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Viewpoint
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Editorial

As many of us head off on conferences or holidays this June, this issue of *Viewpoint* roams far and wide on the topic of travel.

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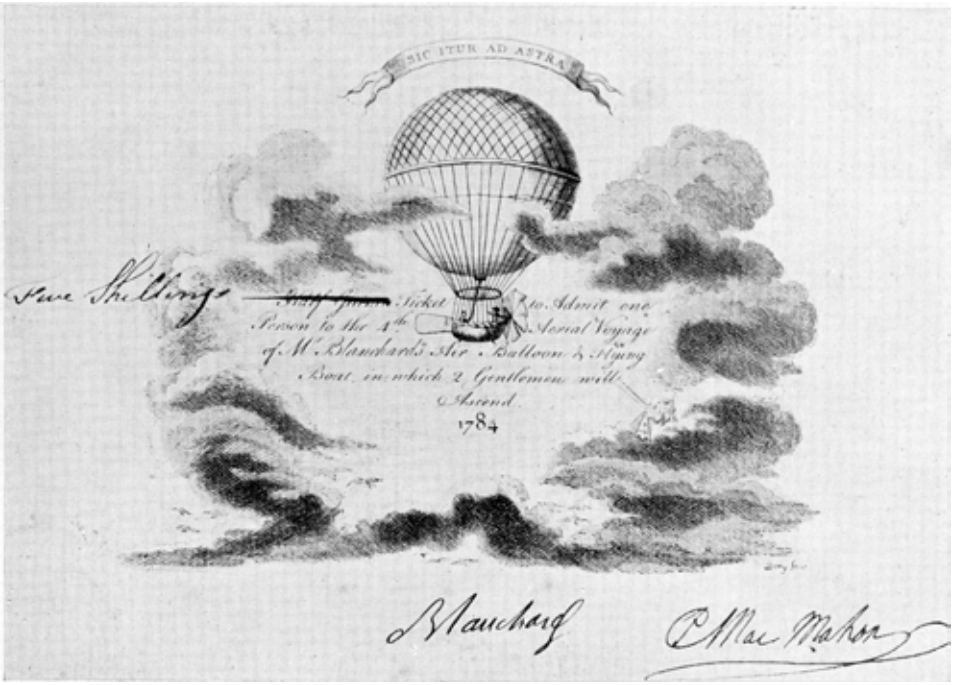
Also featured are reports on the promotion of family friendly history of science by Laura Hobbs and on a fascinating 20th century statistician by Jochen F. Mayer (6-7).

Contributions to the next issue should be sent to viewpoint@bshs.org.uk by 15th August 2015

Alice White, Editor



Signed admission ticket for Blanchard Balloon ascent from Chelsea, October 16, 1784. Courtesy of the Wellcome Library, London.

Up and Away! 18th Century Science of Ballooning

Caitlín Doherty on the lofty ambitions of 18th century balloonists

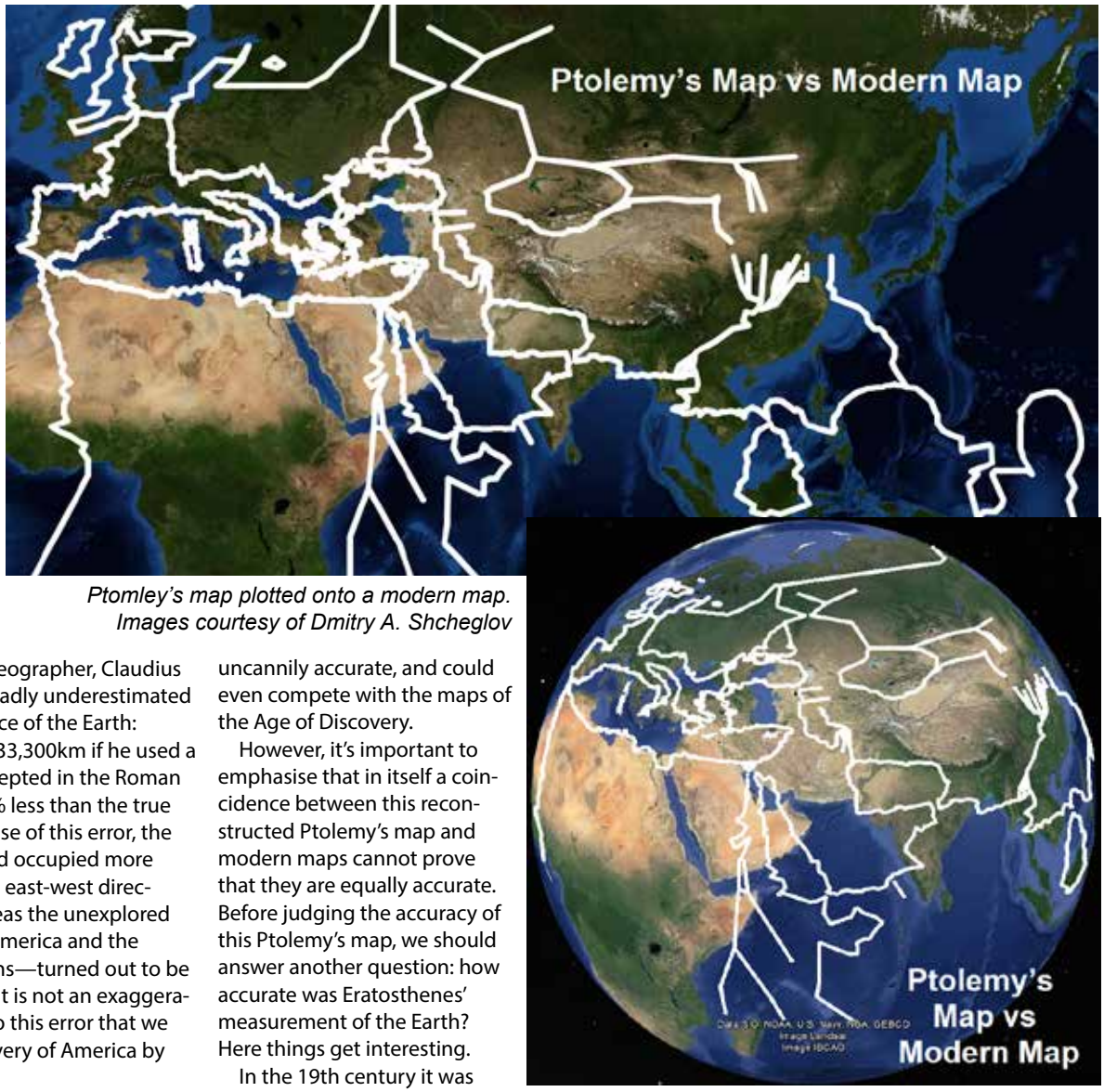
Distance travelled is usually measured along a horizontal axis, but for a group of natural philosophers, showmen, and members of a rapt public audience at the end of the eighteenth century, vertical movement was a far more exciting prospect.

The invention of balloons capable of carrying human weight (and at first the weights of various farmyard animals) took place in France during the year 1783. First the Montgolfier brothers created a linen sack, which they inflated with noxious smokes in the fields of Annonay. They then repeated this at the Tuileries gardens in Paris before a royal audience. Shortly after, Jacques Charles and the Robert brothers pioneered the use of hydrogen as a much safer (and less fragrant) lifting agent for aerostats, and balloons became a popular European phenomenon. So goes the traditional history of humankind's first experience of flight. The balloon has since become a symbol of Enlightenment thought and culture, representative of an early-Romantic escape from the limits of the Earth, especially in France and Britain. This view, however, is one derived from the terrestrial position of watching a balloon rise. To begin to understand the complex and multiple roles of balloons in this period, it's necessary to take an imaginative step inside the basket of an aerostat. This reveals that although the balloon was itself the product of a series of natural philosophical inquiries into the nature of gases, it was also a site of knowledge production. In Britain, during the final 15 years of the 18th century, the hydrogen balloon observed from the ground seemed a levitating testimony to mankind's genius. For the aeronaut above, however, a dangerous and unpredictable experimental journey was in progress.

The reputation of balloons as scientific instruments suffered early on from association with insubstantial properties of airs and gases, and from balloons' popularity among the general public. To rectify some of the discredit poured upon them – notably by men such as Joseph Banks – those who fashioned themselves as aerial pioneers took two approaches:

Mistakes & Map-Making in Antiquity

Dmitry A. Shcheglov discusses historical interpretations of the cartography of antiquity



Ptomley's map plotted onto a modern map. Images courtesy of Dmitry A. Shcheglov

Was there a high accuracy cartography in antiquity? "Yes, there was!" is the bold statement made independently by a number of researchers in recent years. Dennis Rawlins (Baltimor), Lucio Russo (Rome), Irina Tupikova and Klaus Geus (Berlin) share basically the same hypothesis that challenges conventional views on ancient cartography. But how serious is this challenge? Should we get ready to rewrite our textbooks?

Paradoxically, the argument for the high accuracy cartography was provided by the most glaring error made by the greatest ancient geographer, Claudius Ptolemy. He accepted a badly underestimated value for the circumference of the Earth: 180,000 stades (equal to 33,300km if he used a stade of 185m as was accepted in the Roman time). This was about 17% less than the true value of 40,000km. Because of this error, the explored part of the world occupied more space on the globe in the east-west direction than it should, whereas the unexplored part—which embraced America and the Atlantic and Pacific Oceans—turned out to be equally underestimated. It is not an exaggeration to say that it is due to this error that we ultimately owe the discovery of America by Christopher Columbus.

Meanwhile, there was another value for the circumference of the Earth, 252,000 stades, put forward by Eratosthenes in the 3rd century B.C. This was accepted by ancient intellectuals. Even Ptolemy used this value in his life-work, the *Almagest*, so Ptolemy's *Geography* with its 180,000 stades is a strange anomaly. Hence it's reasonable to assume that early versions of Ptolemy's map were also initially based on Eratosthenes' value.

A striking phenomenon is revealed by this connection: if we place Ptolemy's map onto a sphere with Eratosthenes' circumference, with distances remaining unchanged, then all its coordinates expressed in degrees improve drastically, down to a complete coincidence with modern maps. Thus researchers concluded that an earlier version of Ptolemy's map, based on Eratosthenes' value, was uncannily accurate, and could even compete with the maps of the Age of Discovery.

However, it's important to emphasise that in itself a coincidence between this reconstructed Ptolemy's map and modern maps cannot prove that they are equally accurate. Before judging the accuracy of this Ptolemy's map, we should answer another question: how accurate was Eratosthenes' measurement of the Earth? Here things get interesting.

In the 19th century it was supposed that Eratosthenes and many other Greek authors used a "short" stade of 157.5m instead of the "Roman" one of 185m. In these stades, Eratosthenes' value for the Earth's circumference works out at 39,690m, and has an error of less than 1%! This result is so spectacular, and the temptation to hail it a triumph of Greek scientific genius is so strong, that it has been eagerly accepted by many scholars. Many distances in the Greek sources, when expressed in the "short" stades, also turn out to be surprisingly accurate. Thus a fascinating prospect emerges: in antiquity there was a tradition of "thrice" high-accuracy geodesy and cartography. Firstly, unknown surveyors measured distances with amazing accuracy, secondly, Eratosthenes calculated the Earth's circumference to within 1% of the true value, and thirdly, on this basis his unnamed successors composed an incredibly accurate map of the world. Then came Ptolemy, who not only pocketed the work of all his predecessors, but also perverted it completely.

But the fascination of this hypothesis is elusive. Its Achilles' heel is the postulated "short" stade. Without it, the whole construction topples like a house of cards. The main argument for the "short" stade is based on comparison between ancient and modern distance measurements: modern distances are divided by their ancient counterparts in stades, giving the length of one stade. The idea is excellent in principle. However, as a rule, ancient sources give only rough distance estimates including various curves of routes that are completely unknown to us. This is why

ancient distances are usually overestimated in comparison with modern ones, even when we try to reconstruct ancient routes. Despite this, within the hypothesis of high-accuracy ancient cartography there is no place at all for the notion of "measurement error". The "short" stade is deduced from a tacit assumption of ancient measurements' accuracy. Then this is substituted into Eratosthenes' calculations, which makes his value for the Earth's circumference amazingly accurate. However, a more thorough analysis shows that ancient distances were overestimated by 20% on average. This means that an average stade must have been about 20% longer than the "short" one and closer to the Roman standard of 185m.

The return of the "measurement error" into play gives a more plausible explanation for the high accuracy of the reconstructed Ptolemy's early map. If all distances in antiquity were overestimated, it's no wonder that the same was true of the distance used in Eratosthenes' measurement of the Earth. Consequently, Eratosthenes' value for the Earth's circumference proved equally overestimated. This result has an interesting effect: if overestimated distances are expressed in degrees of an equally overestimated Eratosthenes' globe, then these two errors mutually annihilate each other, and a map constructed on this basis becomes quite accurate. This explains why Ptolemy's map, placed on Eratosthenes' Earth, demonstrates remarkably accurate coincidence with a modern map.

Once the "delusion of high accuracy" is eliminated, everything starts to fall into place. Ancient surveyors measured distances with considerable errors, which was inevitable for that time. Eratosthenes' measurement of the Earth also had an error of about 17%, which should be recognized as an achievement of ancient science rather than as a failure. The incredible accuracy of the reconstructed early map of Ptolemy proves to be a quaint illusion produced by a superposition of two opposite errors. Ptolemy's error in the value of the Earth's circumference indeed contributed to the stretching of his map in the east-west direction. But it can only account for about a half of this stretching, whereas another half was due, most probably, to a banal overestimation of distances underlying the map. There is no need, therefore, to see Ptolemy as an evil genius who did away with ancient cartography and plunged the world into the darkness of ignorance.

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Evolution travels to the colonies

Cristiano Turbil discusses a science dialogue that travelled the world

If the law of Nature is "struggle," it is better to look the matter in the face and adapt yourself to the conditions of your existence. Nature will not bow to you, neither will you mend matters by patting her on the back and telling her that she is not so black as she is painted. My dear fellow, my dear sentimental friend, do you eat roast beef or roast mutton?

Samuel Butler, 'Darwin on the Origin of Species - A Dialogue', *The Press*, 20 December, 1862.

In the 19th century, natural science was crossing the geographical limits of Europe becoming an international discipline promoting research expeditions all around the globe. Reports of research journeys and narratives of evolution and the exploration of unknown territories were becoming fashionable. This, of course, was not limited to England; the dissemination of evolutionary ideas also played an important role in the colonies. Expressions such as "natural selection" and "survival of the fittest" became common in small colonial newspapers too.

In New Zealand, on 20th December 1862, Samuel Butler anonymously published a dialogue on Darwin's *On the Origin of Species* in *The Press*. Although written in a peculiar style, Butler's dialogue offered an accessible explanation of Darwin's hypothesis of evolution to New Zealand citizens. The narrative adopted by the British born emigrant, Butler, was a mix of satirical writing and scientific explanation combined into a deep philosophical analysis. From the 1870s onwards, Butler started a crusade against Darwin and his hypothesis of evolution. However, in the early 1860s, Butler declared without hesitation: 'I was one of Mr. Darwin's many enthusiastic admirers, and wrote a philosophic dialogue (the most offensive form, except poetry and books of travel into supposed unknown countries, that even literature can assume) upon the Origin of Species' (Butler's Notebook).

The dialogue mimics a colloquial conversation between two individuals: 'C' a very conservative Christian and 'F' an enthusiastic middle class admirer of Darwin's work. Starting with a direct question from 'F': 'So you have finished Darwin? Well, how did you like him?' it tried to explain how Darwin's work was something more than a piece of writing 'so hard and logical' as defined by 'C'. Butler's aim was to 'catechise' the colonials, explaining the potential of evolution with a simple language and a very jocular colonial terminology. Butler explained evolution via breeding of cats, parrots and sheep but also satirically attempted to conciliate Darwinism and Christianity.

The dialogue attracted a great deal of discussion in the colony and even the Bishop of Wellington responded to Butler with a long letter also published in *The Press*. The letter, entitled 'Barrel-organs' stated that Darwin's work was reiterating ideas already known, not promoting any revolutionary new understanding of the origin of life. Butler replied to the Bishop and recalled the episode in his own notebooks: 'I remember answering an attack (in the Press, New Zealand) on me by Bishop Abraham, of Wellington, as though I were someone else, and, to keep up the deception, attacking myself also. But it was all very young and silly.'

Aside from this quarrel, Butler's dialogue has another story to tell. The dialogue was not only acclaimed by New Zealand citizens; Butler's popularisation of Darwin's science was even able to cross the borders of the small colonial community and make a rapid journey back to England. As reported by Henry Festing Jones, friend and biographer of Butler, a copy of the paper was sent to Darwin. Darwin forwarded it to an English editor with a letter, dated 24th Mar 1863, speaking of the dialogue as 'remarkable from its spirit and from giving so clear and accurate an account of Mr. D's theory' and highlighting that fact that the dialogue was 'also, remarkable from being published in a Colony exactly 12 years old, in which, it might have thought, only material interests would have been regarded'.

Darwin was fascinated by this dialogue. At first, he thought it was written by the German geologist Julius von Haast who was conducting research on rock formation in the Canterbury region. On 18th July 1863 Darwin wrote to Haast: 'I wonder whether you were the Author of a very amusing & really excellently done Dialogue on Natural Selection, in a New Zealand paper, which was sent to me?' Haast presumably replied to Darwin revealing the name of Butler but this letter did not survive. The solution to this interesting epistolary exchange arrived only later on in 1863 when Emma Darwin attached to a letter to Hooker (7th Dec 1863): '2 squibs by the Author of the Dialogue in the New Zealand paper on Origin. He is a Mr Butler Grandson of the old master of Shrewsbury C.'s schoolmaster.'

This short story about a dialogue written in a very young colony in New Zealand illustrates how Victorian scientific ideas rapidly travelled all around the globe, and how discussions of science might even begin with questions like 'do you eat roast beef or roast mutton?'

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