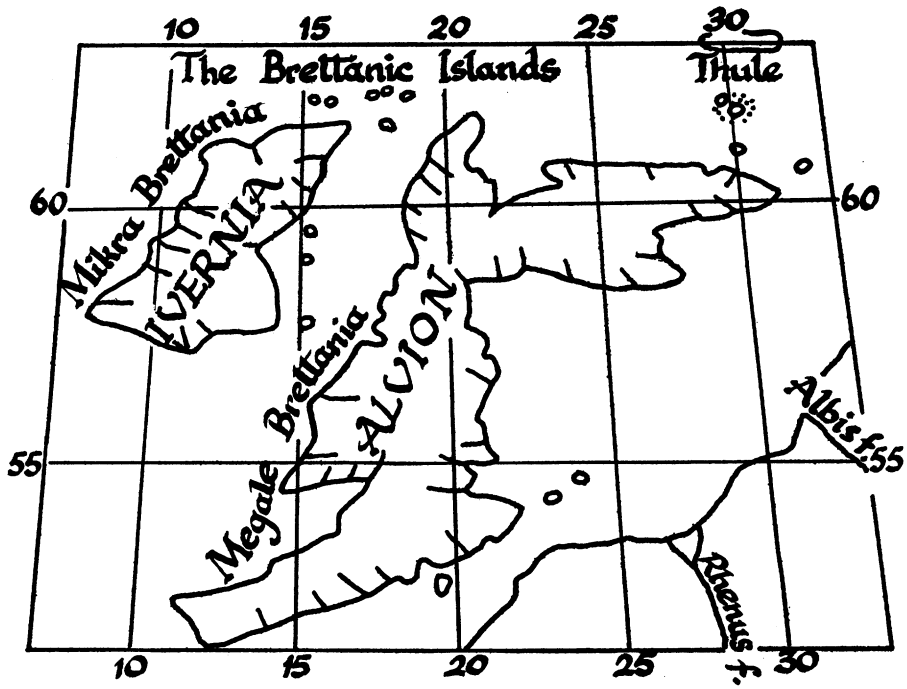
[2] Rylands, 32, 66, 77 ff.



STRABO



ERATOSTHENES



PTOLEMY

FIG. I

regard for the position given the island by Eratosthenes again came into play.' It is surprising that Berger never did actually come to solve the problem as he has supplied many of the elements necessary for its solution both in the book just mentioned and more particularly in his earlier work on the fragments of Eratosthenes.

Later investigations of the subject have unfortunately not pursued the line of inquiry hinted at more or less vaguely by Kiepert and Berger. Professor Flinders Petrie wrote: 'Thus the great distortion can be definitely run down to the mistake of reckoning the day in Yorkshire to include twenty minutes more twilight than was reckoned in London or Nairn.'[3] Again, in a later volume of the same journal, I. A. Richmond accepted the basis of the work of T. G. Rylands, mentioned above, and tried to work further upon it. The latest reference to the problem which I can find is in a note by the late Professor J. G. C. Anderson where the author wishes to absolve Ptolemy of blame, by suggesting that the distortion may be due to errors in the transmission of his figures.[4]

It is my conviction that, however great the merit of their work in other ways, the views of the scholars mentioned regarding Ptolemy's map are mistaken, with the exception of Kiepert and Berger who at least guide us in the right direction, and that the solution of the problem is rather to be sought in the general history of Greek geography and cartography, particularly as these arts and sciences were influenced by the advance of the Roman Empire to Gaul and Britain in the period 50 B.C. to A.D. 100. The distortion of the map of Scotland is not due to any positive action of Ptolemy or his predecessors, as has often been stated or implied, but rather to a correction of the position of Britain carried out by Marinos of Tyre or one of his predecessors. This correction could not include Scotland, as sufficient information on this land was not available, and Scotland was therefore left distorted as it had been on all the maps since the time of Eratosthenes and Pytheas. It would seem logical to discuss the development of Greek geographical ideas concerning the islands of the north-west in three stages, the first considering the earlier Greek views represented chiefly by Pytheas, Eratosthenes, Hipparchos and Strabo; the second, the new geographical information of Roman date from the time of Julius Caesar onwards; and the third, the later stage of Greek geographical information in Marinos, Ptolemy, and their sources.

We may begin by considering the shape of Britain as it lay off the coast of Europe in the map of Eratosthenes, with the dimensions given by Pytheas, namely 7,500 stadia for what is now called the south coast, 15,000 for the east coast, and 20,000 for the west coast.[5] These dimensions give an obtuse angle of 122° at Kantion and the island is regarded as stretching very far away to the north-east with what is actually the west coast facing rather towards the north. Eratosthenes had adopted the idea of the rectangular shape of the inhabited earth from his predecessors Demokritos and Eudoxos,[6] as opposed to the circular shape of the old Ionic maps, and it was this rectangular shape which led to the importance of the British islands and Thule as the geographical features delimiting the latitude of the *oikoumene* to the north. There was no possibility of establishing a high latitude on the Russian steppes (ἡ σκυθικὴ ἐρημία)[7] where Herodotos had described the air as being full of feathers,[8] a description clearly imitated, and perhaps surpassed, by Pytheas in his description of the sea north of Thule as an amalgam of earth, sea and sky.[9] The convexity of Spain and Portugal was wrongly supposed to provide by far the greatest continental western extension of longitude (which fact in itself shows that the British islands and Thule were thought of as lying much further to the north-east), so that the importance of the British islands plus Thule was that of providing a geographical limit of latitude of the *oikoumene* in the north. This is of course the reason for the endless argument on the point in Strabo and for his outrageous attempts (after Polybios) at discrediting the authority of Pytheas,

[3] Flinders Petrie, 15.
[4] Anderson, 56.
[5] Berger, *Erat.* 373.
[6] Agathemeros i 2, *GGM* ii 471.
[7] Arist. *Ach.* 704.
[8] Hdt. iv. 31; *cf.* the story of Sataspes iv 43.
[9] Strabo ii 4.1 f., p. 104; Mette F 7a.

Eratosthenes and Hipparchos primarily in regard to the latitude of Thule and secondarily in regard to that of the British Isles.[10]

Berger points out that Strabo omits the line of the Eratosthenic parallels through those areas where the authority of Eratosthenes was challenged, that is especially Europe.[11] Strabo goes on to conduct a kind of Parthian campaign against the parallels of high latitude in Hipparchos, from 43° to 61° north latitude. Making a quick raid on Eastern Europe along the 3,800 stadia running north from Byzantium to Borysthenes he gazes with incredulity at an alleged further 11,500 stadia north to Thule.[12] Thence he retreats to his base at Marseilles to conduct a more slogging campaign up the west coast. Starting from the (incorrect) equation of Marseilles with Byzantium he asserts that Keltike ends at the ocean 3,700 stadia to the north, that is on the parallel of Borysthenes,[12a] and here he finds a marvellous opportunity for honest indignation and a cheap victory over Hipparchos who had simply used the word Keltike in the older and wider sense of Pytheas.[13] Somewhere at this point Brettanike begins. Its longest side lies along Keltike but stretches north and east to a point 6,300 stadia north of Marseilles. Ierne in turn lies north of Britain, 9,000 stadia north of Marseilles or 5,000 north of Keltike.[14] He goes on to mention a point north of Ierne at which Hipparchos had (ridiculously in Strabo's view) placed the south of Britain.[15]

Berger remarks that in the course of this running campaign of expostulation Strabo has apparently lost 2° of latitude but continues nevertheless to give us the Hipparchic 'phenomena' (altitude of sun and length of longest day) for points (in Britain and Ireland according to Strabo) where the figures of Hipparchos give a latitude 2° higher than that provided by Strabo's measurements in stadia north of Marseilles.[16] A distance of 6,300 stadia north of Marseilles (43°), using the degree of Eratosthenes and Hipparchos equivalent to 700 stadia, gives a latitude of 52°, whereas the Hipparchic figure of 6 cubits or 12° for the sun's altitude at the winter solstice gives a latitude of 54° for the same place. Similarly a distance of 9,100 stadia north of Marseilles gives a latitude of 56°, whereas the figures of Hipparchos for the same place, that is a solar altitude of 4 cubits or 8° and a longest day of 18 hours, give a latitude of 58°.[17] Berger supposes that the most likely reason for this discrepancy is that Strabo's eye wandered in hastily consulting the table of 'phenomena' in Hipparchos. But a little reflexion will show that the reason is rather that Strabo was bound to make this 'mistake', for it was not really a 'mistake' at all and only became apparent when new knowledge of modern times substituted a new value for the degree differing from that assumed by Eratosthenes and Hipparchos.

Hipparchos approved of Eratosthenes' measurement of the meridian arc from Alexandria to Syene as one-fiftieth part of a great circle without in any way accepting as mathematically correct the resulting value for the earth's circumference. He merely accepted it as a working hypothesis, knowing that this length made no difference to the working out of his proportional table of latitudes within the 90° running from the equator to the north pole, each with its appropriate 'phenomena'.[18] Strabo's figures for Gaul, Britain and Ierne are not taken from Hipparchos, as Berger understandably imagined in view of the divisibility of 6,300 and 9,100 by 700. On the contrary they are taken both from dead reckoning in Gaul,[19] and from rough estimates or mere guesswork farther north. These

[10] *E.g.* i 4.3–4, p. 63; iv 5.5, p. 201.

[11] ii 1.40–1, pp. 92–4; 4.1–2, p. 104; 4.4, p. 107; Berger, *Erat.* 190.

[12] i 4.2, p. 63

[12a] ii 1.12, p. 72; 1.18, p. 75.

[13] Berger, *Hipp.* 67 ff.

[14] i 4.3–4, p. 63; ii 1.13, p. 72; 1.18, p. 75; iv 5.1, p. 199; 5.4, p. 201.

[15] ii 1.18, p. 75.

[16] Thomson here accepts Berger's view that Strabo garbled the evidence of Pytheas (Thomson 207, *cf.* 147).

[17] ii 1.18, p. 75; 5.42, p. 135.

[18] Berger, *Hipp.* 25, 34, 36–7; *Geschichte* 468–9, 473.

[19] ii 1.12, p. 72; iv 1.11, pp. 185–6.

partly real figures, wrongly calculated at 700 stadia per degree, are then rounded off to the nearest points on the table of 'phenomena' of Hipparchos, where the measurements are strictly proportional and the length of the degree, whether real or assumed, does not arise.

Strabo describes his own procedure as being the same as that of Eratosthenes: *οὐ . . . γεωμετρικῶς . . . ἀλλὰ γεωγραφικῶς μᾶλλον* (ii 1.41,p. 94). From the astronomically fixed base at Marseilles his reckonings are as follows: Marseilles to the coast of Keltike, 3,700 or 3,800 stadia (ii 1.12, pp. 71–2; 5.8, p. 115); Keltike to Ierne, not more than 5,000 stadia (ii 1.13, p. 72; 1.17, p. 74); length (*μῆκος*) of Britain along Keltike, 5,000 stadia (i 4.3, p. 63; ii 5.28, p. 128); Marseilles to the centre of Britain, not more than 5,000 stadia (i 4.4, p. 63); centre of Britain to the neighbourhood of Ierne, not more than 4,000 stadia (i 4.4, p. 63); Britain to Ierne is not known (ii 5.8, p. 115); from Britain to the limit of the *oikoumene* is 3,000 or 4,000 stadia (ii 5.8, p. 115); Britons live 6,300 stadia north of Marseilles, or 2,500 north of Keltike (ii 1.18, p. 75; 3,800 plus 2,500 equal 6,300).

From these data we can see that Strabo was eager to express an opinion on the chief points north of Keltike which were of importance in the work of Pytheas, Eratosthenes and Hipparchos. Of these three points (Thule, Ireland and Britain) he rejects Thule but brings in the other two, giving Ierne as a point rounded off to the distance 9,100 stadia above Marseilles on the scale of Hipparchos and Britain as one rounded off to 6,300 stadia north of the same (that is 4° lower than Ierne; we shall meet these 4° again). If we ask how the error recorded by Berger arose, we can answer at once that there was no error here on the part of Strabo. He merely equated his roughly estimated distances in stadia north of Marseilles with the nearest point in the stadiastic scale of Hipparchos, adding the astronomic data of Hipparchos, or at least part of them. We know of course that with a degree of 700 stadia his measurements were one-seventh too high. In the 9,100 stadia reckoned from Marseilles to Ierne therefore his number of degrees was reckoned as thirteen-sevenths (= thirteen-sixths) of a degree too low, which accounts for the discrepancy of 2° between his 56° and the 58° of Hipparchos. In the 6,300 stadia reckoned to England the number of degrees was taken as nine-sevenths (= nine-sixths) too low, and we must either round this off to the next integer upwards, or much more probably consider that Strabo simply reckoned that 6,300 stadia was 2,800 stadia less than 9,100 and therefore four points lower down on the scale of Hipparchos, from which he then read off the appropriate 'phenomena'. We should, however, keep in mind that Strabo is guilty here of no mistake of any kind. The 'mistake' could only arise as the result of a new measurement of the circumference of the earth and consequently of the degree. This we know was done either by Poseidonios or rather by an authority whom Poseidonios accepted, giving a degree of 500 stadia, which was later accepted by Marinos and Ptolemy.[20] But Strabo accepted the older measurement. It was not until modern times that a more exact measurement of the degree was established and only then that the 'error' of Strabo became visible.

The reasoning of this argument may perhaps be clarified by the use of a hypothetical analogy. Let us suppose that Hipparchos and consequently Strabo had accepted the alternative degree length of 500 stadia which we know to have been maintained by other astronomers before Hipparchos or contemporary with him.[21] In this case Strabo's supposedly measured figures of 9,100 and 6,300 stadia north of Marseilles would have become respectively 18° and $12\frac{3}{5}$° north of Marseilles. Rounding off the latter figure to 13° we find that Strabo would have equated his two points with 61° and 56° north latitude. These are now too high for the correlated 'phenomena' of Hipparchos which again are 58° and 54°, giving discrepancies of 3° below in one case and 2° below in the other. The fact to bear in mind is that the reckonings of Hipparchos were true (approximately) for each and every

[20] *Cf.* Berger, *Geschichte* 579 ff.; Fischer, 61 ff.; Schnabel, 226 ff.

[21] Berger, *Hipp.* 25; Strabo i 4.1, p. 62; ii 5.7, p. 113; 5.34, p. 132.

size of a spherical earth which itself was the centre of a spherical universe. The earth might vary in size from the one extreme of being a mere point in the centre to the other extreme of being as large as the containing universe itself, and still all the relations laid down in the 'phenomena' of Hipparchos would remain valid. Only a more precise value for the degree could reveal discrepancies in the values either of Strabo or of Ptolemy. There have of course been many modern reckonings of the value of a degree of latitude and longitude at various points on the surface of the earth from the sixteenth century onwards, and particularly since the time of the famous expeditions of members of the French Academy of Sciences in the eighteenth century. If Strabo had been an astronomer and if his measurements in Gaul had been extremely exact and if the tables of Hipparchos had been highly accurate, then Strabo might have discovered discrepancies between his figures and the latitude tables of Hipparchos, and he might have calculated afresh the circumference of the earth and have obtained a more accurate value for the degree. But of these three conditions only the third came anywhere near to being fulfilled.

We may now pass on to another difficulty in Strabo's criticisms of his predecessors' opinions about these northern latitudes. In ii 1.18, p. 75, Strabo says that Hipparchos, trusting Pytheas, puts the area where the sun rises less than 3 cubits and where the longest day is 19 hours, in the south of Britain, that is at 61° north latitude; and further on in the same passage he says that the most southerly of the Britons live north of the area 9,100 stadia north of Marseilles, where the sun's altitude is 4 cubits, and the longest day is 18 hours, that is at 58° north latitude. This shows that in Hipparchos Britain stretched north from above 58° to at least 61° north latitude. In i 4.4, p. 63, and ii 1.12, pp. 71–2, however, we are told that Hipparchos put the parallel through Britain at 3,700 stadia above Marseilles. This provides a vague latitude for Britain of 48° north latitude, a figure quite at variance with his other reckoning, even if we assume that it is the south of Britain that is intended. Berger offers no solution of this difficulty, although he clarifies the different usages by Hipparchos and Strabo of the word Keltike. 'Strabo (he says) was unwilling to hand down the points which Hipparchos had accepted from among the localities defined by Pytheas, and which he had co-ordinated with his parallels, since he regarded the information of Pytheas as unworthy of belief, and the places concerned as lying beyond the known and inhabited world and therefore useless. Merely in a critical aside, however, he affords us a slight indication which points towards his general opinion.'[22] This critical aside is the passage quoted above from ii 1.18, p. 75. I think it is possible to defend Hipparchos against the utter confusion of thought of which Strabo accuses him. The problem is similar to that which arose in the case of the word Keltike. Here the word is Brettanike, which, apparently from the time of Pytheas onwards, was used alike for Britain, Ireland and the adjacent islands. It was natural to call Britain the large Brettanike and Ireland the little Brettanike. Ptolemy calls Ireland little Britain, and gives its latitude in the *Almagest* (ii 6) as 58° to 61° north latitude. This clearly corresponds to the position of the northern Brettanike in Hipparchos and Strabo. Ireland in Hipparchos, as also in Strabo, lies quite north of Britain, so that we can understand the remark that the south of Brettanike (= Ireland) lies north of Brettanike (= Britain). Britain itself is a larger island with a lower latitude which is that referred to in Strabo i 4.4, p. 63, and ii 1.12, pp. 71–2.

I do not think we can absolve Strabo of deliberately misleading his readers as regards the views of Hipparchos, in almost exactly the same way as Berger has shown that he misled them in regard to his use of the word Keltike. But those who are most familiar with Strabo are also most familiar with his peculiar misrepresentations caused variously by ignorance, bad faith, a naïve megalomania, or some combination of these qualities.[23] It would be unrealistic to think that Strabo was attempting to achieve any exact degree of accuracy in

[22] Berger, *Hipp.* 67.

[23] On Strabo's psychology, *cf.* Honigmann, 90 ff.

his references to these high latitudes. Through the distrust of Pytheas inspired in him by Polybios and Artemidoros he ventures to attack Eratosthenes and Hipparchos, who followed the guidance of Pytheas; and he does not shrink from omitting or mangling their evidence. Nevertheless his account of the west coast of Europe is still far more dependent on them than he seems to be aware or at least is willing to admit. Berger has shown that the outline of the west coast of Europe in Eratosthenes and later authorities (except partly in Strabo, who attempts to minimise the westward projection of the peninsula of Brittany) comes from the observations of Pytheas, and the same is obviously true of the position of the off-shore islands.[24] Strabo quotes Hipparchos here as following Pytheas, and we can assume that Eratosthenes did much the same in the intervening period.[25] As in the case of the peninsula of Brittany, Strabo attempts to show his intellectual independence by disbelieving altogether in Thule, but he still accepts fundamentally the position given to Ireland and Britain by Eratosthenes, with Ireland north of Britain. At the same time, however, he reduces the latitude of Ireland from the figure of Hipparchos (north of 58° to beyond 61°) to 9,000 stadia above Marseilles (= 58°: i 4.4, p. 63), and that of Britain from somewhere south of 58° (we have not got the exact figures of Hipparchos except for the south: i 4.4, p. 63, and ii 1.12, pp. 71–2) to between 3,800 and 6,300 stadia north of Marseilles, which is roughly 48° to 52° (54° in Hipparchos). From his figures given earlier it is clear that, while he makes Britain run mainly east to west,[26] he was extremely vague about the position of the islands, and that particularly in the case of Ireland he was quite ready to add or subtract 1,000 stadia or more. It is when we consider his account of Britain in detail, however, that we begin to appreciate the full measure of his incompetence in visualising its geographical position.

Caesar, whom Strabo had studied,[27] had made decisive changes in the picture given by Eratosthenes, whose work he had read:

> '[*Britannia*] *insula natura triquetra, cuius unum latus est contra Galliam. Huius lateris alter angulus, qui est ad Cantium, quo fere omnes ex Gallia naves appelluntur, ad orientem solem, inferior ad meridiem spectat. Hoc pertinet circiter milia passuum quingenta. Alterum vergit ad Hispaniam atque occidentem solem; qua ex parte est Hibernia, dimidio minor, ut existimatur, quam Britannia, sed pari spatio transmissus atque ex Gallia est in Britanniam. In hoc medio cursu est insula quae appellatur Mona: complures praeterea minores subiectae insulae existimantur, de quibus insulis non nulli scripserunt dies continuos XXX sub bruma esse noctem. Nos nihil de eo percontationibus reperiebamus nisi certis ex aqua mensuris breviores esse quam in continenti noctes videbamus. Huius est longitudo lateris, ut fert illorum opinio, septingentorum milium. Tertium est contra septentriones, cui parti nulla est obiecta terra; sed eius angulus lateris maxime ad Germaniam spectat. Hoc milia passuum octingenta in longitudinem esse existimatur. Ita omnis insula est in circuitu vicies centum milium passuum*' (*BG* v 13).

Caesar gives much shorter lengths for the sides than did Pytheas, and places the south coast nearer the French coast than did Eratosthenes. But his main innovation lay in making a change in the longest side. For Eratosthenes this was the actual west coast, although he imagined it rather as running north-east to south-west. Caesar makes the east coast the longest side, and moreover makes its line run more or less east to west, since the angle formed at the apex looks towards Germany rather than Gaul. Ireland is then put to the west or south-west between Britain and Spain. In addition we find that there are certain small islands in the neighbourhood of Ireland of which it has been *written* that their night at midwinter lasts for thirty days. According to Ptolemy (*Almagest* ii 6) a similar item of information for the longest day at midsummer would refer to latitude 67° north,

[24] Berger, *Erat.* 217.

[25] Despite Berger, *Erat.* 219. *Cf.* Strabo ii 4.2, p. 104.

[26] i 4.3, p. 63; ii 5.28, p. 128; iv 5.1, p. 199.

[27] iv 3.3, p. 193; 4.1, p. 194; 5.2, p. 199.

a figure which the *Nautical Almanac* shows to be true within 15 minutes, making no correction for semi-diameter, dip, or refraction. The *Almanac* similarly shows that the latitude for a night of thirty days in midwinter will be but a few minutes greater, again making no corrections. This information, which obviously refers to Thule, must have come from Eratosthenes.[28] Berger says that Caesar has mistaken one side of the triangle of Eratosthenes for the other ('*Er verwechselt die Seiten*'), but it must surely be clear that the shifting of Ireland and Thule from the north to the west means that Caesar has pivoted the triangle of Eratosthenes approximately 90° to the west on the point of Kantion.[29] I do not think that Caesar would have done this merely to disparage the view of Eratosthenes whom he does not mention here and whom he obviously respected.[30] It is possible that with a better alignment of the south coast and better information about the length of the sides he felt that he was possessed of superior knowledge, particularly since we can assume that his mathematical proficiency would not enable him to see that the length of the sides of Eratosthenes' triangle necessitated a large obtuse angle at Kantion (122°). Caesar changes this to a narrow acute angle (60° is the angle subtended by the side 7, in a triangle whose sides are 5, 7, and 8), bringing Lands End nearer to the French coast ('*inferior ad meridiem spectat*') as we see from Strabo, and therefore pivoting the triangle as a whole through approximately 90°.

It is this verbal picture presented by Caesar which Strabo now quite ineffectually strives to combine with the cartographic tradition of Eratosthenes. He accepts Caesar's view of the south coast of Britain, but he in turn makes *it* into the longest side; and he even proceeds to labour the point by insisting that Britain stretches on an east-west axis for from 4,300 to 5,000 stadia parallel to the coast of Gaul from the Rhine to the Pyrenees, while the peninsula of Brittany is abolished.[31] About the other two sides he provides no information, although the shadow of the Eratosthenic map is still discernible in other very vague passages which seem still to show a triangular Britain stretching south-west opposite Spain, and north-east to the Elbe.[32] Ireland, however, he leaves quite definitely to the north of Britain. Caesar's view that north was west was clearly not destined to prevail against the Greek cartographic tradition which was strong enough to generate geographical theories of its own. It is interesting to note, as Berger points out,[33] that Pliny (*NH* iv 103) and Mela (iii 6.6) preserve the Eratosthenic theory of the position of Ireland. Caesar's theory, on the other hand, is accepted by Tacitus (*Agricola* 24), by an anonymous geographer (Anonymus, *geogr. comp.* 13, *GGM* ii 497), and by Orosius (*Hist.* i 2, p. 28 *ed.* Haverc.). In this matter Caesar's theory temporarily lost the day. But in the matter of twisting the apex of the triangle of Britain into the Atlantic, so that the east coast faced north, his theory prevailed; and this fact, combined with the view expressed by himself and Strabo that the south coast was anchored to that of Gaul, and with the information derived from the Roman network of roads in Britain in the first century A.D., conspired to force a 'Roman' theory of the position of south Britain on the Greek geographers which, when combined with the original Eratosthenic position of Scotland and Ireland, resulted in the well-known distortion of Scotland which is the subject of this article.

In this connexion it should always be remembered that there is no separate word to distinguish Scotland from England. The larger island Brettanike includes both, and Scotland can only be differentiated by calling it the northern part of Brettanike or by using the later Roman word Caledonia. Perhaps it may not be illusory to think that some feeling of difficulty in regard to the shape of Britain, clearly latent in Strabo, is also

[28] Strabo i 4.4, p. 63; ii 5.42–3, p. 135.

[29] That Caesar should do this throws a glaring light on the standard of education of the upper classes in the late Roman Republic.

[30] *BG* vi 24.2.

[31] Berger, *Erat.* 214 ff.; Strabo ii 5.28, p. 128; iv 5.1, p. 199.

[32] Berger, *Erat.* 213; Strabo iv 5.1, p. 199; vii 3.1, p. 295.

[33] *Erat.* 376.

to be seen in Livy, Fabius Rusticus, and Tacitus, who abandoned the triangular form in favour of the shape of a *scutula*, or a double-axe head, or of a wedge at the northern end (Tacitus, *Agr.* 10). Pliny, writing about A.D. 70, gives the following account of Britain and Ireland:

> '*Ex adverso huius situs Britannia insula clara Graecis nostrisque monimentis inter septentrionem et occidentem iacet, Germaniae, Galliae, Hispaniae, multo maximis Europae partibus magno intervallo adversa. Albion ipsi nomen fuit, cum Britanniae vocarentur omnes de quibus mox paulo dicemus. Haec abest a Gesoriaco Morinorum gentis litore proximo traiectu* $\overline{\text{L}}$. *Circuitu patere* $\overline{\text{XXXXVIII}}$ $\overline{\text{LXXV}}$ *Pytheas et Isidorus tradunt,* XXX *prope iam annis notitiam eius Romanis armis non ultra vicinitatem silvae Calidoniae propagantibus. Agrippa longitudinem* $\overline{\text{DCCC}}$ *esse, latitudinem* $\overline{\text{CCC}}$ *credit, eandem Hiberniae, sed longitudinem* CC *minorem. Super eam haec sita abest brevissimo transitu a Silurum gente* $\overline{\text{XXX}}$' (*NH* iv 102–3).

The first part of this account comes from Isidoros of Charax quoting Pytheas, and gives us the map of Pytheas and Eratosthenes with the original over-large dimensions of Britain, and even the wide passage separating the south coast at both ends from the French coast. This is followed, however, by a more modern and interesting statement taken from the map (or commentary) of Agrippa.[34] Here Agrippa gives the east-west measurement of Britain as 800 miles and the north-south measurement as 300. Ireland has the same north-south measurement as Britain, but its east-west measurement is 600 miles. There is no possibility of misunderstanding the words *longitudo* and *latitudo*. They are literal translations of the corresponding Greek words, which had indeed been technical terms for over four hundred years.[35]

Strabo's description of the shape of Ireland corresponds with that of the map of Agrippa, without giving any dimensions:

> *Εἰσὶ δὲ καὶ ἄλλαι περὶ τὴν Βρεττανικὴν νῆσοι μικραί· μεγάλη δ' ἡ Ἰέρνη, πρὸς ἄρκτον αὐτῇ παραβεβλημένη, προμήκης μᾶλλον [ἢ] πλάτος ἔχουσα.* (iv 5.4, p. 201).

The last phrase can only be translated: 'With its greatest dimension east to west rather than north to south.' The meaning of *προμήκης* is well illustrated in a passage of Agathemeros in which after speaking of the round Ionic maps he refers to the emergence of the idea of the rectangular *oikoumene* with Demokritos: *πρῶτος δὲ Δημόκριτος, πολύπειρος ἀνήρ, συνεῖδεν ὅτι προμήκης ἐστὶν ἡ γῆ, ἡμιόλιον τὸ μῆκος τοῦ πλάτους ἔχουσα.*[36] The same view is expressed incidentally in a passage of Ptolemy: *τῷ γοῦν τοῦ Φιλήμονος λόγῳ, δι' οὗ τὸ μῆκος τῆς Ἰουερνίας νήσου, τὸ ἀπὸ ἀνατολῶν ἐπὶ δυσμάς, ἡμερῶν εἴκοσι παραδέδωκεν, οὐ συγκατατίθεται διὰ τὸ φάναι αὐτὸν ὑπὸ ἐμπόρων ἀκηκοέναι.* (*Geog.* i 11.8). Ptolemy remarks here that his predecessor Marinos did not accept the statement of Philemon giving the longitude of Ireland from east to west as a journey of twenty days, because Philemon said that he obtained this information from merchants. What Marinos suspected was not so much the question of longitude as the figure of twenty days, derived from merchants who were elsewhere thought to have exaggerated their travel-mileage, notably on the long land-route to China.

The views expressed here, placing the long axis of Britain on a line from east to west and that of Ireland parallel to it on the north, merely distort slightly the position which these islands had held, as we have already seen, on the map of Eratosthenes and continued to hold on the map of Agrippa; for Agrippa's map clearly followed Greek models closely,

[34] On the map of Agrippa see Kubitschek 2100–12.

[35] *Cf.* Agathemeros i 2, *GGM* ii 471; Arist., *Meteor.* ii 5, 362b; Strabo ii 4.7, p. 108; iii 1.3, p. 137.

[36] Agathemeros *ibid.*

with the addition perhaps of a little extra information in the area of Western Europe derived from travellers, merchants and soldiers.[37] Pliny's position for Britain (iv 100: '*Britannia . . . inter septentrionem et occidentem iacet*') means that the lie of the island is from north to west. Ireland is again '*super eam*', that is to the north or north-west of Britain as in the fixed tradition of Greek cartography. The account of the islands in Pomponius Mela is even more specifically Eratosthenic than that in Pliny:

> '*Ceterum, ut adhuc habuimus, inter septentrionem occidentemque proiecta, grandi angulo Rheni ostia prospicit: deinde obliqua retro latera abstrahit, altero Galliam, altero Germaniam spectans: tum rursus perpetuo margine directi litoris ab tergo obducta, iterum se in diversos angulos cuneat triquetra*' (iii 6.6).

Britain is still a triangle lying north to west with the large angle of Pytheas at Kantion looking towards the mouth of the Rhine, and the two sides enclosing this angle running south-west and north-east to form the angles at the base of the triangle. Ireland again lies north or north-west of Britain, forming a rectangle nearly as great as the larger island ('*super Britanniam Iverna est, paene par spatio, sed utrinque aequali tractu litorum oblonga*').

Perhaps it may now be evident that, despite Caesar's theory of the position of the British islands, which was accepted in part by Strabo and repeated by Tacitus (*Agr.* 24), the prevalent view during the first century A.D. was quite uncompromisingly that of Eratosthenes. For all the strictures of Hipparchos it was Eratosthenes who chiefly determined the cartographic tradition of later antiquity, and this tradition was clearly not to be lightly disturbed. It was inevitable, however, that the volume of more exact information which slowly began to become available following the Roman invasion of southern England in A.D. 43, particularly after the rapid advance of the Roman military roads with their system of milestones up towards the Scottish border, should ultimately affect the work of the cartographers. This first occurred, so far as our information goes, at the end of the first and the beginning of the second centuries A.D. in the successive maps and accompanying treatises of the geographer Marinos of Tyre, the main source of the extant cartographical work of Ptolemy of Alexandria. I find it difficult to concur with the views of those who hold that Ptolemy's work was to any great extent independent of that of Marinos. He seems to have depended on Marinos in cartography, as he did on Hipparchos in astronomy and on Poseidonios in the *Tetrabiblos*; and his independence consisted largely in a rearrangement of the material of Marinos and the use of a new type of map-projection, with the omission of the ethnography and everything extraneous to the arid materials of his *Introduction to Cartography*. We know from Ptolemy that Marinos was a conscientious worker and that he had consulted every source available which might forward his research, the progressive nature of which is sufficiently indicated by the numerous editions of his work, each of which except the last, as I understand the phrase in Ptolemy, was accompanied by its appropriate map.[38] Marinos therefore was a man who, though presumably far removed from Western sources of information, might be trusted to have obtained and used Roman information, official and otherwise, although we may suspect that the information was not always up to date. We know specifically that he used the reports of Roman soldiers and merchants on Africa,[39] and the reports of Greek travellers and geographers on China and Ireland.[40] It is very probable therefore that it was he, and not some unknown predecessor, who collected and handed on most of the exact information that Ptolemy possessed concerning the British islands.

The studies of G. Schütte have thrown much light on the influence exercised by Roman

[37] Compare for instance Pliny's phrase about the length of the coast of Germany (*NH* iv 99): 'haud multum ora deerit Graecorum opinioni et longitudini ab Agrippa proditae'.

[38] Ptol., *Geog.* i 6.1, 17.1.

[39] Ptol., *Geog.* i 8.5.

[40] Ptol., *Geog.* i 11.7–8.

sources on the material which we find in Ptolemy, both in regard to Latin forms of place-names and also to information derived from recently built Roman road networks. In particular Schütte believes that the Ptolemaic map of Germany is not only related to the Roman itineraries such as the *Tabula Peutingeriana* and the *Itinerarium Antonini*, but reveals in itself all the characteristics of the itinerary type.[41] The itineraries were like the modern schematic representations of railway systems, and did not pretend to offer a correct topography. It is equally evident that some information about the Roman milestone system in England was available to Ptolemy, and there can be no reasonable doubt that Marinos was among the first to exploit this information. We may perhaps conjecture that it was the work of Marinos that forged the link between the Greek cartographic tradition and the new knowledge derived from the Roman road-system with its mileage reckonings together with the miscellaneous information collected from officials, merchants and other travellers on areas both within and without the Empire.[42]

In a chapter of his *Geschichte der wissenschaftlichen Erdkunde der Griechen* Berger has admirably deduced the main lines of the geographic work of Marinos from the odd references and animadversions in Ptolemy. Only the north-west corner of his map concerns us here. We have to keep in mind the fact that Marinos accepted the measurement of the degree at 500 stadia from Poseidonios. This new and equally wrong measurement was not due to any fault of Poseidonios,[43] and its later acceptance by Marinos was perhaps the result of casual and misleading references to the activity of Poseidonios in later geographers such as Strabo, who understood neither the method of Eudoxos nor that of Eratosthenes for measuring the earth's circumference. Marinos cannot, however, be absolved of a 'frightful carelessness in the use of his materials' in this respect.[44] He was a geographer working on the lines of Eratosthenes rather than Hipparchos. Nevertheless he took many of his parallels from Hipparchos, just as Strabo had done. He also used reports of itineraries from West Africa and reports of ships' captains from East Africa to establish his southern parallels beginning at 24° south latitude. For the more northerly parallels he had like his predecessors to go to the north-west. Berger says that the appearance of no small number of (new) geographical names in the table of Ptolemy (*Almagest* ii 6) can be attributed to Marinos, who took from Hipparchos what he could use as a geographer and then employed the increased geographical knowledge of his own time to provide further points of support for his parallels.[45] Such points or names in the north are: southern Britain 51° 40′, then the mouth of the Rhine, the mouth of the Don, and especially the information on Great and Little Britain (a distinction which Ptolemy drops in his *Geography*), that is Brigantion 55°, mid-Britain 56°, Katuraktonion 57°, south of Little Britain 58°, middle of Little Britain 59° 30′, north of Little Britain 61°, and the Ebudic isles 62°. Thule was put far to the west compared with Eratosthenes (*Geog.* ii 3.32), namely between 29° and 31° 40′ east longitude, the reckoning being taken from the Fortunate Isles, which were placed $2\frac{1}{2}$° west of Cape St. Vincent. Marinos placed Thule no longer on the Polar Circle but at 63° (Ptol. *Geog.* i 7.1), a change probably due to the expedition of Agricola's fleet mentioned by Tacitus (*Agr.* 10). In regard to his map we have further to remember that his parallels and meridians were straight lines intersecting at right angles. The parallels were merely reduced to four-fifths of the degree length on the chief line of longitude through Rhodes, which made the longitudes expand greatly to the north and contract unduly towards the equator.[46] The main meridians were sixteen in number enclosing his *oikoumene*, 225° in longitude, at intervals of 15°.

[41] Schütte, xxxi 580–9.

[42] *Cf.* Plut., *de def. orac.* xviii, and the valuable series of articles by Zimmer.

[43] If we accept Berger's argument, *Geschichte* 577–82, more fully developed in Berger, *Berichte* 53–77. Thomson, in accord with the plan of his work, only mentions this problem and does not discuss it in detail (Thomson, 212–13, 334).

[44] Berger, *Geschichte* 593.

[45] Berger, *Geschichte* 612.

[46] Ptol., *Geog.* i 20.4.

My earlier interpretation of Strabo's remarks on the two Britains in Hipparchos shows, I think, that this terminology in regard to Ireland and England, 'Little and Great Britain', is not an invention of Marinos but goes back at least to Hipparchos and perhaps to Eratosthenes and Pytheas. Berger seems to suggest that he himself understood Little Britain as Scotland, although he never specifically says so. If this was his view, however, it was certainly quite untenable. This is proved not only by the fact that the word Brettanike, when it refers to the large island, always means England plus Scotland (the distinction in area being itself based on the ethnical consequences of invasions which occurred centuries later), but also and more particularly by my argument stated above concerning the 'Britain' north of Britain in what was the traditional position of Ireland on the map. Further, there is the natural and fully attested fact that Ireland is always the small island compared with the neighbouring great island while both, including also Thule and many smaller islands, share the common name of 'British' islands, so that an early use of the terms 'Little Britain' and 'Great Britain' was a perfectly natural, indeed inevitable development. Apart from this I entirely accept Berger's view that the list of new names in *Almagest* ii 6 is a set of identifications by Marinos of geographical points with certain steps on his ladder of parallels.

One may ask what effects were produced by the acceptance of a fundamental unit, the degree, as being equal to 500 stadia instead of 700. We find for instance that the 5,000 stadia of Eratosthenes between Syene and Alexandria has now to become 3,500 stadia between 24° and 31°,[47] while the second test interval for measuring the earth's circumference, the 3,750 stadia between Alexandria and Rhodes, becomes about 2,700 stadia. This argues a fundamental incompetence in the mathematical and astronomical bases of geography in Marinos—a wilting of the traditional Greek curiosity about the nature of things which is barely compensated for by his undoubtedly great merits as a compiler and analyst of masses of heterogeneous geographical and ethnographic material. More pertinent to our theme is the effect of the curtailed degree on positions in northern latitudes.

Berger proves that the map of Western Europe in Ptolemy shows an excellent basis which is in general the design of Eratosthenes after Pytheas. Some of the errors in Strabo caused by Polybios (iii 38) are rectified.[48] The coast of France, Belgium, Holland, up to Jutland is given reasonably correctly. South Britain and the Bristol Channel are very well presented. Ireland is properly positioned towards the British coast. But the north part of Britain, that is Scotland, is nevertheless extraordinarily twisted. It is to be understood that the figures in Ptolemy must be reduced by one-sixth to approach reality, *i.e.* the degree of 500 stadia must be transformed into one of 600 stadia. This same point has of course already been observed in the case of the degree of 700 stadia. But we must avoid being wise after the event. For us it is now known that the degree is about 600 stadia, but neither Hipparchos nor Ptolemy knew this, and they had to work by their own lights. Hipparchos may be excused for using the degree of Eratosthenes with an adequate caution about its uncertainty, but neither Marinos nor Ptolemy can be absolved quite so lightly.[49]

Ptolemy has informed us of his exact procedure as concerns astronomic and stadiastic data, together with a note on previously existing knowledge:

> *Ἐπεὶ δὲ μόνος ὁ Ἵππαρχος ἐπ' ὀλίγων πόλεων, ὡς πρὸς τοσοῦτον πλῆθος τῶν καταταssομένων ἐν τῇ γεωγραφίᾳ, ἐξάρματα τοῦ βορείου πόλου παρέδωκεν ἡμῖν καὶ τὰ ὑπὸ τοὺς αὐτοὺς κείμενα παραλλήλους, ἔνιοι δὲ τῶν μετ' αὐτὸν καί τινας τῶν ἀντικειμένων τόπων, οὐ τοὺς ἴσον ἀπέχοντας τοῦ ἰσημερινοῦ, ἀλλ' ἁπλῶς τοὺς ὑπὸ τοὺς αὐτοὺς ὄντας μεσημβρινοὺς ἐκ τοῦ τοὺς πρὸς ἀλλήλους αὐτῶν διάπλους οὐρίοις ἀπαρκτίαις ἢ νότοις διανύεσθαι, τὰ δὲ πλεῖστα τῶν*

[47] Ptol., *Geog.* iv 5.9, 5.73.

[48] Berger, *Geschichte* 511, 543 ff., 629 ff.

[49] On this question see Ptol., *Geog.* i 11.2, vii 5.12; Schnabel; Fischer; Kubitschek, 2069 ff., 2077 ff.; Berger, *Geschichte* 579 ff. Berger's view seems more acceptable than that of Schnabel.

διαστημάτων, καὶ μάλιστα τῶν πρὸς ἀνατολὰς ἢ δυσμὰς ὁλοσχερεστέρας ἔτυχε παραδόσεως, οὐ ῥᾳθυμίᾳ τῶν ἐπιβαλλόντων ταῖς ἱστορίαις, ἀλλ' ἴσως τῷ μηδέπω τὸ πρόχειρον κατειλῆφθαι τῆς μαθηματικωτέρας ἐπισκέψεως, καὶ διὰ τὸ μὴ πλείους τῶν ὑπὸ τὸν αὐτὸν χρόνον ἐν διαφόροις τόποις τετηρημένων σεληνιακῶν ἐκλείψεων,—ὡς τὴν μὲν ἐν Ἀρβήλοις πέμπτης ὥρας φανεῖσαν, ἐν δὲ Καρχηδόνι δευτέρας,—ἀναγραφῆς ἠξιῶσθαι, ἐξ ὧν ἐφαίνετ' ἄν, πόσους ἀπέχουσιν ἀλλήλων οἱ τόποι χρόνους ἰσημερινοὺς πρὸς ἀνατολὰς ἢ δυσμάς · εὔλογον ἂν εἴη, καὶ τὸν τούτοις ἀκολούθως γεωγραφήσοντα τὰ μὲν διὰ τῶν ἀκριβεστέρων τηρήσεων εἰλημμένα προϋποτίθεσθαι τῇ καταγραφῇ, καθάπερ θεμελίους, τὰ δ' ἀπὸ τῶν ἄλλων ἐφαρμόζειν τούτοις, ἕως ἂν αἱ πρὸς ἄλληλα θέσεις αὐτῶν μετὰ τῶν πρὸς τὰ πρῶτα τηρῶσιν ὡς ἔνι μάλιστα συμφώνως τὰς ἀδιστακτοτέρας τῶν παραδόσεων. (*Geog.* i. 4.2.)

'Hipparchos had supplied the altitude of the pole (for reckoning latitude) only in the case of a few cities compared with the vast number of points to be located on the map, and had extended this in some cases to points of the same latitude (*e.g.* his parallels of Rhodes, Byzantium and Borysthenes). After his time other scholars had made lists of corresponding points, not points equidistant from the equator but simply points on the same meridian, using the fact that voyages were made from one to the other with north or south winds directly astern. Most reckonings of distances, however, in the east and west especially, depend on a rough reckoning, not through the inertia of the investigators, but rather because their mathematical capacity had not advanced to that stage of ready usage, and because more lunar eclipses simultaneously observed in different places had not been adjudged worthy of record—eclipses such as that seen at Arbela at the fifth hour and at Carthage at the second, which would have made clear how many equinoctial hours the places concerned were apart to east or west. It would seem reasonable, therefore, in order to draw a map in accordance with this information, to regard the more accurate observations as the basis, as it were the foundation, of the map. The information derived from other sources should then be made to fit in with these observations, until the reciprocal locations of the second class of information, together with their positionings with reference to the first-mentioned class, preserve with the greatest possible measure of agreement the least doubtful versions of the traditional information.'

We may notice here two fundamental facts, firstly the lack of astronomical observations later than those of Hipparchos, and secondly the clear distinction between the values of the information available in the familiar Mediterranean on the one hand, and in the far-distant east and west on the other. The distinction between 'accurate information' and 'rough reckoning' comes from *Geog.* i 2.2 where the latter is defined as dead reckoning, and therefore what Ptolemy tells us here in so many words is that positions in the west are determined by dead reckoning and not by any astronomical observations.[50] It is unfortunate that this plain statement of fact by Ptolemy has been so long ignored by those scholars who in writing of the British Isles allow themselves the assumption of a gnomonic reading or even an observation of a lunar eclipse in order to support their argument. If we now turn to examine Ptolemy's figures we shall see that his practice follows his theory in the north-west of Europe.

His base-line here is, as we would expect, the parallel of Marseilles, 43° north latitude. The first point which becomes clear is that he has translated the degree of 700 stadia into that of 500. Thus where Strabo gave 3,800 stadia from Marseilles to the north coast of France Ptolemy makes it run from 50° to 53° north latitude, that is 7 to 10 *new* degrees north of Marseilles, which gives an approximate equivalent of 3,500 to 5,000 stadia.[51] Again, his nineteenth parallel, in the most southerly part of Britain,[52] presumably through the Lizard, runs at 51° 30′ or 51° 40′, that is $8\frac{1}{2}°$ or $8\frac{2}{3}°$ north of Marseilles, equivalent to

[50] On the reckonings of Pytheas, see Berger, *Geschichte* 327 ff.; *cf.* Caesar, *BG* v 13, quoted above.

[51] Berger, *Geschichte* 630; Ptol., *Geog.* ii 8.1 f., 9.1.

[52] Ptol., *Almagest* ii 6.

4,250 or 4,333 stadia. We must multiply these figures by five-sixths to reduce them to what we know to be the value of a degree, and the result is $50\frac{1}{12}°$ or $50\frac{2}{9}°$ for the Lizard, a very accurate reckoning, and even more so when we consider that his reading for Marseilles is not 43° but rather 43° 4′. The next two parallels in Ptolemy are the mouths of the Rhine and the Don, both of which are placed too high, especially the latter. There then follows the list of six points which really concern us, followed by the Ebudic islands and Thule.[53] Of the six points the first three are in Great Britain, the second three in Little Britain, and they ascend the scale of parallels like steps in a ladder: Brigantion in Great Britain 55°, middle of Great Britain 56°, Katuraktonion in Great Britain 57°, south parts of Little Britain 58°, middle of Little Britain 59° 30′, north of Little Britain 61°. These are followed in turn by the Ebudic islands 62°, the island of Thule 63°, and unknown Scythian tribes 64° 30′, at which point Ptolemy runs out of geographical names. Reducing these values as before by one-sixth in the interval from Marseilles (the astronomically fixed point) northward to the point in question we get the following: Brigantion 53°, mid-Britain 53° 50′, Katuraktonion 54° 40′, south Little Britain 55° 30′, middle Little Britain 56° 45′, north Little Britain 58°, Ebudic islands 58° 50′, Thule 59° 40′.

There is a number of important things to be learnt from this table. First, it is a purely conventional table, using a one-degree interval (one new degree of 500 stadia) in Great Britain and a $1\frac{1}{2}$ degree interval in Little Britain. The unknown Brigantion and the south, middle and north terminology confirm one's belief in the conventional nature of the points chosen. Secondly, the figures for Britain, to judge from the Lizard and Katuraktonion (Catterick), are very correct. The figures Lizard 50° and mid-Britain 53° 50′ show that north Britain (*i.e.* Scotland) ends at 57° 40′, and that Scotland therefore is already twisted to the east in the *Almagest*. We can assume that this feature is carried over from Marinos. Thirdly, the position and size of Little Britain (= Ireland) is by comparison with that of Britain very erroneous. After the reduction it is still 4° too high, as it always had been too high since the map of Eratosthenes, despite the efforts of Caesar to change its position. Lastly, the direction of the main axis of Ireland has clearly been changed from east-west to north-south, and we must ask why. The long axis east-west is clearly established in Agrippa (Pliny), Strabo and Philemon in the passages already quoted, while the long axis north-south is just as clearly fixed in Ptol. *Geog.* ii 1.4–5 and ii 2.2–4. We know, moreover, that Ptolemy had made no change in the map of Marinos in this respect, since if he had he would have specifically mentioned it. It becomes evident that Marinos has changed the position of Ireland in the same way that he changed that of southern Brettanike, and that therefore Ireland's traditional position as parallel to Britain in Eratosthenes, Strabo, Caesar ('*pari spatio transmissus*' *BG* v 13) and Agrippa ('*brevissimo transitu a Silurum gente* $\overline{\text{XXX}}$' Pliny iv 103) has drawn it into line with southern Britain rather than with northern Britain (= Scotland). We may further connect this change in the general position of Ireland with Marinos' note on Philemon quoted by Ptolemy (*Geog.* i 11.8, quoted above). Where Marinos disagreed with a recorded travel-distance on land we know that he reduced it by half or slightly more, as he does in *Geog.* i 8.3–4 and i 11.5. He specifically disagreed with Philemon's reckoning of the east-west axis in Ireland as twenty days' journey or approximately 420 Roman miles (*Geog.* i 11.4). This figure he presumably reduced to 210 Roman or 192 English miles, and having changed the direction of the axis, longitude became latitude, and this became the north-south dimension. This is exactly the north-south distance given by Ptolemy from North Cape to South Cape ($3\frac{1}{4}$ new degrees = 192 English miles).

Perhaps sufficient evidence has now been adduced to show that the fairly accurate information on England is due to the Roman conquest of the country in the first century

[53] Ptol., *Almagest* ii 6.

A.D., and that Marinos must have had knowledge of the early grid of roads running to the north which enabled him to choose suitable conventional points for each step on his scale of degrees. He had also, as shown above, some information on the dimensions of Ireland, which, whether appearing in Pliny's quotations from the map of Agrippa, or in Philemon, ultimately derived from Gaulish and British merchants visiting Ireland in the first century A.D. His general information on Scotland was extremely poor. If one asks whether Agricola's fleet did not bring back better evidence about the shape and dimensions of the north of Britain the answer must be doubtful. The intricacies of the western Scottish coast are enough to confuse even experienced sailors, and it is improbable that anyone on board could bring back the requisite astronomical data. Even if this were the case it is certain that Marinos was unaware of any fresh information on Scotland, and continued to give it the mainly east-west axis which it had been given since the time of Pytheas and Eratosthenes.[54] To this extent we can answer Macduff's question, 'Stands Scotland where it did?' Scotland stood where it did, on the Greek maps from Pytheas to Ptolemy and for centuries afterwards, so long as the maps based on Ptolemy were reproduced without correction in this quarter.

This does not mean that there is no information in Ptolemy of historical and linguistic value. His evidence on Dacia, a country equally beyond the Roman border, is regarded as excellent,[55] and there is no reason to think that the case is very different in the matter of Ireland and Scotland. But the astronomical data (so-called) have no scientific value as such. Ptolemy describes his method clearly at the beginning of his second book:

> *Ἀρξόμεθα δ' ἐντεῦθεν τῆς κατὰ μέρος ὑφηγήσεως, ἐκεῖνο προλαβόντες· ὅτι τὰς τῶν τετριμμένων τόπων μοιρογραφίας μήκους τε καὶ πλάτους ἐγγυτάτω τῆς ἀληθείας ἔχειν νομιστέον διὰ τὸ συνεχὲς καὶ ὡς ἐπίπαν ὁμολογούμενον τῶν παραδόσεων· τὰς δὲ τῶν μὴ τοῦτον τὸν τρόπον ἐφοδευθέντων ἕνεκεν τοῦ σπανίου καὶ ἀδιαβεβαιώτου τῆς ἱστορίας ὁλοσχερέστερον ἐπιλελογίσθαι κατὰ συνεγγισμὸν τῶν πρὸς τὸ ἀξιοπιστότερον εἰλημμένων θέσεων ἢ σχηματισμῶν· ἵνα μηδὲν ἡμῖν τῶν ἐνταχθησομένων εἰς συμπλήρωσιν τῆς ὅλης οἰκουμένης ἀόριστον ἔχῃ τὸν τρόπον*[56] (*leg. τόπον*).

'I now begin my detailed introduction with this proviso; we must regard the longitude and latitude of well-known areas as nearly correct because of the continuous and generally recognised evidence in this respect. But the positions of areas not traversed in this way we must regard as rather rough reckonings because of the scanty and unconfirmed nature of the evidence, as an approximation, that is, to the positions or shapes most credibly established, so that every point to be located throughout the extent of my map of the whole inhabited world may have its definite place.' Giving a longitude and latitude then is merely a way of fixing points on a map, and we may be certain that the information was normally taken from the map of Marinos. The astronomical data are therefore merely a translation into different terms of information derived from the authorities of Marinos, and they share all the uncertainties of date and value which qualified his different kinds of evidence.

Ptolemy is of course aware of the great unreliability of the evidence derived from land-travel and from sea-voyages. He considers the question specifically[57] and later at great length in his criticisms of Marinos.[58] In chapters 7 to 9 of his first book he criticises the

[54] Thomson (p. 236) here represents a view rather close to that of Mannert (quoted from Berger on p. 132 above). It is true that Strabo is strongly inclined to compress the width of the *oikoumene* at various points, yet he leaves Britain a triangle. Marinos has rather the opposite inclination and yet he distorts the north of Britain. It would be absurd to attribute the distortion to a deliberate falsification of Marinos, and consequently it must be due to his following the older information regarding the north of Britain available to him in the work of Pytheas, Eratosthenes and others.

[55] Schütte, xxx 67 ff.; *cf.* Kubitschek, 2070 ff.

[56] Ptol., *Geog.* ii 1.2, *cf.* 9.8.

[57] Ptol., *Geog.* i 2.4.

[58] Ptol., *Geog.* i 7 and following chapters.

latitudinal dimensions of Marinos derived from (*a*) astronomical data, (*b*) measurements by land, and (*c*) measurements by sea. In chapters 11 to 14 he delivers a similar criticism of his longitude. At the beginning of chapter 15 he summarises all this preceding section as being a curtailment of the general dimensions of longitude in the east and latitude to the south, which shows clearly that he had no such criticism to make in the north-west. Having thus discussed the general outlines of the work of Marinos he then devotes three more chapters (15 to 17) to the mistakes in detail of his predecessor's work. In these the only mention of the British Isles is a note in chapter 15.6 to the effect that the text of Marinos gives Noviomagus as 59 miles south of London, whereas the parallel in the map shows it as rather north of London. In Book ii of the *Geography* Noviomagus is given as 35 minutes south of London, or about 34 miles. It seems that Ptolemy here has manipulated the Roman road-grid and put Noviomagus roughly half-way between the two positions variously assigned to it by Marinos.

It is generally recognised that a passage at the end of *Almagest* ii forecasts the writing of a geographical work with a catalogue of longitudes and latitudes of notable cities as an appendix:

> *ἐφωδευμένης δὴ καὶ τῆς τῶν γωνιῶν πραγματείας, λείποντος δὲ τοῖς ὑποτιθεμένοις τοῦ τὰς ἐποχὰς τῶν καθ' ἑκάστην ἐπαρχίαν ἐπισημασίας ἀξίων πόλεων ἐπεσκέφθαι κατὰ μῆκος καὶ κατὰ πλάτος πρὸς τοὺς τῶν ἐν αὐταῖς φαινομένων ἐπιλογισμοὺς τὴν μὲν τοιαύτην ἔκθεσιν ἐξαιρέτου καὶ γεωγραφικῆς ἐχομένην πραγματείας καθ' αὐτὴν ὑπ' ὄψιν ποιησόμεθα ἀκολουθήσαντες ταῖς τῶν ἐπεξειργασμένων ὡς ἔνι μάλιστα τοῦτο τὸ εἶδος ἱστορίαις καὶ παραγράφοντες ὅσας μοίρας ἀπέχει τοῦ ἰσημερινοῦ τῶν πόλεων ἑκάστη κατὰ τὸν δι' αὐτῆς γραφόμενον μεσημβρινόν, καὶ πόσας οὗτος τοῦ δι' Ἀλεξανδρείας γραφομένου μεσημβρινοῦ πρὸς ἀνατολὰς ἢ δύσεις ἐπὶ τοῦ ἰσημερινοῦ, διὰ τὸ πρὸς τοῦτον ἡμῖν συνίστασθαι τοὺς τῶν ἐποχῶν χρόνους.* (ii 13).

This appendix exists in a later and amplified form in Book viii of the *Geography*. Its information is presumably earlier than that contained in the main body of the *Geography* which was written later, and so we can postulate three successive stages for the information on the British Isles, namely *Almagest* ii 6, *Geog.* viii, and *Geog.* ii.[59] If we tabulate the information derived from these three sources, on the points running north from Vectis to Thule, we find that in nine cases (out of fourteen) the evidence is identical, in two nearly so, while in the remaining three, namely Katuraktonion, Vectis and London, the variants run from 1° to 4°. The variants for Vectis and London must be due to some MS. corruption, but it is possible that the change in Katuraktonion from 57° to 58° may be intentional. It might mean that there were reports that Ireland was not so far north of Britain as had been supposed, and therefore the top step of the scale of parallels within Britain is made level at 58° with the south of Ireland instead of remaining one step below at 57°.

It must then be recognised that the system of Ptolemy in giving locations is highly

[59] J. Fischer, in his work on Ptolemy (see n. 1), states that the *πρόχειροι κανόνες*, of which there is as yet no critical edition, is a still later work giving additions to and differences from the tables of *Geog.* viii, agreeing more closely with the data of the earlier books. Fischer thinks that these tables are an improved version of those in the *Geography*, based largely on new information. Otto Cuntz argues on the contrary that the positions given in this work are borrowings or corruptions from the data of the *Geography*. It would be premature to express a definite opinion before adequate critical editions of both this work and the *Geography* are available. Meanwhile it may be said that the MSS. readings given by Fischer on the British Isles provide nothing of interest other than a tendency to reduce the latitude of the middle of Ireland by 1° 10′. The latitude of 66° for Thule in the printed Oxford edition of 1712 (*Geog. veteris scriptores Graeci minores*, vol. iii) seems to be a retention of the old latitude of Thule from one of the early works of Marinos. Considering the fact that no information reached Ptolemy about his major inaccuracies regarding Scotland it seems very unlikely that he was in a position to get information causing him to shift the positions of towns in Ireland by seventy or less miles, and indeed he states that the evidence of Marinos was most lacking in regard to cities of the interior (*Geog.* i 18.6).

conventionalised with a very low degree of accuracy, as indeed he himself admits in his very first chapter.[60] His minimal unit is 5′, but anyone who cares to plot out the British Isles with his figures will be well aware that his real unit of measurement is 15′ or even 30′. Whatever check there may have been on his manipulation of the evidence by reason of the existence of itineraries within the empire,[61] outside it there was little in the way of guidance but the wild surmise which Strabo had castigated in Eratosthenes.[62] As a field of study therefore the identification of places in Scotland and Ireland with those mentioned in Ptolemy is fully open to those who are qualified to deal with it whether from the linguistic or from other points of view; and I hope I have shown, for those who would undertake the task, that their scope and freedom of speculation need not be hampered by the *damnosa hereditas* of a list of apparently astronomical data which in fact never really existed.

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[60] Ptol., *Geog.* i 1.5–6. [61] Ramsay, 69–74; Kubitschek. [62] *στοχασμός*, Strabo, *Geog.* i 4.4, p. 63.