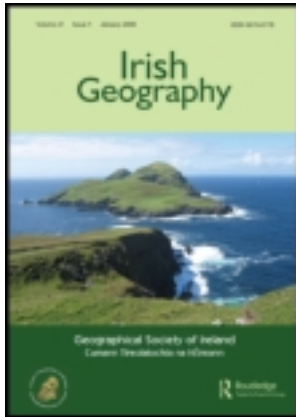


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Ptolemy's map of Ireland: a modern decoding

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Ptolemy's map of Ireland: a modern decoding

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Claudius Ptolemy (roughly AD 90–168) presents us the oldest surviving account of Ireland in the form of a set of coordinates showing different geographical features or a 'virtual map'. While Ptolemy's map looks roughly like today's Ireland there are a number of discrepancies. Likewise, while some locations are obvious, others are disputed or obscure. After reviewing earlier attempts at reconciling Ptolemy's map with modern ones we adjust Ptolemy's coordinates to modern references with two equations. We find Ptolemy's map is consistent with some intimate Mediterranean knowledge of Ireland, its peoples, coastal features and principal places with their respective locations. We correct some of the modern locations attributed to Ptolemy, offer possible explanations for certain disputed or uncertain locations and offer some external validation to the prehistoric division of Ireland passed down from pre-Patrician sources.

Keywords: Ptolemy; Hibernia; first century Ireland; historical cartography; ancient Irish locations

Introduction: Ptolemy's map of Ireland

Our pre-Patrician sources for Irish history are the archaeological facts on the ground, legends, stories and histories that have come down to us and Irish language place-names as they embody historical experience. The earliest glimpse we have into Irish affairs is roughly the first century AD, thought to be the age of the *Táin Bó Cúailnge*. Yet 'the later first millennium BC and the early periods AD are amongst the most obscure periods in Irish prehistoric archaeology' (Waddell 2005, p. 279). True, we have written records of the period but they were set in writing only half a millennium later by scribes living in a different Ireland. Some scholars today think the compilers of the ancient texts produced 'a fantastic compound of genuine racial memories, exotic Latin learning ... euhemerized Celtic mythology, dynastic propaganda, folklore, and pure fiction' (Byrne 1973, p. 9).¹ Others defend the legacy of the *senachies* and seek keys to Ireland's past in these records. 'While we cannot assign dates to characters such as Medbh, Aillil, and Fergus, it is perhaps easier to believe that they existed rather than that they are "fictional" or "mythic"' (Carney 2005, p. 478).

There is another source to first century Ireland, Ptolemy's map. Greek mathematician, astronomer and geographer Claudius Ptolemy (roughly AD 90–168) spent his life in the eastern Mediterranean. He contributed to the foundation of spherical trigonometry and applied it to integrating astronomical and terrestrial observations into a systematic account of the heavens as related to the earth. His

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system had the heavens forming a sphere within which another sphere, the earth, was centred. Determining the obliquity of the ecliptic, the tilt of the earth relative to the perceived path of the sun, became ‘the foundation of all astronomical science’ (Bunbury and Beazley 1926, p. 620). Ptolemy accomplished this by analysing the angle of the sun during the longest day for locations on 26 parallels of longitude. The parallels were defined by the length of the longest day in quarter hours. Among these are the parallels through York (17.25 hours) and Catterick (17.75 hours) in Britain (Ptolemy 1952).

Building on his astronomical work, Ptolemy turned to mapping the known world. He divided what he assumed to be a sphere by parallels of latitude and meridians of longitude. On to this grid Ptolemy placed a number of locations. The latitude of some sites could be located with relative precision from observations of the longest hours of daylight. Relative longitude could be determined by the hour of an astronomical event such as a lunar eclipse. Thus, an eclipse that was seen at Arbela (i.e. Gaugamela) at the fifth hour and at Carthage at the second hour separated the two cities by three hours. Given Ptolemy divided the globe into 360° which the sun took 24 hours to traverse, the two cities were separated by $(3/24) \times 360^\circ = 45^\circ$. Ptolemy’s *Geography* placed the two locations at longitudes $79^\circ 30'$ and $34^\circ 50'$. Ptolemy tells us it was reasonable to use locations ‘obtained through the more accurate observations, as foundations, so to speak, but to fit [the features] that come from the other [kinds of data] to these, until their positions with respect to each other and to the first [features] stand as much as possible in agreement with those reports that are less subject to error’ (Ptolemy, *Geography*, Book 1, p. 4 quoted in Berggren and Jones 2000, p. 63). The ‘other kinds of data’ are traveller, merchant and military reports of distances and directions collected by previous geographers, notably Marinus of Tyre.² The result is the latitude and longitude of approximately 8000 locations from Ireland through China.

Ptolemy’s map of Ireland is a long exposure photograph in the sense that it most likely represents points recorded not instantaneously but over time, written down and fixed at roughly AD 100. Ptolemy references 15 rivers, six promontories and ten cities. He names and gives the proximate locations of 16 tribes (Figure 1).

For centuries scholars have tried to reconcile Ptolemy’s description with Irish tradition as to ancient conditions revealed to us through romances such as the *Táin Bó Cúailnge*, fragments of oral history preserved in works such as the *Annals of the Kingdom of Ireland by the Four Masters*, ancient Brehon law and other material (see O’Curry 1878). As with the Irish tradition itself, some throw up their hands (O’Flaherty 1793, I, p. 25, Thomson 1948, p. 343). Others find in Ptolemy, despite difficulties, vindication of the Irish tradition (O’Conor 1766, pp. 181–182).

Ptolemy’s map shares the difficulties of the surviving Irish sources. We do not have the original. Over the centuries, various hands amended, translated, and copied copies yielding what is available today. We recognise these difficulties, especially difficulties with the Stevenson (Ptolemy [1932] 1991) edition (see Berggren and Jones 2000, p. 53). Nevertheless we used the names and coordinates from that text as the most accessible source.³ Of Ptolemy’s specific information on Ireland, or its sources, we know nothing.

It is clear the Roman world knew Ireland and Ireland knew Roman Britain, continental and Mediterranean Europe (Cooney and Grogan 1999, pp. 200–202, Waddell 2005, pp. 374–377). Romans may even have had had settlements in Ireland.

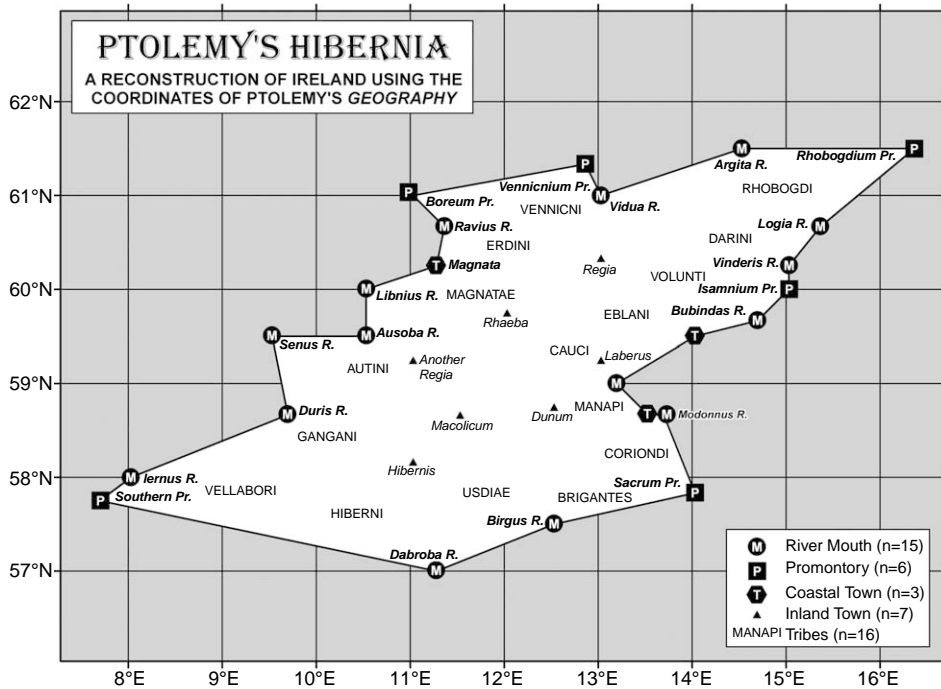


Figure 1. Source: Authors' own.

A second-century candidate is Stoneyford, County Kilkenny, navigable from Waterford on the Nore (Raftery 2005, p. 175). Loughshinny in County Dublin is another.

The fort has been identified as a significant Roman beachhead, built to support military campaigns in the 1st and 2nd centuries AD. It was heavily defended and is believed to have developed into a big trading town. Coins found at the site are stamped with the names of the emperors Titus, Trajan and Hadrian, suggesting that Roman involvement in Ireland extended at least from AD79 to AD138. (Byrne and Maas 1996; see also Raftery 1994, p. 208, Edwards 2005, p. 254)

Ptolemy, therefore, would have military, trading and traveller evidence as to Irish locations.

Ptolemy, first and foremost, was a mathematician. He did not simply give credulity to any and all information. Rather, he took seriously the task of integrating the available reports with the appropriate mathematics, not fancy.

Ptolemy underestimated the size of the equator, and hence the earth, by about 18% (Berggren and Jones 2000, p. 21). His prime meridian went through Hierro (17° 58'W) in the Canaries, rather than our Greenwich and he placed Ireland about five degrees more to the north than it should be (Thomson 1948, p. 342). Using this information, we can write preliminary equations to convert Ptolemy's parallels (π) and meridians (μ) into estimates (p' , m') of today's (p , m) parallels and meridians.

$$p' = 5 + .82\pi$$

$$m' = -17.917 + .82\mu$$

Drawing on equations in Kirvan (1997) we can convert differences in degrees between Ptolemy's and today's locations, into great circle kilometres, k . If we assume the earth is a sphere – it is actually flattened at the poles – each degree of latitude is separated by 111.325 kilometres. The meridians, on the other hand, converge toward the poles. The great circle distance between meridians is, then, a function of latitude. The kilometre distance, k , between meridians m_1 and m_2 at a given parallel p_1 is $k = 111.325 \times \cosine(p_1) \times |m_1 - m_2|$. The great circle kilometre distance, k , between two locations is

$$k = 111.325 \times \arccosine(\text{sine}(p_1) \times \text{sine}(p_2) + \cosine(p_1) \times \cosine(p_2) \times \cosine(|m_1 - m_2|)).$$

The difference in kilometres between the corrected Ptolemy estimates for a particular location and modern coordinates is

$$k = 111.325 \times \arccosine(\text{sine}(p) \times \text{sine}(p') + \cosine(p) \times \cosine(p') \times \cosine(|m - m'|)).$$

Ptolemy's precision

Ptolemy had at least some information on a number of Irish locations. We might expect his latitude information was more precise than his longitude. We expect he had relatively reliable data on direction from one place to another – toward the sunset, at right angle to the arc of the sun, etc. – and less reliable information on distance – three days journey, for example. All this he was able to sift and bring to some order with mathematics, perhaps throwing away some locations because of hopelessly inconsistent or vague information. As they come to us, Ptolemy's Irish parallels and meridians are reported to one-sixth of a degree.

At this point it will be useful to investigate how precisely Ptolemy estimated Irish locations. For a moment, let us assume that Ptolemy had precise longitude and latitude information which he rounded to the nearest one-sixth of a degree or 10'. Assume the minutes of latitude and longitude were uniformly distributed, and they should be. Consider locations between 53°N and 53° 10'N. Those $\geq 53^\circ\text{N}$ and $< 53^\circ 5'\text{N}$ would be rounded to 53°N. The average difference between the actual and Ptolemy's latitude would be $5'/2 = 2.5'$. At Athlone, 53° 25' 59"N, 7° 57'W, the average difference between Ptolemy's coordinates and the true coordinates, assuming he knew locations accurately to the minute and rounded to the one-sixth of a degree, is 2.76 kilometres longitude, 9.87 kilometres latitude and 10.24 kilometres as the crow flies.⁴

We do not think Ptolemy's data is near that level of precision and therefore expect our tentative assumptions as to precision will be contradicted by the pattern of Ptolemy's data. Table 1 shows the distribution of minutes in Ptolemy's Irish data and what would be expected if minutes were uniformly distributed throughout the range 0'–60'. Twenty of Ptolemy's 31 longitude minutes and 13 of his latitude minutes are either at one-half a degree or a whole degree. This compares with 10.3 expected.

It appears Ptolemy did not have precise observations rounded to the nearest one-sixth of a degree. Rather, latitudes are estimated to a higher precision than his

Table 1. Observed distribution of minutes of latitude and longitude compared to what would be expected if minutes were uniformly distributed and Ptolemy rounded to nearest sixth of a degree.

Grossest measurement in degrees ¹	Ptolemy minutes observed		Expected ² longitude or latitude
	Longitude	Latitude	
Sixths	2	2	7.75
Quarters	2	7	5.166667
Thirds	7	9	7.75
Halves	8	6	5.166667
Whole degrees	12	7	5.166667
Total	31	31	31
Chi square	16.870968	5.9032258	
Df	4	4	
Prob.	0.0020478	0.2064929	

Notes: 1. 10' and 50'=1/6; 15' and 45'=1/4; 20' and 40'=1/3; 30'=1/2; 0'=1.

2. Assumes Ptolemy observed uniformly distributed exact minutes which he rounded to the nearest of 0, 10, 15, 20, 30, 40, 45 or 50 minutes.

longitudes. Ptolemy is clearly estimating Irish longitudes to the nearest degree or half degree and then placing a few locations further east or west, where necessary, in thirds, quarters or sixths of a degree. His estimates of latitude, in contrast, are not significantly different from what are to be expected. We believe that Ptolemy's median Irish location is estimated to the half degree of longitude, yielding an average error of 15' and the one-third degree of latitude yielding an average error of 5'. At Athlone his accuracy would average 16.580 kilometres for longitude and 14.509 for latitude; making the total average error built into his data to be 22.01 kilometres as the crow flies.⁵ That assumes, of course, Ptolemy precisely estimated locations to the minute and rounded. Most likely, his actual average error is higher.

Evaluation of Ptolemy's identified Irish locations through use of his coordinates

Over the past four centuries scholars have devoted considerable effort to reconcile Ptolemy's locations and peoples with contemporary Ireland. We are now in position to evaluate this scholarship.

Two principles guided the bulk of these efforts. The first is that Ptolemy proceeded accurately from west to east across the north coast; down the west coast from north to south; across the south coast from the west to the east; and up the east coast from the south to the north. Thus, the river mouths, towns and promontories are in the correct order. The second is that Ptolemy's names for many locations can be understood and traced through the Irish language – 'linguistic archaeology' – to use Wagner's term (1971), and ancient documents. Thus, plausibly,

Buvinda is the River Boyne, O. Ir. *Boänd* (in Adamnan, *Boend*), gen. *Boindeo* (L. Ardm. 16 a 2, 16 b 1), *Bóinde*, dat. *Boind*. These show fluctuation between the *ü* and *i* declensions. The original form may have been **Bou-vindä*, 'cow-white (goddess) ...

Bou-vinā* is a co-ordinate (or *dvandva*) compound. The goddess, in addition to being white or bright (vindā*) was often regarded as possessing bovine shape. (O’Rahilly 1946, p. 3).

Or, less plausibly, ‘the *oss* of Ossory, and Ptolemy’s *OŪδισι* may be derived from a Pictish word related to the Basque *otso*, a wolf’ (Orpen 1894, p. 122).

Overall, ‘There is ... a surprising lack of correspondence between Ptolemy’s names and those attested later in Old Irish sources. There may be an element of textual corruption involved in Ptolemy’s text, but this discrepancy may also be indicative of substantial tribal movements and changes in the balance of power in the intervening period’ (Russell 2005, p. 410; see also Andrews 1997, p. 26).

If linguistic archaeology is not always useful we can turn to Ptolemy’s other data, his geographical coordinates. We are aware of no systematic attempt to use these coordinates to help reconcile his locations with archaeology and those documented in Irish sources. Indeed, several scholars, in re-ordering Ptolemy’s west coast locations from south to north, acted as if Ptolemy provided no coordinates at all (see Mac an Bhaird 1991, p. 4, Toner 2002, pp. 76–77, O’Connor 2003, p. 153).

Our starting point is the existing scholarship. It would be foolish to simply place Ptolemy’s adjusted points on to a modern Irish map and conclude ancient Regia is Monaghan’s modest Darraghlan. Rather, we see our mathematics as helping to sort the differences among scholars and to give greater precision to their work.

We make these assumptions:

1. Ptolemy has documented 31 Irish locations known to the Roman world.
2. Enough is known from ancient Irish sources to aid identification of Ptolemy’s locations.
3. Ptolemy’s placement of these locations about the coast and interior towns is in the same order as their actual locations. Thus, Ptolemy’s Raeba is both between the latitudes of Regia and Laberus and between the longitudes of Dunum and Macolicum. This is a more demanding assumption than the order along the coasts as the coastal order is in only an east – west or a north – south direction while our identification of the interior cities holds to Ptolemy’s relative placement both in latitude and longitude.
4. Where scholars differ as to the proper identification of Ptolemy’s locations, the candidate that is closer to Ptolemy’s coordinates, adjusted to the modern grid, is the most likely correct location, if condition 3 is met; the candidate, where appropriate, has some first century links through the Irish tradition, condition 2; and the candidate has not been better fitted elsewhere.

Our assumptions recognise that while Ptolemy’s placement of Irish locations cannot be exact, his relative placement will be correct, given the sort of information we assume he used, e.g. Raeba is a two day journey north and west from Dunum.

Scholarly identification of Ptolemy’s Irish locations

While there are earlier topographical descriptions (see Gerald of Wales 1982), those of Camden (1607) and Sir James Ware (1654) attract our attention by their thoroughness, their careful reliance on scholarship, and their explicit references to Ptolemy. They represent what learned seventeenth-century geographers thought of

Ptolemy's map. With certain reservations,⁶ both accepted that Ptolemy's map represented first-century Ireland. Table 2 summarises their assignments along with those of subsequent scholars.

We selected eight locations for which we felt the strongest case had been made linking Ptolemy's with modern sites and calculated the difference in kilometres between today's location and the corrected Ptolemy coordinates. These are shown in Table 3. The average error, given our corrections, is 44.46 kilometres with average latitude error of 27.1 kilometres and longitude error of 27.0 kilometres.

Our initial estimate that Ptolemy's earth is 18% too small, his latitudes were five degrees off, and his longitudes 17 degrees off, was rough. It is not clear which stade Ptolemy was using when he declared the equator to be 180,000 stades and 180,000 is too round to be considered precise (Berggren and Jones 2000, p. 21 note 21). The stade was a measure of distance used by the ancient Egyptians, Greeks and Romans and, depending on the time and place, varied from about 150 to about 200 metres. Certain Olympic footraces were over a distance of exactly one stade. Hence, the amphitheatre where they were held was a stadium. We tried values for .81 through .83 for Ptolemy's underestimation and found .8165 gave the closest fit to our eight locations. This reduced the overall kilometre error from 44.4667 to 38.2551. We can remove the non-random error from the longitude and latitude estimates by further adjusting the correction formulas. The mean adjusted longitude is .2142° too far west, the mean corrected latitude .025° too far south. The adjusted correction formula is

$$\begin{aligned} p' &= 4.975 + .8165\pi \\ m' &= -17.7028 + .8165\mu \end{aligned}$$

The adjustments are shown in Table 4. The average error for these eight locations is now 35.75 kilometres as the crow flies.

Using the equations in Table 4, we evaluated competing candidates for the remaining 23 locations. In each case, we selected the candidate that is closest to Ptolemy's estimated location, subject to the constraint that the order around the coasts and the relative order of the inland cities had to be maintained. Tara presented a special case. The authorities we consulted did not assign Tara to any of Ptolemy's ten towns, although a number implied Tara was one of them (O'Connor 1766; MacNeil 1919; Duffy 2000). We calculated the kilometres to Tara from each of the ten towns with Ptolemy's latitudes and longitudes corrected (see Table 5). The closest of Ptolemy's inland towns to Tara is Laberus. We discarded the closer, but coastal town, Eblana.

We then further adjusted the correction equations to eliminate non-random error in longitude and latitude so that the mean modern latitude and longitude is the same as that of the corrected Ptolemy estimates. As this adjustment occasionally made an alternate closer to Ptolemy's estimated location, the process was iterated until no changes were called for. Overall, the average error was 37.936 kilometres. This overall error is 15.926 kilometres more than expected from Ptolemy's estimated measurement precision.

Coastal locations are all in Ptolemy's original order. On the north and south coasts Ptolemy's relative latitudes are maintained for the several locations. On the west coast our mouth of the R. Iernus is too far west compared to Ptolemy's other west locations, on the east coast R. Oboca is too far west compared to Ptolemy's

Table 2. Scholarly identification of Ptolemy's Irish locations.

Ptolemy locations	Scholarly identification
Boreum	<i>Bloody Foreland Head</i> ¹ (Camden 1607, Ware 1654, Orpen 1894); <i>Malin Head</i> (Martin 1910, Mac an Bhaird 1991–93); <i>Rossan Point Co. Donegal</i> (Francis 1994).
Vennicium	<i>Horn Head</i> ¹ (Camden 1607, Ware 1654, Lewis 1837, Martin 1910, Mac an Bhaird 1991–93); <i>Malin Head</i> (Orpen 1894); <i>Rathlin Island</i> (Francis 1994).
Vidua	<i>R. Tullaghbegley Co. Donegal</i> ² (Camden 1607, Martin 1910); <i>R. Foyle</i> (Ware 1654, O'Connor 1766, Orpen 1894, Mac an Bhaird 1991–93; Toner 2002, Duffy 2000); <i>R. Bann</i> (O'Rahilly 1946); <i>Lough Swilly</i> (Martin 1910); <i>R. Gweenbarra Co. Donegal</i> (Stempel 2002).
Argita	<i>Lough Swilly</i> (Camden 1607); <i>R. Bann</i> (O'Connor 1766, Orpen 1894, Mac an Bhaird 1991–93, Stempel 2002, Toner 2002); <i>Lough Foyle</i> (Ware 1654, Lewis 1837, Martin 1910, Francis 1994); <i>R. Bush Co. Antrim</i> (Byrne and O'Kelly 1984).
Rhobogdium	<i>Malin Head</i> ³ (Camden 1607, Ware 1654, Lewis 1837); <i>Fair Head Co. Antrim</i> (Orpen 1894, Martin 1910, Bursche and Warner 2000); <i>Benbane Head Co. Antrim</i> (Mac an Bhaird 1991–93).
Ravius	<i>R. Erne</i> ² (Camden 1607, Ware 1654, O'Flaherty 1793, Orpen 1894, Martin 1910, O'Rahilly 1946, Francis 1994); <i>R. Srahmore Co. Mayo</i> (Parsons and Sims-Williams 2002); <i>R. Roe Co. Derry</i> (Byrne and O'Kelly 1984, Duffy 2000); <i>R. Newport Co. Mayo</i> (Stempel 2002); <i>R. Roughty</i> (Mac an Bhaird 1991–93).
Magnata	<i>In Co. Sligo</i> ⁴ (Camden 1607, Ware 1654, Lewis 1837, Martin 1910); <i>Ballina Co. Mayo</i> (Orpen 1894); <i>Westport Co. Mayo</i> (Stempel 2002); <i>Achill Island</i> (Ilkins 1996–2005); <i>Galway</i> (Hardiman 1820, Lewis 1837); <i>On Erris Peninsula Co. Mayo</i> ⁵ (Mac an Bhaird 1991–93).
Libnius	<i>R. Garavogue</i> ⁶ (Camden 1607, Ware 1654); <i>R. Laune Co. Kerry</i> (Mac an Bhaird 1991–93, Toner 2002); <i>R. Corrib</i> (Stempel 2002); <i>R. Liffy</i> (Martin 1910); <i>Moy Co. Mayo</i> (O'Connor 1766); <i>Westport Bay</i> (Orpen 1894, Francis 1994); <i>R. Erne</i> (Byrne and O'Kelly 1984).
Ausoba	<i>R. Corrib – Galway Bay</i> (Camden 1607, Ware 1654, O'Connor 1766, Hardiman 1820, Orpen 1894, Martin 1910, Francis 1994, Ilkins 1996–2005); <i>R. Doonbeg Co. Clare</i> (Stempel 2002); <i>R. Feale, Co. Kerry</i> (Mac an Bhaird 1991–93).
Senus	<i>R. Shannon</i> ⁷ (Camden 1607, Ware 1654, O'Connor 1766, Martin 1910, O'Rahilly 1946, Mac an Bhaird 1991–93, Francis 1994, Ilkins 1996–2005, Stempel 2002, Toner 2002, Bursche and Warner 2000, Duffy 2000, Keenan 2003); <i>R. Kenmare</i> (Orpen 1894).
Duris	<i>R. Lee at Tralee, Tralee Bay</i> (Camden 1607); <i>R. Maine Co. Kerry</i> (Ware 1654, Francis 1994, Stempel 2002); <i>R. Shannon</i> (Orpen 1894); <i>R. Dunkellin, Co. Galway</i> (O'Connor 2003); <i>R. Duff, Co. Sligo and Co. Leitrim</i> (Mac an Bhaird 1991–93).
Iernus	<i>R. Kenmare</i> ² <i>Co. Kerry</i> (Camden 1607, Ware 1654, Rivet and Smith 1979, Francis 1994, Ilkins 1996–2005, Stempel 2002); <i>Bantry Bay</i> (Orpen 1894); <i>R. Erne</i> (Martin 1910, Mac an Bhaird 1991–93, Toner 2002); <i>R. Maine, Dingle Bay</i> (Quiggin 1926).
Southern	<i>Missen Head</i> (Camden 1607, Ware 1654, O'Flaherty 1793, Mac an Bhaird 1991–93); <i>Dursey Head Co. Cork</i> (Francis 1994).
Dabrona	<i>R. Lee Co. Cork</i> (Camden 1607, Ware 1654, O'Connor 1766, Orpen 1894, O'Rahilly 1946, Francis 1994, Mac an Bhaird 1991–93, Stempel 2002, Toner 2002, Bursche and Warner 2000, Duffy 2000).

Table 2 (Continued)

Ptolemy locations	Scholarly identification
Birgus	<i>R. Barrow</i> (Camden 1607, Ware 1654, O'Connor 1766, O'Flaherty 1793, Orpen 1894, Tozer [1897] 1964, Mac an Bhaird 1991–93, Francis 1994, Toner 2002, Bursche and Warner 2000, Duffy 2000).
Sacrum	<i>Hook Head</i> (Camden 1607, Lewis 1837); <i>Carnsore Point</i> (Ware 1654, Orpen 1894, Martin 1910, Mac an Bhaird 1991–93, Francis 1994, Bursche and Warner 2000).
Modonnus	<i>R. Slaney</i> ⁸ (Camden 1607, Ware 1654, Lewis 1837, Orpen 1894, Mac an Bhaird 1991–93, Stempel 2002); <i>R. Moy Co. Sligo and Co. Mayo (misplaced by Ptolemy in Leinster)</i> (O'Connor 1766); <i>R. Avoca</i> (Duffy 2000); <i>R. Liffy</i> (Martin 1910, Francis 1994).
Manapia	<i>Wexford town</i> ¹⁰ (Camden 1607, Ware 1654). <i>Port-Kaelranna, Carman, Wexford town</i> (O'Connor 1766, Lewis 1837, Orpen 1894); <i>Dublin</i> (Francis 1994); <i>Wicklow town</i> (Martin 1910); <i>Near Enniscirthy Co. Wexford</i> (Mac an Bhaird 1991–93); <i>Near Bray Co. Wicklow</i> (Bursche and Warner 2000).
Oboca	<i>R. Avoca</i> . (Camden 1607, Ware 1654, Orpen 1894, Martin 1910, Tozer [1897] 1964, Mac an Bhaird 1991–93, Keenan 2000); <i>R. Liffy</i> (Bursche and Warner 2000, Duffy 2000); <i>R. Boyne</i> (Francis 1994).
Eblana	<i>Dublin</i> . ⁹ (Camden 1607, Ware 1654, O'Connor 1766, Lewis 1837, Orpen 1894, Martin 1910, Stempel 2002); <i>Belfast</i> (Francis 1994); <i>Oenach Descrit Maige, Dundalk</i> (MacNeil 1919); <i>Drumanagh-Loughshinny</i> (Bursche and Warner 2000).
Bubindas	<i>R. Boyne</i> (Camden 1607, Ware 1654, O'Flaherty 1793, Orpen 1894, O'Rahilly 1946, Tozer [1897] 1964, Stempel 2002, Toner 2002, Bursche and Warner 2000, Duffy 2000, Keenan 2003); <i>Belfast Lough</i> (Francis 1994).
Isamnium	<i>St. John's Foreland – St. John's Point Co. Down</i> (Camden 1607, Ware 1654, Martin 1910); <i>Emain Macha – Navan Fort</i> (Mac an Bhaird 1991–93, Duffy 2000); <i>Dundalk</i> . (Orpen 1894); <i>Cooley Peninsula</i> (Toner 2002); <i>Black Head Co. Antrim</i> (Francis 1994).
Vinderis	<i>Carrickfergus (Belfast Lough, R. Lagan)</i> (Camden 1607, Ware 1654, Martin 1910); <i>Carlingford Lough</i> (Stempel 2002); <i>Larne Lough</i> (Francis 1994); <i>Dundrum Bay</i> (Orpen 1894); <i>R. Quoynl – Strangford Lough</i> (Mac an Bhaird 1991–93).
Logia	<i>R. Foyle – Loch Foyle</i> (Camden 1607); <i>R. Bann</i> (Ware 1654, Lewis 1837, Martin 1910); <i>Belfast Lough – R. Lagan</i> ¹⁰ (Orpen 1894, Tozer [1897] 1964, Mac an Bhaird 1991–93, Stempel 2002, Toner 2002, Bursche and Warner 2000, Duffy 2000, Keenan 2003); <i>Red Bay Co. Antrim</i> (Francis 1994).
Regia	<i>Near Loch Ree in Co. Longford</i> ¹¹ (Camden 1607, Ware 1654); <i>Eamhania Co. Armagh</i> (O'Connor 1766, Orpen 1894, O'Rahilly 1946, Bursche and Warner 2000); <i>Cruachu Co. Roscommon</i> (Duffy 2000); <i>Clogher Co. Tyrone</i> (Lewis 1837); <i>Grianan of Aileach Co. Donegal</i> (O'Hart 1892); <i>Athenry</i> (Orpen 1894).
Rhaeba	<i>Rheban – Great Moat of Ardscull near Athy</i> ¹¹ (Camden 1607, Ware 1654, Martin 1910); <i>Loch Rhee near Athlone</i> (Orpen 1894, Duffy 2000).
Laberus	<i>Rathconrath, Killare Castle, Uisnech Hill Westmeath</i> ¹² (Camden 1607, Martin 1910); <i>Near Kells</i> (Ware 1654); <i>Near Glendalough</i> (Orpen 1894); <i>Near Portlaoise</i> (Stempel 2002).
Macolicum	<i>Malc, Male On Shannon in Co. Longford between Roosky and Lanesborough, roughly Cloondara, Co. Longford</i> ¹¹ (Camden 1607); <i>Melick, Co. Galway</i> (Ware 1654); <i>Mallow, Co. Cork</i> (Martin 1910); <i>Cashel</i> (Orpen 1894); <i>Clonmel, Co. Tipperary</i> (Mac an Bhaird 1991–93).

Table 2 (Continued)

Ptolemy locations	Scholarly identification
Another Regia	<i>St. Patrick's Purgatory, Loch Derg Co. Donegal</i> ¹³ (Camden 1607); <i>Near Turoe Co. Galway</i> (Ware 1654, O'Connor 2003); <i>Limerick</i> (Lewis 1837).
Dunum	<i>Down Co. Down (in wrong place), Downpatrick</i> ¹⁴ (Camden 1607); <i>Rock of Dunamase, near Portlaoise Co. Laois</i> (Ware 1654); <i>Dinn Riogh, Leighlinbridge Co. Carlow</i> (O'Connor 1766, Orpen 1894); <i>Dún Ailinne, Knockaulin Co. Kildare</i> (Duffy 2000); <i>Near Mallow Co. Cork</i> (Stempel 2002); <i>Waterford town</i> (Martin 1910).
Hibernis	<i>Dunkeraran Castle (Dun Ciaráin), Kenmare Co. Kerry</i> (Ware 1654); <i>Limerick</i> (O'Connor 1766); <i>Near Kinsale</i> (Stempel 2002); <i>Cork City</i> (Orpen 1894); <i>Teamhair'Erann [Ballahantouragh Co. Kerry]</i> (Mac Neill 1919). ¹⁵

Notes: 1. Camden's St. Helen's Head and Rames-Head identified under that name as Bloody Foreland Head and Horn Head on the Goghe map of 1567 reproduced in Andrews (1997, p. 43), and Swift (1999, p. 23).

2. Camden's R. Crodagh, R. Trobis or R. Trowis and R. Maire identified under those names as R. Tullaghbegley, R. Erne and R. Kenmare from the map of Speed (1610).

3. Suggested by Camden's 'The Robogdii placed above Logia held all that Northern sea coast of Ireland, where O-Dogherty an obscure Potentate had great sway. Amongst these, Robogh, a little Episcopall towne, reteineth the expresse footings of the old name Robogdii. Which should be that promontory Robogdium unlesse it be Faire Foreland, I know not.' In Speed's 1610 map the O'Dougherty have the area to include Malin Head.

4. Quoting Camden, 'In some place heereabout Ptolomee setteth the City Nagnata, but what City it was, it passeth my wit to finde out.'

5. Killala, Co. Mayo, also puts in a claim for Magnata. Available from: <http://www.killalafestival.ie/aboutkillala.htm> [accessed 24 April 2006].

6. Quoting Camden, 'This Liffy doubtlesse is mentioned by Ptolomee, but through carelesnesse of the transcribers banished out of his owne due place. For the rover Libnius is set downe in the Copies of Ptolomee at the very same latitude or elevation of the Pole, in the other part of the Iand, where there is no such river at all.' and 'He hath placed also the river Libnius in this tract, which through the rechlesnesse of the transcribers I reduced even now from out of exile to Dublin his owne City. But that place which Ptolomee heere pointeth out is now called The Bay of Slego.'

7. Quoting Camden, 'the people dwelling thereby call it Shannon, that is, as some expound it, The ancient river. He springeth out of Therne hils in the County Le Trim, and forthwith, cuting through the lands Southward, one while overfloweth the bankes and enlargeth himselfe into open Pooles, and otherwhiles drawes backe again into narrow straights, and after he hath run abroad into one or two Lakes, gathering himselfe within his bankes, valeth bonet to [tips his hat to] Macolicum, now called Malc (as the most learned Geographer Gerard Marcator hath observed), whereof Ptolomee hath made mention, and then by and by is entertained by another broad Mere (they call it Lough Regith), the name and situation whereof doth after a sort imply that the City Rigia, which Ptolomee placeth there, stood not far off from hence.'

8. Quoting Camden, 'In this place Ptolomee setteth the river Modona, and at the mouth thereof the Citie Menapia, which are so stript out of their names that I am out of all hope in so great darknesse to discover any twy-light of the truth. But seeing that there is one onely river that voideth it selfe in this place, which cutteth this Country as it were just in the mids, and is now called Slane, seeing also that at the very mouth thereof, where it maketh a Poole, there is a towne by a Germane name called Weisford, the Head place of the whole County, I may the more boldly conjecture that Slane was that Modona, and Weisford Menapia.'

9. Quoting Camden, 'For the antiquity of Dublin I finde no certainty, but that very ancient it is the authority of Ptolomee perswadeth me to thinke.'

10. See also http://www.lisburn.com/books/historical_society/volume8/volume8_3.html [accessed 24 April 2006].

11. Quoting Camden, 'but in steed of a city it is altogether, as one saith, πόλις ἄπολις, that is, A City Citylesse or The remaines of that which was a City'.

12. Quoting Camden, 'For they say that Killair, a castle in these parts, which seemeth to be in Ptolomee Laberus.'

13. Quoting Camden, 'But seeing that this place is named in Saint Patricks life Reglis, I would deeme it to be the other Regia that Ptolomee mentioneth, and the very situation of it in the Geographer implieth no lesse.'

14. Quoting Camden, 'Dunum, whereof Ptolomee also made mention (though not in the right place), now named Down [Downpatrick], a towne of very great antiquity and a bishops See.'

15. See also Hogan (1910), Moody *et al.* (1984, p. 16). Available from <http://www.sliabhluachra.com/tour.html> and <http://www.sip.ie/sip064/Kilsorcan.html> [accessed 24 April 2006].

Table 3. Initial calibration of conversion equations from Ptolemy's to current coordinates.

Ptolemy	Location		Ptolemy		Modern ¹		Corrected Ptolemy		Error in great circle kilometres			
		Modern	Longitude	Latitude	Longitude	Latitude	p' = 5 + .82π	m' = 17.917 + .82μ	Latitude	Longitude	Total	
Ausoba	R. Corrib (Menlough)		10.5000	59.5000	-9.0690	53.3030	53.7900	-9.3070	54.2153	15.8332	56.4546	
Vennicium	Horn Head (Dunfanaghy)		12.8333	61.3333	-7.9670	55.1830	55.2933	-7.3937	12.2826	36.4419	38.4082	
Bubindas	R. Boyne (Baltray)		14.6667	59.6667	-6.2670	53.7330	53.9267	-5.8903	21.5602	24.8053	32.8223	
Sacrum	Carnsore Point (Nethertown)		14.0000	57.8333	-6.3590	52.1810	52.4233	-6.4370	26.9775	5.3244	27.4950	
Regia	Emain Macha		13.0000	60.3333	-6.6860	54.3571	54.4733	-7.2570	12.9352	37.0424	39.1863	
Manapia	Wexford town (Ferrycarrig)		13.5000	58.6667	-6.5070	52.3540	53.1067	-6.8470	83.7909	23.1184	86.8691	
Birgus	Waterford Harbour (Dunmore East)		12.5000	57.5000	-6.9860	52.1510	52.1500	-7.6670	0.1113	46.5171	46.5176	
Dabrona	R. Lee/Ballinluska		11.2500	57.0000	-8.2940	51.7900	51.7400	-8.6920	5.5663	27.4061	27.9805	
				Mean		-7.2669	53.1315	53.3629	-7.4364	27.1799	27.0611	44.4667
				St. Dev.						28.2642	13.0136	19.6610
				St. Error						3.5330	1.6267	2.4576
				Count								8

Note: 1. Modern longitudes and latitudes calculated from <http://www.heavens-above.com> [accessed 24 April 2006].

Table 4. Second calibration of conversion equations from Ptolemy's to current coordinates.

Location Ptolemy	Modern	Ptolemy		Modern ¹		Corrected Ptolemy		Error in great circle kilometres		
		Longitude	Latitude	Longitude	Latitude	p' = 4.975 +.8165π	m' = - 17.7028 +.8165μ	Latitude	Longitude	Total
Ausoba	R. Corrib (Menlough)	10.5000	59.5000	-9.0690	53.3030	53.5568	-9.1296	28.2487	4.0281	28.5328
Vennicium	Horn Head (Dunfanaghy)	12.8333	61.3333	-7.9670	55.1830	55.0537	-7.2244	14.3983	47.2019	49.4220
Bubindas	R. Boyne (Baltray)	14.6667	59.6667	-6.2670	53.7330	53.6928	-5.7275	4.4713	35.5307	35.8277
Sacrum	Carnsore Point (Nethertown)	14.0000	57.8333	-6.3590	52.1810	52.1959	-6.2718	1.6603	5.9524	6.1786
Regia	Embain Macha	13.0000	60.3333	-6.6860	54.3571	54.2372	-7.0883	13.3519	26.0982	29.3492
Manapia	Wexford town (Ferryarrig)	13.5000	58.6667	-6.5070	52.3540	52.8763	-6.6801	58.1491	11.7666	59.3138
Birgus	R. Barrow (Waterford, Dunmore East)	12.5000	57.5000	-6.9860	52.1510	51.9238	-7.4966	25.2986	34.8742	43.1558
Dabrona	R. Lee/Ballinluska	11.2500	57.0000	-8.2940	51.7900	51.5155	-8.5172	30.5587	15.3677	34.2263
			Mean	-7.2669	53.1315	53.1315	-7.2669	22.0171	22.6025	35.7508
			St. Dev.					18.0613	15.7075	15.8874
			St. Error					5.7115	4.9671	5.0240
			Count							8

Note: 1. Modern longitudes and latitudes calculated from <http://www.heavens-above.com> [accessed 24 April 2006].

Table 5. Distance to Tara for Ptolemy's ten Irish towns.

Ptolemy's Town	Kilometres to Tara
Regia	71.4
Rhaeba	80.6
Laberus	40.9
Macolicum	137.2
Another Regia	133.7
Dunum	93.9
Hibernis	188.2
Eblana	30.0
Magnata	139.2
Manapia	85.1

Source: Authors' calculations.

other locations on that coast, and R. Bubindas, R. Logia and the Rhobogdium Promontory are too far east compared to other Ptolemy locations. The inland cities maintain their relative north–south and east–west orders.

The results for all Ptolemy's Irish locations are displayed in Table 6. Ptolemy also locates 16 peoples. These Ptolemy located in relation to the four coasts and to one another, but not to any specific feature or coordinates. Nevertheless, the names of some of these peoples connect them to better located similarly named features. With this information and the information Ptolemy provides, we locate them on Figure 2. Locations are numbered in Table 6 to indicate placement in Figure 2.

Discussion

MacNeill reminds us that in Irish the principal divisions of Ireland are termed 'Fifths' as in '*cúig cúigídh na hÉireann*', 'the Five Fifths of Ireland' (MacNeill 1919, p. 101). This does not correspond to the political reality of historical Ireland, however, and, according to MacNeill, is a vestige in the language of the pre-Patrician era. O'Connor (1766) and MacNeill (1919, pp. 104–105) centre Irish political power at the time of Ptolemy's map in five locations: Tara (Meath or north Leinster), Dinn Riogh (Leinster or south Leinster), Teamhair'Erann (Munster), Cruachain (Connaught) and Emain Macha (Ulster). This is against those who leave out Meath and, instead, place two of Ireland's first-century Fifths in Munster (MacNeill 1919, p. 102). We have matched these centres, using the modern locations as identified in Hogan (1910) and other sources, successively with Ptolemy's Laberus, Dunum, Hibernis, Rhaeba and Regia. Another candidate, Turoe, is 'hetro' (the other, of two) Regia which we place in Co. Galway. Only one of these locations, Hibernis in Kerry, can be said to be in Munster. Locating centres of power, if we have done so, does not help settle territorial lines, for example whether Co. Clare was in Munster or Connaught. Ptolemy's map does, however, offer some external validation to the five part prehistoric division of Ireland passed down from pre-Patrician sources.

Ptolemy's Irish towns were not in the nature of Roman towns.

Of course in the sense in which the word oppidum was applied in Romanised Gaul or Britain, it may be said that there can have been no towns in Ireland in Ptolemy's time. His polis must be regarded as referring to the principal duns, cashels, cathairs, or raths,

Table 6. Final conversion equations from Ptolemy's to current coordinates.

Location Ptolemy	Modern	Ptolemy		Modern ¹		Corrected Ptolemy		Error in great circle kilometres		
		Longitude	Latitude	Longitude	Latitude	$p' = 4.9299$ $+ .8165\pi$	$m' = -17.7163$ $+ .8165\mu$	Latitude	Longitude	Total
1 Boreum Prom.	Rossan Point (Malin More Co. Donegal)	11.000	61.000	-8.774	54.695	54.736	-8.735	4.61	2.522	5.253
2 Vennicium Prom.	Horn Head (Dunfanaghy)	12.833	61.333	-7.967	55.183	55.009	-7.238	19.419	46.344	50.341
3 R. Vidua	Lough Foyle (Co. Derry)	13.000	61.000	-7.333	55.000	54.736	-7.102	29.345	14.763	32.871
4 R. Argita	R. Bann (Coleraine)	14.500	61.500	-6.667	55.133	55.145	-5.877	1.297	50.274	50.283
5 Rhobogdium Prom.	Fair Head (Benmore Co. Antrim)	16.333	61.500	-6.137	55.229	55.145	-4.380	9.408	111.570	112.081
6 R. Ravius	R. Erne	11.333	60.667	-8.259	54.508	54.464	-8.463	4.836	13.132	14.000
7 Magnata	Sligo town	11.250	60.250	-8.521	54.250	54.124	-8.531	14.005	0.622	14.019
8 R. Libnius	River Moy (Ballina)	10.500	60.000	-9.167	54.117	53.920	-9.143	21.942	1.563	21.998
9 R. Ausoba	R. Corrib (Menlough)	10.500	59.500	-9.069	53.303	53.512	-9.143	23.228	4.926	23.742
10 R. Senus	Galway Bay (Onaght, Innishmore)	9.500	59.500	-9.790	53.151	53.512	-9.960	40.149	11.320	41.702
11 R. Duris	R. Shannon (Doonaha)	9.667	58.667	-9.644	52.623	52.831	-9.823	23.182	12.128	26.149
12 R. Iernus	R. Maine (Fahan)	8.000	58.000	-10.443	52.103	52.287	-11.184	20.473	50.691	54.571
13 Southern Prom.	Dursey Head	7.667	57.750	-10.236	51.580	52.083	-11.456	55.975	84.439	100.915
14 R. Dabrona	R. Lee (Ballinluska)	11.250	57.000	-8.294	51.790	51.470	-8.531	35.579	16.297	39.158
15 R. Birgus	Waterford Harbour (Dunmore East)	12.500	57.500	-6.986	52.151	51.879	-7.510	30.319	35.796	46.994
16 Sacrum Prom.	Carnsore Point (Nethertown)	14.000	57.833	-6.359	52.181	52.151	-6.285	3.360	5.031	6.051
17 R. Modonnuus	R. Slaney (Castlebridge)	13.667	58.667	-6.449	52.386	52.831	-6.557	49.566	7.370	50.105
18 Manapia	Wexford town (Ferrycarrig)	13.500	58.667	-6.507	52.354	52.831	-6.694	53.128	12.685	54.606
19 R. Oboca	R. Liffey (Dublin)	13.167	59.000	-6.250	53.330	53.103	-6.966	25.226	47.583	53.968
20 Eblana	Loughshinny Co. Dublin	14.000	59.500	-6.088	53.547	53.512	-6.285	3.935	13.050	13.636

Table 6 (Continued)

Location Ptolemy	Modern	Ptolemy		Modern ¹		Corrected Ptolemy		Error in great circle kilometres		
		Longitude	Latitude	Longitude	Latitude	$p' = 4.9299$ $+ .8165\pi$	$m' = -17.7163$ $+ .8165\mu$	Latitude	Longitude	Total
21 R. Bubindas	R. Boyne (Baltray)	14.667	59.667	-6.267	53.733	53.648	-5.741	9.492	34.642	35.952
22 Isamnum Prom.	St. John's Point	15.000	60.000	-5.659	54.227	53.920	-5.469	34.165	12.398	36.361
23 R. Vinderis	Strangford Lough (Strangford)	15.000	60.250	-5.500	54.367	54.124	-5.469	27.049	2.024	27.125
24 R. Logia	Belfast Lough (Groomspout)	15.333	60.667	-5.617	54.667	54.464	-5.197	22.573	27.064	35.294
25 Regia	Embain Macha	13.000	60.333	-6.686	54.357	54.192	-7.102	18.373	26.974	32.681
26 Rhaeba	Carn Fraoich mhic Fhiodaigh Fholtrúadh (Carnfree)	12.000	59.750	-8.271	53.754	53.716	-7.918	4.278	23.202	23.603
27 Laberus	Tara	13.000	59.250	-6.619	53.574	53.308	-7.102	29.636	31.916	43.627
28 Macolicum	Limerick	11.500	58.667	-8.623	52.665	52.831	-8.327	18.506	20.015	27.232
29 Another Regia	Turoe (Kiltullagh)	11.000	59.250	-8.634	53.272	53.308	-8.735	3.955	6.711	7.787
30 Dunum	Dinn Riogh (Leighlinbridge)	12.500	58.750	-6.973	52.736	52.899	-7.510	18.177	36.200	40.447
31 Hibernis	Teamhair' Erann (Ballahantouragh, Co. Kerry)	11.000	58.167	-9.376	52.146	52.423	-8.735	30.835	43.803	53.457
			Mean	-7.651	53.487	53.488	-7.651	22.130	26.034	37.936
			St. Dev.					14.602	24.615	23.372
			St. Error					2.623	4.421	4.198
			Count					31	31	31

Note: 1. Modern longitudes and latitudes calculated from <http://www.heavens-above.com> [accessed 24 April 2006].
Source: Authors' calculations.

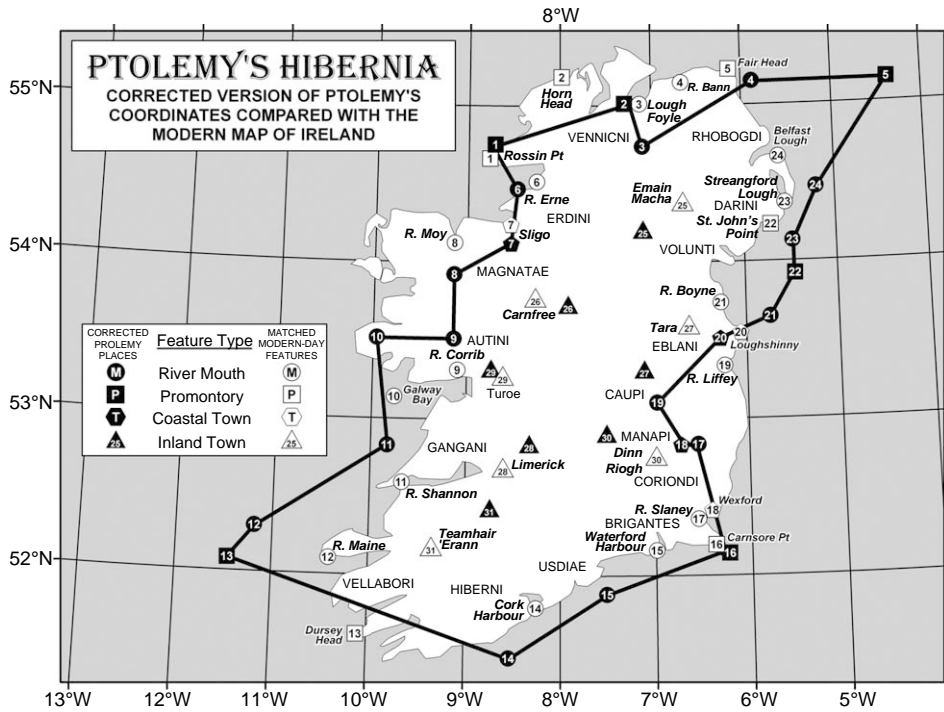


Figure 2. Source: Author's own.

inside of which the chieftains of tribes and their attendants dwelt in either dry-stone clochuans or round wicker-work huts. (Orpen 1894, p. 126)

Surviving manuscripts of Ptolemy's *Geography* refers to the towns Hibernis (Teamhair'Erann), Rhaeba (Cruchain) and Magnata (Sligo) as *επισημοι* or 'notable' (Orpen 1894, p. 122, Nobbe 1966, pp. 63, 65). It is not clear if this is marginalia added by some reader and incorporated by later copyists, however.⁷

What of the remaining five towns?

As Ptolemy's information was derived through traders, it is not unlikely that some of the places which he calls cities were ancient places of assembly. From the poem on the Fair or Assembly of Carman, we know that these were places of resort for traders from the Mediterranean . . . during the time of assembly the place of assembly bore the aspect of a city . . . Somewhere about the middle of County Louth . . . Oenach Desreit Maige 'the Assembly of the South of the Plain' – probably the Plain of Muirtheimhne in the district of Dundalk. This place of assembly may have been the city of the Eblani named by Ptolemy. (MacNeill 1919, p. 138)

We find these trading locations to be Sligo town in Connaught (Magnata), Loughshinny in Meath or north Leinster (Eblana), Limerick, in Munster (Maco-licum), and Wexford in Leinster or south Leinster (Manapia). Some have argued Ptolemy's Isamnum is not a promontory but a town (Orpen 1894, p. 126). If so, it would put a trading location in Ulster. A candidate would be in the vicinity of Downpatrick, near to St. John's Point.

Table 7. Estimation of the location of R. Senus, Manapia and Hibernis.

Location Ptolemy	Modern	Ptolemy		Modern ¹		Corrected Ptolemy		Error in great circle kilometres		
		Longitude	Latitude	Longitude	Latitude	$p' = 4.9299$ $+ .8165\pi$	$m' = -17.7163$ $+ .8165\mu$	Latitude	Longitude	Total
Senus	R. Shannon (Limerick)	9.500	59.500	-8.624	52.665	53.512	-9.960	94.290	90.196	129.875
	R. Shannon (Dreenagh)	9.500	59.500	-9.917	52.417	53.512	-9.960	121.862	2.889	121.895
	R. Shannon (Kilbaha)	9.500	59.500	-9.867	52.550	53.512	-9.960	107.056	6.265	107.235
	R. Corrib (Galway)	9.500	59.500	-9.049	53.272	53.512	-9.960	26.679	60.619	66.074
	Galway Bay (Spiddal)	9.500	59.500	-9.303	53.247	53.512	-9.960	29.462	43.735	52.620
	Galway Bay (Killeany, Inishmore)	9.500	59.500	-9.663	53.110	53.512	-9.960	44.714	19.817	48.871
	Galway Bay (Onaght, Innishmore)	9.500	59.500	-9.790	53.151	53.512	-9.960	40.149	11.320	41.702
Manapia	Wexford town (Ferrycarrig)	13.500	58.667	-6.507	52.354	52.831	-6.694	53.128	12.685	54.606
	New Ross	13.500	58.667	-6.937	52.397	52.831	-6.694	48.341	16.537	51.065
	Carlow town	13.500	58.667	-6.926	52.397	52.832	-6.694	48.371	15.790	50.859
	Arklow	13.500	58.667	-6.141	52.793	52.832	-6.694	4.287	37.196	37.426
	Bray	13.500	58.667	-6.100	53.200	52.832	-6.694	41.023	39.582	57.123
	Wicklow town	13.500	58.667	-6.050	52.983	52.831	-6.694	16.895	43.133	46.394
Hibernis	Teamhair Erann (Ballahantouragh, Co. Kerry)	11.000	58.167	-9.376	52.146	52.423	-8.735	30.835	43.803	53.457
	Castleisland	11.000	58.167	-9.463	52.231	52.423	-8.735	21.382	49.671	53.979
	Limerick town	11.000	58.167	-8.624	52.665	52.423	-8.735	26.906	7.506	27.939

Note: 1. Modern longitudes and latitudes calculated from <http://www.heavens-above.com> [accessed 24 April 2006].

The fit between Ptolemy's Eblana and Loughshinny is particularly good and the Roman connection strong (Byrne and Maas 1996, McDonald 1996, Edwards 2005, p. 254), something absent from less well fitting candidates Dublin, Dundalk and Belfast.

Ireland's major rivers are the Erne, Shannon, Lee, Barrow, Slaney, Liffy, Boyne, Lagan and Bann. We find Ptolemy places the Erne (Ravius), Shannon (Duris), Lee (Dabrona), Barrow (Birgus), Boyne (Bubindas), Bann (Argita) and Lagan (Logia) on his map.

As with some scholars, we had trouble placing the Senus. Locations from the mouth of the Shannon to Limerick yielded errors exceeding 100 kilometres. Our data indicated that a better fit will be found to the north and west. The centre of the entrance to Galway Bay makes the best fit (see Table 7). Ptolemy's R. Ausoba is at the same parallel and east of the R. Senus. The R. Corrib meets these criteria and fits well with Ptolemy's coordinates.

Two other locations had alternatives within five kilometres of the distance to a selected site. We ruled out the New Ross vicinity as Manapia because it is an interior, rather than a coastal, town, although easily accessible by sea. We ruled out Wicklow town and Carlow town because they did not connect with Irish tradition to the extent Wexford did. The fit for Manapia and R. Oboca was much better for Arklow and R. Avoca. The absence of any Irish tradition for their first-century importance, however, in contrast to Carman, which scholars place at or near Wexford, lets us hold to Wexford as Manapia and, hence, R. Slaney as R. Oboca. Ptolemy places the Manapi above the Coriondi and Brigantes. If the Manapi are to be associated with Manapia, however, the Coriondi will either need a very small coastal area or the Brigantes need to be moved away from the east coast. Smyth (1982, p. 35) suggests Carman was near Dinn Riogh. If, however, we allow Manapia to be Smyth's Carman we have a better fit in kilometres but a problem with order. Ptolemy places Dunum to the north of Manapia whereas we would be placing Dunum to the south. We sacrificed kilometre accuracy to keep Ptolemy's order. For Hibernis we selected Teamhair'Erann for its connections with the Irish tradition and ruled out the Limerick area as already assigned to Macolicum.

We had thought there would have been more longitudinal than latitudinal errors in Ptolemy's coordinates. This we attributed to the relative ease of calculating the one as opposed to the other. We found only a slightly higher mean error for Ptolemy's longitudes. Ptolemy's longitudes, however, had one and one half times his latitude's standard error. Ptolemy's coordinates help give organisation to fragmentary material passed down to us from first-century Ireland.

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Notes

1. Byrne refers specifically to the *Leobor Gabála* but his comments could easily refer to the much wider literature.
2. 'He has clearly laid his hands on numerous records of research besides those that had come to knowledge still earlier; and treated those of nearly all his predecessors with care, giving

appropriate correction to everything that he found that either they or he himself, at first, had trusted without good reason, as can be seen from his publications of the revision of the geographical map, which are numerous' (Ptolemy, *Geography*, Book 1, p. 6, quoted in Berggren and Jones 2000, pp. 63–64)

3. The Stevenson ([1932] 1991) edition provides two different latitudes for the Southern Promontory. We use the value in Francis (1994).
4. $2.76 = 111.325 \times \cosine(53.433) \times |7.95 - 7.99|$; $9.87 = 111.325 \times |53.433 - 53.52167|$; $10.24 = 111.325 \times \arccosine(\sin(53.433) \times \sin(53.521) + \cosine(53.433) \times \cosine(53.521) \times \cosine(|7.95 - 7.99|))$.
5. $16.580 = 111.325 \times \cosine(53.433) \times |7.95 - 8.20|$; $14.509 = 111.325 \times |53.433 - 53.56333|$; $22.01 = 111.325 \times \arccosine(\sin(53.433) \times \sin(53.563) + \cosine(53.433) \times \cosine(53.563) \times \cosine(|7.95 - 8.20|))$.
6. Camden claims Ptolemy, or his copiers, made two mistakes, one regarding the Liffy and the other Downpatrick.
7. Henry Shapiro at Harvard brought to our attention that Strabo (1923, p. 375, 1930, p. 197) uses *επισημοι* in connection with ostensibly obscure places where, at some point in the past, something important happened.

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