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John Walsh's Missing 1777 Communication to the Royal Society of London:
On the Electric Spark from *Gymnotus electricus* (Part 1) and its Electrical Sense (Part 2)

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Abstract

This note continues discussion of the recent discovery of the existence of a Draft Letter presented to the President of the Royal Society Sir John Pringle by John Walsh MP in the summer of 1777. The first part of the letter, which outlined Walsh's success in generating an electric spark from the "electric eel" *Gymnotus electricus*, was presented orally to the Society. The second part which described his observations of the eels' mysterious "electrical sense" was never formally published. Walsh's unaccountable failure to publish any of his work on electric eels in the Transactions of the Society has long been a subject of speculation.

Introduction

Wealthy nabob Colonel John Walsh MP FRS (1726-1795) undertook a historic fishing expedition to the coastal town of La Rochelle and nearby Île de Ré in the summer of 1772. There he successfully gave the first conclusive demonstrations, at least in modern eyes, of the electrogenicity of the marine Torpedo Ray by showing that the transmission of a physiological shock from the Torpedo required an electrically conducting path.

Walsh reported his success to the Royal Society of London in the form of a letter to his mentor, Benjamin Franklin, published in the Philosophical Transactions in the following year (1773, 462). In awarding him the Society's prestigious Copley Gold Medal in 1774, its President, Sir John Pringle stated (1775): "*If these reflections be just, we may with some probability foretell, that no discovery of consequence will ever be made by future physiologists, concerning the nature of the nervous fluid, without acknowledging the lights they have borrowed from the experiments of MR WALSH upon the living torpedo and the dissection of the dead animal by MR HUNTER.*".

The Elusive Spark

The acclamation of his peers was not universal however and Walsh worried that he had been unable to detect the expected signature of the "electric fluid": the deflection of pith balls and generation of a visible spark discharge. Walsh's other collaborator, natural philosopher Lord Henry Cavendish rebutted these and other objections raised by the sceptics by constructing a physical model of an electric torpedo ray charged by a battery of Leyden Jars (Schaffer 2004). Nevertheless, the absence of a visible spark remained a sticking point to widespread acceptance of the electric fish hypothesis despite Cavendish's clarification of the separate concepts of electric spark-enabling "pressure" (*Potential*) and shock-producing *Charge*.

The work of Cavendish (1776) and Williamson (1775) led Walsh (Edwards 2021a) to realise that the South American electric “eel”, then named *Gymnotus electricus*, was a better candidate for a spark than the Torpedo Ray by virtue of its higher discharge potential, now known to be of the order of 500 volts, capable of administering a shock to a loop of as many as 40 people. He imported several healthy *Gymnotus* specimens from Dutch Guinea and succeeded in demonstrating a visible spark to an audience of Royal Society Fellows, including the President Sir John Pringle in 1776 (Finger and Piccolino 2011). His demonstration capped four years of experimentation with electric fish which began with the expedition to La Rochelle in 1772 during which he confirmed the electrogenicity of the marine Torpedo Ray.

Walsh’s London spark demonstration briefly became a *cause célèbre*, and was reported in numerous journals and newspapers, including *The Gentleman’s Magazine*. It was widely reported in scientific circles on the European continent as well, following publication of an article by Walsh’s physician acquaintance Jean-Baptiste Le Roy in the *Observations sur la Physique* (1776). Walsh had written to Le Roy informing him of his success with the spark and Le Roy quoted Walsh’s letter in his article, adding Pringle’s imprimatur. Other reports circulated, including those of eye witnesses, but Le Roy’s article is believed to contain the only published account written by Walsh himself of what was considered by the scientific community to be his crowning achievement.

Walsh’s unaccountable failure to publish his work on the spark from *Gymnotus* has led to considerable speculation. Suggested reasons for this omission have included writers’ block, family business and political pressures; the departure from England of his former mentor Benjamin Franklin and Pringle’s removal from the Presidency (Edwards, 2013); rapid pre-emptive dissemination within the “*Republic of Letters*” following Le Roy’s report, and a desire to obtain more experimental data from the eels (Finger and Piccolino, Piccolino, Piccolino and Bresadola, Edwards, 2021b).

New Evidence

We have previously reported (Edwards, 2021b) the discovery of an extract from a letter written by John Walsh to his nephew Francis Fowke in Bengal dated July 7th 1777 (Benn-Walsh, 1852, Walsh, 1777). This letter reveals Walsh’s intention to publish, not only his work on *l’étincelle électrique*, but also his observations of the eels’ navigational “electrical sense”, now known to be used for the location of its prey. This had evidently supplanted the spark in his research interests, despite the spark’s perceived importance at the time.

Walsh wrote to Fowke in Bengal:

“At the last meeting of the Royal Society before their Summer recess, I delivered in a Draft of a letter to the President concerning the spark exhibited by the Gymnotus a very extraordinary property I had observed in that animal; In short, no less than a new sense, by which the Gymnotus perceives the presence of any better conductor of his Electricity than the water which surrounds him. By the application of which principle I can, at his tub-side, or even in the next Room, govern him as if I had a bridle in his mouth, by making him stop short, advance, or reverse, turn to the right or to the left as I please; the slightest Varnish on the Metallic Conductor masks it so far that he cannot perceive it by his electrical sense, as I am disposed to call it. It is difficult for me to explain more of this Matter to you without taking a wide

compass, So that I believe I must refer you for the rest to the printed letter whenever it appears. He has passed thro' the winter very well & is now returned to Warfield for the Summer."

"Warfield" refers to his country residence Warfield Park in Berkshire to which he had evidently returned for the Summer, together with the long-suffering *Gymnotus* eel.

In passing we note Walsh's ingenious use of an insulating varnish to interrupt the flow of current between the metallic conductor and the surrounding water in order to verify the electric nature of the phenomenon. He had employed the same principle at La Rochelle to verify the electric character of the Torpedo's shock transmitted around a conducting loop.

A Debt of Long Standing

Fowke was the recipient of a second letter (Davies, 1777) in June of the following year, concerning Walsh's unpublished account of his work on "Gymnotus". It was written on November 26 1777 by Fowke's former tutor, Walsh's secretary, David Davies, who wrote:

Mr Walsh is at present occupied in repeating his experiments on the Gymnotus and preparing an Account of them for the Royal Society. This is a debt of long standing which various accidents have prevented him from discharging. But having delivered in a Sketch of his intended memoir, he cannot much longer excuse to his brother Members not completing it.

Davies continues:

I will not anticipate the pleasure you must soon receive from Mr Walsh's Paper by giving you an imperfect detail of his Experiments and Discoveries. You are already informed [Walsh, 1777] that beside the Shock which the Torpedo had communicated, he had obtained from the Eel the Electrical Spark. To these Proofs of its possessing the power of electrifying, is now added that of its having a Faculty of perceiving when it can exercise that Power with effect..... It is surprisingly sensible of the Presence of such substances as give a readier passage to its electric Virtue than the water in which it swims.

As far as is known, Davies had no scientific training, although he had participated in the 1772 expedition to La Rochelle. So it is likely that he was echoing Walsh's own interpretation of the "Electrical Sense", since confirmed by modern research to be enabled by the higher conductivity of the target prey relative to its freshwater environment.

Davies mentions numerous demonstrations of the eels' *Electrical Sense*:

The Experiments by which Mr Walsh proves the Existence & Effect of this Faculty are simple and elegant. He had shown them long since in private to some select Persons; but thinking it proper to render this Discovery as authentic as those of the Shock and Spark, he lately repeated them publickly before numerous Companies of the Royal Society & others to their great wonder and admiration. The experiments on the Eel have put beyond all doubt the Conclusion drawn from those on the Torpedo, & further, they indicate in Electric Fishes a particular Faculty of perception subservient to their Electrical Power.

He concludes with a possible reason for Walsh's non-payment of his "debt of long standing".

You will be sorry to hear that the favourite Eel from which Mr Walsh gained these secrets died an untimely death last summer at Warfield. One unlucky night it made an Effort to get out of the Tub in which it had lived so long seemingly content and satisfied, and alas! next morning

was found dead on the floor. It will add to your concern that Baker, the man who brought these eels from Surinam in making a Tour to Oxford and several other Places, in order to get a little money, had the misfortune in his Peregrination to lose Two out of the three belonging to him, so that now only one remains alive out of the whole family. It was on this surviving one that Mr Walsh, lately made the Experiments above alluded to.

Davies' letter to Fowke also reveals that Walsh had become preoccupied with the electrical *Sense* and that the electrical *Spark* had definitely taken a back seat, despite not having been formally reported in the scientific literature, apart from the paragraph quoted in Le Roy's 1776 paper.

Walsh's Gymnotus Spark Presentation

Further enquiry (Mills, private communication 2021) has revealed that according to the minutes of the final meeting of the Royal Society before the Summer recess, held on June 19 1777, "*part of a paper was read on the gymnotus electricus by Mr Walsh*". No further mention of Walsh's paper, either in part or in full is made in the minutes of the next meeting on November 6, after the recess. Unfortunately records of the Society's Committee of Papers (its Publications Committee) are incomplete before 1780 (Mills, Private communication) so that it is not clear whether Walsh's "*draft of a letter*", or a more complete version, was ever submitted to the committee for its consideration. It seems from his letter to Fowke that Walsh presented his draft letter directly to Pringle, perhaps in the expectation that Pringle would communicate it, or perhaps a more complete report, to the *Transactions* on his (Walsh's) behalf as Franklin had done previously for his 1773 Torpedo paper.

It seems clear though, that on July 7, nearly 3 weeks after the meeting, Walsh fully anticipated seeing "*the printed letter, whenever it appears*" (Walsh, 1777). According to Finger and Piccolino (2011), Pringle wrote to Albrecht von Haller in a letter dated June 28, one week before Walsh wrote to Fowke, that "*he expects Walsh will have an article on these sparking eels in the Philosophical Transactions*". Pringle continues "*The most curious memoire of the second part will be, I imagine, that other of Mr Walsh upon the Gymnotus electricus or Surinam eelof which he has other interesting circumstances to tell*".

This suggests that the missing Draft Letter was in two parts, the first an account of the spark experiments, delivered by Walsh at the June 19 meeting of the Society; the second more controversial part, concerning the eel's "electrical sense". Although Pringle appears not to have taken issue with this "electrical sense", it may possibly have been a step too far for the Committee of Papers – hence the non-appearance of the Letter in the *Transactions*.

Another contributory impediment to publication may have been Pringle's preoccupation with the quasi-scientific lightning-conductor controversy involving Franklin, Cavendish and others which led to Pringle's forced resignation and the accession of royal favourite Joseph Banks to the Presidency in 1778. Davies' departure to become Rector of Barham in the same year and the absence of his Fowke niece, nephew and brother in law in Bengal may also have contributed. Walsh certainly took an active interest in their welfare and in the politics of the East India Company and he remained an active member of parliament in the 1780s.

Whatever the reasons for the lack of formal publication, 60 years passed before Faraday was to unknowingly repeat Walsh's spark demonstration, and nearly 200 years passed before electro-sensing was rediscovered by Lissman and Machin in 1958.

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