The Expeditions of William Bayly and Jeremiah Dixon to Honningsvåg and Hammerfest, 1769

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Abstract. In 1769 the Royal Society in London sent the astronomers William Bayly and Jeremiah Dixon to northernmost Norway to observe the transit of Venus taking place the night between 3 and 4 June. The astronomers should set up two prefabricated observatories and were brought to Norway by HMS Emerald, a ship provided by the Admiralty and commanded by Captain Charles Douglas. This paper describes the expedition as well as some results including Captain Douglas’ attempt to measure the temperature of sea water at great depth.

1. From 1761 to 1769

After the transit of Venus in front of the Sun in 1761, it became clear that the observations had not provided a reliable value of the solar parallax – it was only enclosed between 8.5 and 10.25 arcseconds. A new opportunity would however soon present itself: in 1769 another transit of Venus could be observed, and then one could build upon the experiences from 1761. The transit in 1769 would take place during night-time in Europe, more specifically the night between 3 and 4 June. The scientific communities in Europe therefore wanted to send observers to different locations around the globe. The most obvious would be to go west where one could observe the transit while the Sun was high in the sky. Another possibility was to send observers to the far north – inside the Arctic Circle. There they could take advantage of the Midnight Sun, and the transit could be seen even though it was night. Before the transit, Britain launched an ambitious program with several overseas expeditions, one to northernmost Norway, one to Hudson Bay in Canada and one to Tahiti in the Pacific. These expeditions involved maritime navigation, and the opportunity for exploration and a host of themes of interest to the scientific community. We will here focus on the expedition to Norway. The expedition has of course been discussed earlier by others, for instance Woolf (1959) and Aspaas (2012).

2. Preparations by the Royal Society

In 1763 James Ferguson wrote an article in the Philosophical Transactions of the Royal Society where he suggested that one should send observers to Vardåhus [Vardø] in Norway or “any other place near the north cape” (Ferguson 1763, p. 30). In 1765 Thomas Hornsby followed up with an article on the forthcoming transit and suggested that “Wardhus [Vardø], and in the neighborhood of the North Cape” would be locations where the transit could be very advantageously observed (Hornsby 1766), see Fig. 1.

As pointed out by Woolf (1959) it lasted however until 1767 before the Royal Society formed a Committee to look into what should be done to observe the transit.
This Committee consisted of eight persons, John Bevis, John Campbell, Charles Cavendish, James Ferguson, Nevil Maskelyne, Patrick Murdoch, Matthew Raper and James Short. As it happened, the scientific work was done by Maskelyne, Bevis, Short and Ferguson who also worked out the proposal that was presented to the Council on November 19, 1767. One of their recommendations was to send observers to Vardø and to the North Cape “unless it was learned that Swedish or Danish astronomers were planning to make use of these stations” (Woodf 1959). In any case the Admiralty should be consulted on the use of the annual ship sent out to those regions. On January 5, 1768, Maskelyne wrote a letter to the Swedish astronomer Pehr Wargentin asking Sweden to send observers to Vardø and to the North Cape. Such a letter was not sent to astronomers in Denmark–Norway, probably because Maskelyne “had such low faith in the quality of the Danish astronomers that he found it futile to encourage them” (Aspaas 2012, p. 247). Apparently the Royal Astronomer was not aware of the fact that the eminent astronomer Maximilian Hell of Vienna had accepted an offer by the Danish-Norwegian King to go to Vardø to observe the transit in 1769. However, by the end of January 1768 Nevil Maskelyne had abandoned Vardø as a possible station. Maybe he by then had learned of Hell’s forthcoming expedition? In a letter to Doctor James Lind (1736–1812) of Edinburgh, who had asked to join the expedition at his own expense, Maskelyne wrote:

It is proposed to send 2 observers, one to be landed at the North Cape, on the Island of Maggeroe, in Latitude $71^\circ\frac{1}{2}$, & the other at Cherry Island, Latitude $74^\circ40'$ lying between the N. Cape & Spitzbergen, about 70 leaguer North of the former. A wooden observatory with a movable roof, fit for one observer, together with a wooden dwelling house 12 foot square is provided for each place. (Maskelyne 1769a)
Cherry Island is today known by the name Bear Island (Bjørnøya), a small island without any permanent settlement. Maskelyne intended to send his assistant William Bayly to Cherry Island. Another observer should go to the North Cape together with the captain and the chaplain of HMS *Emerald*, the ship provided by the Admiralty. Maskelyne offered Lind, who was skilled in botany and natural history, to join Bayly on Cherry Island. All Maskelyne could tell about the island was that "scoury-grass grows there, and there is plenty of wild fowl. What animals there are there, if any, I don't know, but rather believe there are none, not even bears". But Lind was also interested in astronomy and he had a good 2½ foot telescope made by Dollond. In addition to this Maskelyne asked him to bring a good watch and also a tent since the observatory only had space for one telescope.

In another letter dated 14 February 1769 Maskelyne informed Lind that the expedition to Cherry Island would not take place, probably because the Admiralty refused to call at the island due to lack of harbors. Instead Maskelyne hoped the Admiralty would agree to carry one observer "to Spitzbergen where there are noble harbors" (Maskelyne 1769b). Whether Lind still wanted to join was of course up to him, but Maskelyne told him that he had understood from friends of the captain that he would be incommoded by the addition of another gentleman. This might be the reason why Lind ended up observing the transit from Hawkhill outside of Edinburgh (Lind 1769). The captain on board the HMS *Emerald* was Charles Douglas.

In February 1768 the Royal Society sent a memo to the King presenting their ideas and asking for 4000 pounds to support their plans. In the letter they explained that

> The Memorialists are humbly of opinion, that Spitzbergen, or the North Cape, in the higher northern latitudes; Fort Churchill, in Hudson’s Bay; and any place not exceeding 30 degrees of Southern latitude, and between the 140th and 180th degrees of longitude, West, from your Majesty’s Royal Observatory in Greenwich Park, would be proper stations for observing the ensuring transit, to each of which places two observers ought to be sent.

The King instructed that the sum of 4000 pounds should be paid to the Royal Society, enabling the preparation for the three expeditions to continue. In May 1768 Samuel Wallis returned from his voyage of exploration around the globe and reported that King George’s Island (today Tahiti) would be a perfect location in the Pacific. In November 1767 the Committee had suggested names of possible observers, among them Charles Mason and Jeremiah Dixon. They had both observed the transit in 1761, and in 1768 they were asked to go to Norway. Only Dixon expressed a willingness, and by December 1768 it was decided that William Bayly and Jeremiah Dixon should go north (Woolf 1959).

3. **The observers and their instruments**

Charles Douglas was born in Carr in Scotland in 1727 and joined the Royal Navy at the age of twelve. He was appointed captain of the HMS *Emerald* in 1767, a position he held until 1770. Charles Douglas was known as a mechanical genius, but today he is remembered for his part in the American War of Independence. Charles Douglas died in Edinburgh, Scotland, in 1789 (Valin 2009).

Jeremiah Dixon was born in 1733 near Durham in England as the son of a Quaker coalmine owner. During his education he became interested in astronomy and mathematics and got to know the instrument maker John Bird. In 1761 Dixon observed
the transit of Venus from the Cape of Good Hope together with Charles Mason. From 1763 to 1767 the two worked together surveying what is today known as The Mason–Dixon Line, a demarcation line forming part of the borders of Pennsylvania, Maryland, Delaware and West Virginia in the U.S. After his visit to Norway in 1769 Dixon resumed his work as a surveyor in Durham, where he died ten years later, in 1779 (Danson 2002).

William Bayly was born in 1737 as the son of a farmer. His interest in mathematics was discovered and local gentlemen helped him to some education. He became an usher at a local school, and when Nevil Maskelyne heard of his talents he engaged him in 1766 as an assistant at the Royal Observatory (Croarken 2003). Bayly held this position until 1771. In 1772 and 1776 he sailed as one of the astronomers on James Cook’s second and third voyages of discovery (Fig. 2). In 1785 he was made headmaster of the Royal Academy at Portsmouth, an office he held until 1807 when he retired. Bayly died in 1810.

Figure 2. William Bayly observing with a quadrant set up on a cask in Anamooka during James Cook’s third voyage. This is the only known picture showing Bayly and it is taken from an engraving titled A view of Anamooka made by John Weber.

We do not know exactly which instruments William Bayly and Jeremiah Dixon used on their expedition to Norway, but from the papers they published we may put together the following list of William Bayly’s instruments:

1. an astronomical quadrant of 1 foot radius, by [John] Bird,
2. a 2-foot reflector telescope, by [Peter] Dollond,
3. a transit instrument of 4 foot by John Bird, with achromatic object glass by [Peter] Dollond,
4. an astronomical clock with gridiron pendulum, by [John] Shelton,
5. a journeyman clock, by [John] Shelton,
6. an alarm clock, by [John] Shelton,
7. a variation compass, by [Gowin] Knight,
8. a dipping needle (belonging to the Royal Observatory) by [George] Graham,
9. a barometer by [Jesse] Ramsden, and
10. two thermometers by [John] Bird.

According to Bayly’s information Jeremiah Dixon had similar instruments except for the dipping needle.
4. Instructions given to the observers

In the beginning of March 1769 the Danish-Norwegian King assured the Royal Society of full cooperation in connection with their expedition to the North Cape. As a result local authorities in Norway were instructed to help the astronomers in all possible ways. But the local authorities where also told to report whatever they learned about the British astronomers’ arrival (Thott 1769). The information from Denmark reached the Royal Society on April 6 (Woolf 1959). Around the same time Maskelyne gave the two observers their instructions (Maskelyne 1769c), in which they were informed that they should go to the North Cape and to “some other place at some distance, to be fixed by Captain Douglas”. It was up to the observers to settle which of them should observe at one place, and which at the other. We do not know why Spitzbergen was abandoned but the reason maybe that it was considered too risky to set up an observatory so far north during springtime – or maybe the Admiralty refused to go there. On their voyages to and from Norway the astronomers should make observations of the latitude of the ship’s position with a sextant or a quadrant, determine the longitude of the ship by measuring the distance of the Moon from the Sun and fixed stars, and observe the variation by the azimuth compasses of the ship.

On Monday 24 April HMS Emerald arrived at Magerøy and Captain Douglas wrote in his logbook: “Working into Magero Sund. 2pm Sailed into Honnings Bay” (Douglas 1769a). According to their instructions (Maskelyne 1769c) they should as soon as possible put up the observatory and the dwelling house, and then fix up the clock firmly and calibrate it to determine the difference of gravity between that place and Greenwich. From this they would find the length the pendulum should have to assure that the clock would keep near sidereal time at the North Cape.

Figure 3. Map of the area around North Cape and Hammerfest drawn by Bayly (1769) and Dixon (1769) showing the locations of their observatories.
They should then observe several corresponding altitudes of the Sun every day in order to test the accuracy of the clock and to draw a meridian line. From this they could align the observatory to the true north so the transit instrument could move through the meridian. They should also erect a meridian mark at a convenient distance from the observatory.

To determine the latitude of the place, they should observe meridian altitudes of the Sun, both to the north and to the south, and also of the fixed stars as well as the planet Venus. In order to ascertain the astronomical refractions they should measure a series of altitudes of the Sun and Venus from the horizon and note the time of the rising and setting of Venus and of the bright fixed stars. From this it seems as if Maskelyne was not aware (or had forgotten) that fixed stars would not be in sight from late April to the middle of August because the bright sky due to the Midnight Sun.

To determine the longitude of the place they should as often as possible observe the transits of the Sun and Moon and of the principal fixed stars of the first and second magnitude lying between the tropical circles. These celestial objects were also observed at the Royal Observatory at Greenwich. In addition they should, particularly with a view to this purpose, attend to the eclipse of the Sun, which would happen soon after the transit of Venus.

Throughout this time they should note the height of the barometer and thermometer. In addition to all this they should determine the elevation of the observatory above the sea and use the quadrant to observe the depression of the horizon of the sea.

Most important of all was of course the observation of the transit of Venus. Here they should especially take care to observe the internal contacts, whether by the coincidence of the limbs of the Sun and Venus, or by the breaking in of the Sun’s light behind the hinder limb of Venus, at the first internal contact; or by the disappearance of the light between the limbs at the second internal contact. They should also look out for any thin, faint ring to be seen surrounding the circumference of Venus, or any other signs of an atmosphere. Toward the middle of the transit, they should take several measures of the nearest distance of the limbs of the Sun and Venus, in order to ascertain the nearest approach of Venus to the Sun’s center.

5. The North Cape and Hammerfest

On April 26 Bayly’s observatory and instruments were taken ashore in Honningsvåg and between April 28 and May 5 the observatory and dwelling house were built and the instruments put in place. On May 6 the observations started. This would give plenty of time for Bayly to determine the accuracy of the clock, put up a meridian mark and find the coordinates of the observatory, Fig. 3.

The day before, on May 5, Captain Douglas had taken the ship out of Magerøysund and he and Dixon started to look for a suitable place for the other observatory. They sailed past Kelwick [Kjelvik], the North Cape, the Mother and Daughter-Islands [Storstappen, Kjerkestappen and Bukkstappen], Suroy [Sørøy], (see Fig. 3) and at 10 am on May 7 entered into Hammerfest harbor (Douglas 1769a). After some research Dixon managed to find a place for the Observatory at Rypeklubben just outside Hammerfest (Hagerup 1769). On May 9 the observatory was landed, and three days later the instruments were taken ashore. On May 14 Dixon put up the quadrant on the stand provided for it. To give it a firm foundation it was put on “a large cask filled with water [...] and the box in the bottom of the stand filled
with stones” (Dixon 1769), see Fig. 2. Due to cloudy weather Dixon had to wait until May 20 before he could perform any observations. On 25 May three of his Danish Majesty’s Ships came in to Hammerfest, and the day after HMS Emerald was visited by Eiler Hagerup, county prefect of Finnmark (Douglas 1769a), Fig. 4.

By June 3 Bayly and Dixon were well prepared to observe the transit. But the weather turned out to be cloudy with gales (Douglas 1769a). Bayly reported that “the Sun came out from under a cloud, with Venus on it, about $\frac{1}{4}$ of her diameter”. At 9h 14$^m$.1$^s$ local time Venus’ outer limb was apparently joined to the Sun’s limb by a black ligament, which gradually diminished in breadth until the Sun’s light broke through 55 seconds later. The conditions were however poor and Bayly (1769) reported that (Fig. 5)

Venus seemed very ill defined when on the Sun […] a better idea will be formed of the bad appearance of Venus at the internal contact, owing to the very hazy state of the air, from the representation.

The observation of the transit had failed, and in Hammerfest the situation was more or less the same. In Maskelyne’s instructions it was stated that if they missed the transit due to bad weather they should depart the place immediately, only first observing carefully the eclipse of the Sun, which happened a few hours after the transit. So they did, and on June 6 Dixon’s observatory was taken on board HMS Emerald and on June 25 Bayly’s observatory was taken on board. Ten days later they left Honningsvåg and started on their voyage back to Britain. Today it is not possible to locate the exact position of the observatories as nothing seems to be left.

6. Bonus results from the expedition

Bayly and Dixon published their results in the Transactions of the Royal Society even though they had failed to observe the transit satisfactorily. They reported what they had seen of the transit of Venus, as well as results from the corresponding altitudes of the Sun, transits over the meridian, the eclipse of the Sun and also
some meteorological observations (Bayly 1769, Dixon 1769). The positions of the observatories were given as:

<table>
<thead>
<tr>
<th></th>
<th>Latitude</th>
<th>Longitude</th>
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<tbody>
<tr>
<td>Bayly’s observatory</td>
<td>71° 00’ 47” N</td>
<td>26° 01’ 30” E</td>
</tr>
<tr>
<td>Dixon’s observatory</td>
<td>70° 38’ 23” N</td>
<td>23° 43’ 45” E</td>
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Along with their observations they published a chart showing the sea coast and the islands near the North Cape including three silhouettes of coastal approach.

While Bayly and Dixon were ashore, Captain Charles Douglas was busy doing observations on board the HMS Emerald. Like all naval ships he kept what may be described as a spying log (Douglas 1769b). It was a collection of reports on defenses, commercial information, marks for anchoring, descriptions for sailing in and out of ports with soundings and marks for particular rocks etc. He also added supply possibilities (“watering and wooding”) for any territory they were visiting. These are the headings of columns in a pre-printed reporting volume. For the areas around Honningsvåg and Hammerfest the log was supported by charts of the coast. We do not know whether these charts were made by Douglas or by anyone else – maybe Dixon and Bayly contributed?

In addition to this Professor of Astronomy at Glasgow University, Alexander Wilson, had asked Douglas to measure the temperature of sea water at great depth. Twenty years earlier Wilson had used kites to measure air temperature at various levels in the atmosphere, the first recorded use of kites in meteorology (Wilson 1829). In 1769 Wilson had constructed a special device to be used by Douglas. A thermometer staying upright was placed in a watertight tin cylinder without touching the walls of the cylinder. This cylinder was sunk to great depth by using sounding-lead and should hang free near the bottom for half an hour. It was then hauled up as fast as possible and the thermometer was inspected. After trying this several times Douglas changed the design by making two small holes, one at each end of the cylinder. This would let in water – hopefully most of it at great depths. It sunk 260 fathoms (475 meters) in $3\frac{1}{2}$ minutes and was hauled up in $13\frac{1}{2}$ minutes. Douglas recorded at the same time the temperature in the air and the water temperature at the surface. As far as I have been able to discover this is among the first [maybe the first?] attempts to measure the temperature of deep water, Fig. 6. The results were published in the Transactions of the Royal Society (Douglas 1770).

Before going to Norway, Captain Douglas had read Erik Pontoppidan’s book The Natural History of Norway published in Copenhagen in 1752/53 and in an English
version in London in 1755. During the stay in Finnmark Douglas tried to investigate some of the stories told by Pontoppidan in his *Natural History*. Among these are the stories of the huge aquatic animal called Kraken, the information about Sea Worms and the story of the Whirlpool or Maelstrom laying between the islands of Lofoten. This Maelstrom was well known to sailors and regarded dangerous for ships.

Douglas’ judgments of the stories were based on what information he could collect from Norwegian seamen. Regarding the Maelstrom he was told that by high water it was perfectly smooth, but in ebb or flood it became agitated and dangerous. According to Douglas this was probably due to the unevenness of the rocky bottom over which the current rolled with vast rapidity, since the water was confined in a narrow passage. A Norwegian had even told him that at very low water it was possible to see sharp pointed rocks at the bottom, which would account for the loss of open boats. Douglas hoped that his report would unravel the mystery of the Norwegian Maelstrom.

Talking about the big animals in the sea it was quite obvious for Douglas that the huge Kraken did not exist – none of his informants had ever seen it. In relation to the Sea Worm it was quite another story. Douglas had met with a master of a Norwegian vessel that had seen three Sea Worms outside Bergen just six years earlier. One of them he judged to be 25 fathoms long and about one fathom in thickness. It looks as if Douglas himself trusted the man, but he left to the Royal Society to judge whether these animals existed or not.

Charles Douglas’ paper in the *Philosophical Transactions* earned him a membership in the Royal Society in London probably due to what is referred to as his “series of curious experiments to determine the different degrees of cold at different depths in the Sea” (Royal Society 1770).
7. Conclusion

The expeditions of Bayly and Dixon are not very well known today. The main reason is of course that they failed to observe the important stages of the transit of Venus due to bad weather. In addition they were told only to do observations that were necessary to support their main goal, i.e., to observe the transit of Venus. In Maskelyne’s instruction it is stated that they should leave as soon as possible if they failed to see the transit. This means that there is nothing spectacular or epic from other parts of the expedition that may catch our interest. Despite this the story may broaden our knowledge on how such expeditions were organized and planned 250 years ago. It seems for instance that the Royal Society had to cooperate with the Admiralty and the captain of the assigned vessel when determining where to go. And the Admiralty used the opportunity to get information about the places they visited.

Acknowledgments

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In addition, Rebekah Higgitt, Royal Museums Greenwich, told me that William Bayly could be identified in the engraving entitled A view of Anamooka.

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