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The Frog's Dancing Master: Science, Séances, and the Transmission of Myths

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Myths are not uncommon in the history of neuroscience and their tenacity even when faced with suitable correctives is impressive. The possible origins and transmission of one such myth is examined: the oft repeated quotation, attributed to Luigi Galvani, that he was the "frog's dancing master." The statement does not occur in Galvani's writing and appears to have accrued features in the early nineteenth century, largely from French writers. In the 1870s, the quotation was used by William Crookes, the discoverer of thallium and inventor of Crookes' tube, in implicit support of his investigations into spiritualist phenomena. Crookes arranged séances with the psychic Daniel Dunglas Home and, being unable to explain them, introduced the concept of psychic force. A related myth concerns Galvani's accidental discovery of the neuromuscular action of electricity in the course of preparing a beneficial broth for his ailing wife. The two myths became entwined in the tangled web woven by commentators of Galvani's work. The myth-information is magnified by the World Wide Web.

Keywords Galvani, Flammarion, Crookes, spiritualism, neuromuscular contraction

Introduction

> I am attacked by two very opposite sects—the scientists and the know-nothings. Both laugh at me — calling me "the Frog's Dancing-Master." Yet I know that I have discovered one of the greatest Forces in Nature. (Crookes, 1871b, p. 471)

The story that we will tell has a personal element. It began when one of us (MP) received an email from a colleague in order to verify some points concerning the history of animal electricity. The colleague intended to use the quotation that is given at the head of this article, which referred to a statement by Luigi Galvani (1737–1798; Figure 1), the Bologna doctor who became famous for his electric experiments on frogs carried out more than two centuries ago. The colleague had been unable to find the quotation in neither a reprint of the collected works of Galvani (Gherardi, 1841), nor in other Italian sources. Another colleague told them that the Italian translation had been provided by MP from Galvani's collected works! The story started to be intriguing.

All authorities on Galvani agree that he never made such a statement, at least in extant printed writings. What is more, the statement does not correspond in any way to his scientific and personal character. In addition, it is very unlikely that anybody had laughed at his

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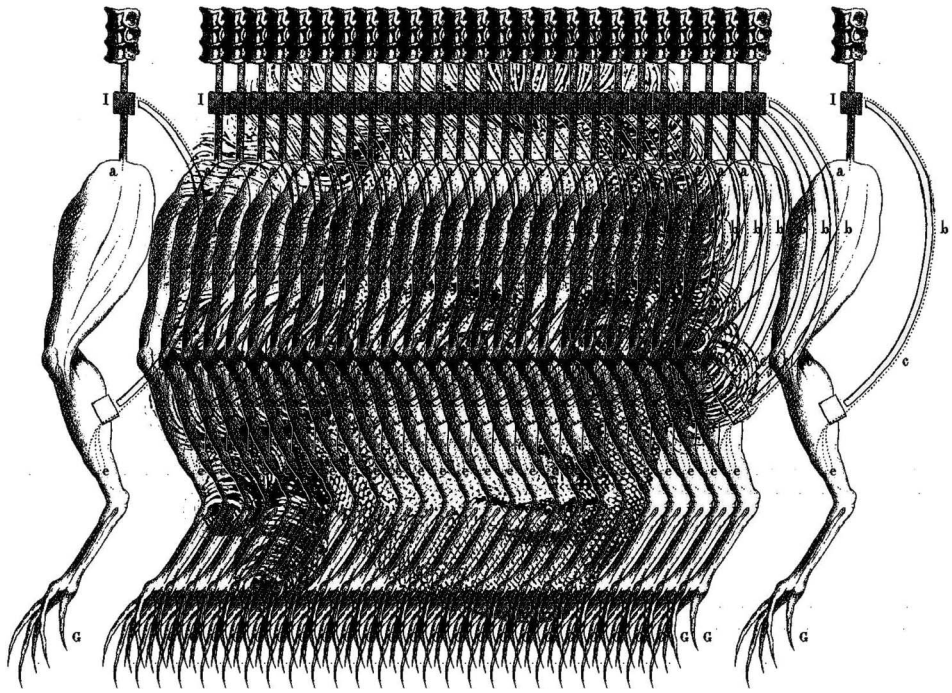


Figure 1. A perceptual portrait of Luigi Galvani contained within a pattern derived from his illustration of the frog neuromuscular preparation. (Nicholas Wade)

experiments in the period they were published. The possibility that MP could have translated into Italian the supposed quotation by Galvani was unlikely but required verification. This could be readily checked because the messages between Alex and MP concerning Galvani and his experiments could be retrieved from the computer, despite being five years old. There was no mention whatsoever of the story of the "frog's dancing master" nor any similar statement.

This was how the story began. One of the reasons for interest was because Galvani's case is not unique. There are many stories in the history of science that, in the absence of any factual or documentary support, have been repeated so frequently over the centuries that they are considered to be true. These myths are often due to the inventiveness of a creative writer and are generally passed down the generations by superficial historiographies. They tend to be perpetuated by encyclopedias such as the many dictionaries of scientists, which provide a rich source of stereotypes, including those on Galvani and his frogs. Thus, it seemed worthwhile to pursue this particular story and to try to understand how the scene of the electric frog's dance had emerged at the dawn of modern neuroscience.

The Frog's Dancing Master

As indicated above, the statement concerning the "frog's dancing master" did not derive from Galvani's pen nor could it be found in the extant manuscripts conserved at the *Istituto delle Scienze* at Bologna that have been studied for years by Bresadola (1998, 2008, 2011; Piccolino and Bresadola, 2003, 2012). The style was suggestive of French origin: words meant for effect, pronounced with a certain rhetorical *nonchalance* by a *savant* , probably

an *académicien*. Perhaps it was inserted in some very free narrative of Galvani's research, particularly since it had been an important source of inspiration for novelists and playwrights. His electrically reanimated frogs are indeed the foundation of tales and novels, not to mention the Frankenstein myth, both in Mary Shelley's versions (1818, 1831) as well in numerous film adaptations.

A French version of the quotation was soon found: "Je suis attaqué par deux sectes bien opposées, les savants et les ignorants. Les uns et les autres se rient de moi et m'appellent le maître de danse des grenouilles. Pourtant, je sais que j'ai découvert une des forces de la nature." It was in a volume by the French astronomer Camille Flammarion (1842–1925), who was also a prolific writer of popular science (and the brother of the famous publisher Ernest Flammarion; Flammarion, n.d., p. 9). The work was very successful; it was published initially in French (probably in 1900, although there is no date in the first edition). It was translated into many languages (Swedish, Spanish, English, Italian, German, Greek, Russian) and there are recent editions including an ebook (see, for instance, Flammarion, 1900, 1902, 1998, 2006). The theme and character of the book are somewhat surprising, being concerned more with séances than sciences. This is evident from the title and long subtitle: *L'inconnu et les Problemes Psychiques: Manifestations de Mourants, Apparitions, Telepathie, Communications Psychiques, Suggestion Mentale: Vue à Distance, le Monde des Rêves, la Divination de L'Avenir* (The unknown and psychic problems: Manifestations of the dying, apparitions, telepathy, psychic communications, mental suggestibility, distant visions, the world of dreams, divining the future). The book sympathetically addresses various expressions of paranormal phenomena that were of interest to many positivist scientists in the second half of the nineteenth century. Typically they commenced with the intention of providing a scientific explanation for the phenomena but failing to do so they often became strong supporters of the existence of psychic forces that were distinct from those operating in the physical and biological sciences. In Flammarion's case, the reference to Galvani and to the "frog's dancing master" is clearly aimed at using his results and their implications as evidence of the possible occurrence of paranormal phenomena. Did not the application of electricity to the frog preparations suggest the possibility of resuscitating dead bodies?

The first chapter of Flammarion's book is a *chef d'oeuvre* of mystifying rhetoric (possibly delivered in good faith). The author artfully made recourse to a series of arguments in order to support his main assumption. These concerned the possible occurrence of phenomena that went beyond the present understanding of science and that tended to be refuted because of the absence of any adequate evidence or interpretation. Among the arguments invoked are the ancients' disbelief of the Earth's rotation and the resistance opposed in the eighteenth century to Lavoisier's chemical theories. Flammarion also mentioned the (then) recent assertions by an important member of the *Académie des Sciences* (Bouillaud, who had been the model of the great physician in Balzac's novels). In Bouillaud's opinion, Edison's phonograph was a deception because "on ne peut admettre qu'un vil métal puisse remplacer le noble appareil de la phonation humaine" (Flammarion, 1900, pp. 4–5). This litany of inaccurate predictions made by past scientists was not new then and can be found in many modern encyclopedias of psychical phenomena (see Spence, 2003).

Could visualization have played a role in the origins of the dancing myth? This journal devoted a special issue to the influence of visualization in the advance of neuroscience (2008, Issue 3, pp. 257–392), and Galvani was included in that, with an emphasis on the importance of the image of the Leyden jar, the first electric capacitor, as a possible suggestion for Galvani's model of the involvement of electricity in neuromuscular function (Piccolino, 2008). Could the arrangement of the preparations in Galvani's (1791) masterpiece (Fig. 2) have suggested a dance? While the appearance of the paired legs

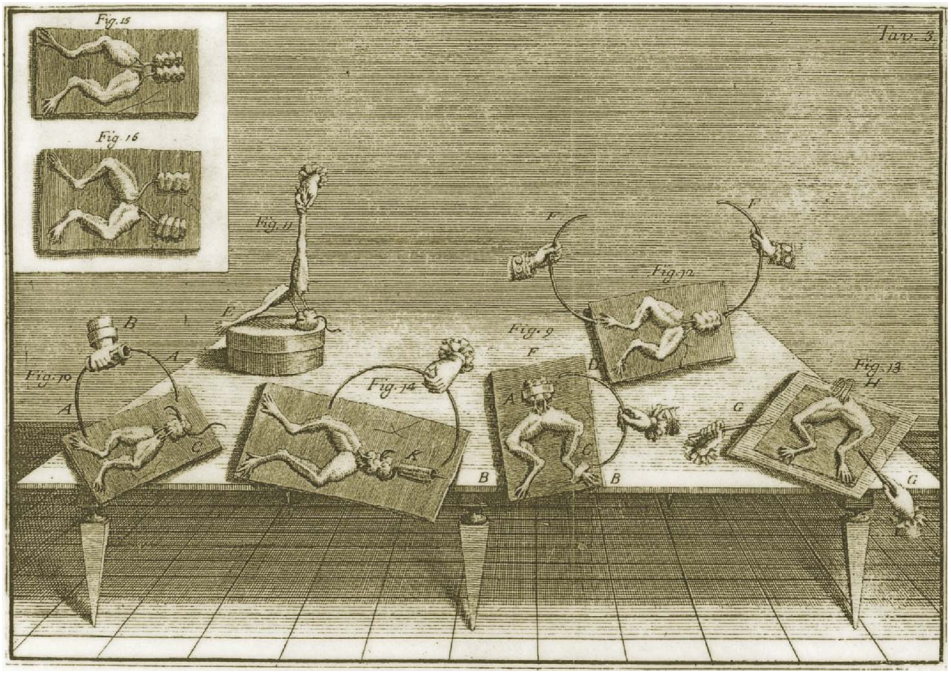


Figure 2. Galvani's (1791) Plate 3 with frogs' legs displayed on a table (color figure available online).

in various locations on the table might suggest such a progressive dance, there is no written evidence that this or any other figures in Galvani's writings, with exposed frog's legs possibly evoking performing dancers, were the source of the "frog's dancing master" attribution.

All that (and much more) was used by Flammarion (Fig. 3) to shake the credulity of readers and to prepare them for acceptance of the possible reality of paranormal phenomena (and the supposedly scientific explanations the author was going to provide). It is at that point that Flammarion inserted his reference to Galvani, which started with another myth, that of *bouillons de grenouilles* (frogs' broth). The Bologna doctor was preparing a broth of frogs for his beloved wife "Lucia Galeozzi" (actually Galeazzi) who was terminally ill with consumption (*se mourant de la poitrine*). According to a spurious tradition, this broth would have been the source of the chance observation, paving the way to the celebrity for Lucia's husband. After having succinctly described some of Galvani's experiments (and an easy method to reproduce them), Flammarion wrote: "L'observation du physicien de Bologne fut accueilli par un immense éclat de rire, à l'exception de quelques savants sérieux qui lui donnèrent l'attention qu'il méritait" (The observation of the physician of Bologna was met with a barrage of laughter, with the exception of some serious scholars who gave him the attention he deserved; Flammarion, n.d., p. 9). He continues with the statement concerning the *maître de danse des grenouilles*.

The fulsome reference to Galvani had a twofold aim in Flammarion's rhetorical strategy: on the one hand to show that, faced with unexpected and surprising phenomena, the genuine scientist does not remain incredulous and impassive but engages in open and active curiosity. On the other hand, Flammarion wished to insinuate the possibility of resuscitation of dead bodies with the image of the poor skinned frogs that seemed to come back to

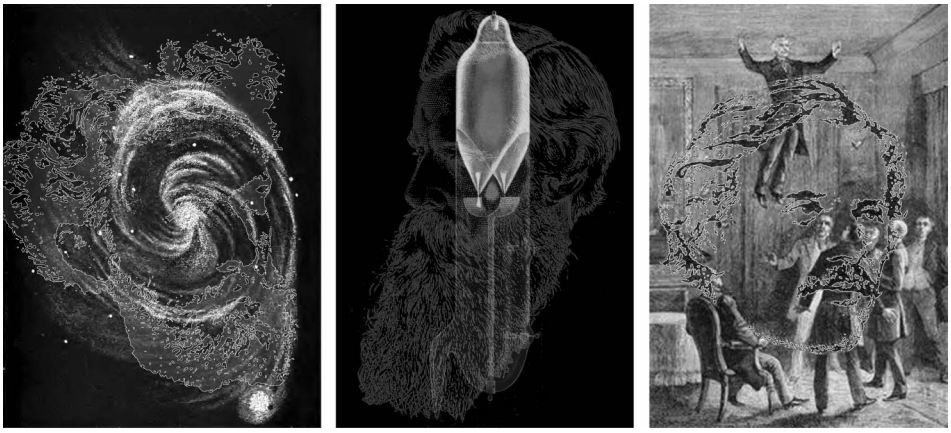


Figure 3. Perceptual portraits of Flammarion, Crookes, and Home. The motif for Camille Flammarion is an illustration of the Hunting Dog nebula from his *Wonders of the Heavens* (Flammarion, 1871). William Crookes is shown in his diagram of the vacuum tube taken from his paper in *Philosophical Transactions* (Crookes, 1879). Daniel Dunglas Home is suspended in air within an illustration of his levitation from Figuier's *Les Mystères de la Science* (1887). (Nicholas Wade)

life under the action of electricity. In this context, it is worth noting that the resuscitating implications of galvanic experiments had been widely used in the past, as for instance in the phantasmagoria of the Belgian physicist and showman, Étienne-Gaspard Robert (1763–1837), more commonly known by the stage name of Robertson. In the intellectual climate of romanticism and *Naturphilosophie* (and following the lead of Paul de Philipsthal, better known as Philidor), Robertson made recourse to the use of magic lanterns in a kind of precinematic performance especially contrived to simulate the appearance of specters or spirits of dead persons. The ghostly atmosphere created by a variety of magic tricks was artfully combined with onstage galvanic experiments on frog preparations in order to inculcate in the public confidence about the possibility of revitalizing dead bodies (Montesperelli, 2002; Warner, 2006).

Flammarion assigned a precise date (1792) to Galvani's supposed statement about the frog's dancing master, leading us to think that it might not be a pure invention of his pen and justifying a possible search for his sources. Without following our meandering search, it soon emerged that the quotation predated Flammarion by at least several decades. Perhaps unsurprisingly, it appeared mainly in texts dealing with occultism and paranormal phenomena. Some of these texts are authored by specialists in the fields or by the pseudoscientific *demi-monde*, but others are the works of highly regarded scientists, sometimes more authoritative than Flammarion himself. Sir William Crookes (1832–1919; Fig. 3), who became President of the Royal Society, is one such example. He was an English physical chemist, now famous for the discovery of the element thallium and for his part in the invention of the cathode-ray tube (Brock, 2008).

Séances

Crookes used, and possibly abused, the quotation regarding the "frog's dancing master" without citing its source although it was parenthetically attributed to Galvani. This strategy

was subsequently adopted by many other writers, like Flammarion, often with a more cavalier approach to accuracy than Crookes. Crookes was using the quotation to support his proposal that feats of the medium, Daniel Dunglas Home (1833–1886; Fig. 3), required a revision of physics to account for them. Home was born in Scotland and brought up in America before moving back to Europe. He conducted séances throughout Europe and established a reputation for defying the laws of nature. He was able to levitate, to make tables move, and to play an accordion without touching it (Home, 1921; Lamont, 2004, 2005). He was one of many nineteenth-century wizards, mediums, and spiritualists who attracted the attention of scientists as well as the population at large. Science had advanced by leaps and bounds in that century and it was as though the spiritualists were providing a counterweight, pointing to the phenomena that were not so easy to account for by the new science. D. D. Home was one of the most famous or notorious of the wizards, and he was examined by the eminent scientist Crookes to determine whether a more mundane explanation of his seemingly spectacular feats could be given. Could it be that the actions of the mediums reflected the operation of forces acting at a distance of the type that the physicists were exploring? Scientific associates anticipated that Crookes would unmask the trickery of Home. Experiments were conducted at Crookes's house in London, and he was accompanied by reliable witnesses. Home was still able to demonstrate seemingly impossible movements of objects and of himself, and the demonstrations were so successful that Crookes considered that they were evidence of a psychic force and Home was described as the first psychic.

Crookes had already discussed some aspects of spiritualism before he examined Home. His first article was published in 1870 in the *Quarterly Journal of Science* that he himself edited. This was followed in the next year by two papers in the same journal dealing with his experiments on Home (Crookes, 1870, 1871a, 1871b). In the first paper of 1871, he wrote: "These experiments appear to conclusively establish the existence of a new force, in some unknown manner connected with the human organisation, which for convenience may be called the Psychic Force" (Crookes, 1871b, p. 471; see also Crookes, 1874, p. 9). The report generated a furor in scientific circles, confirming prejudices either of skepticism about or conviction in the spiritual dimension. In English scientific circles, Crookes' attitude represented an important change in mindset compared to the strong skeptical attitude held some decades earlier by scientists of the caliber of Michael Faraday. Faraday had also made some personal experiments on paranormal phenomena. In one of his famous lectures at the Royal Institution, delivered in the presence of Prince Albert in 1854, he attributed these phenomena to the gullibility and deception of judgement, insisting on the easy way people might be induced to error both because of the fallacy of senses or of the difficulty of proper testing (Faraday, 1854). Charles Darwin was drawn into the debate in Crookes' time, and almost took part in one of Home's séances. However, his summary of the affair was most succinct, displaying the scientific esteem in which Crookes was held and the depths to which he had been deceived: "I cannot disbelieve Mr. Crookes's statement, nor can I believe in his result" (Darwin, 1903, p. 443).

Crookes, together with many other scientists, continued to believe in the psychic force and to entertain the existence of forces for which there was no evidence. He adopted the open-minded view of not excluding presently unknown forces to account for phenomena that seemed otherwise inexplicable. He hoped that, like Galvani, he had exposed a force that would transform our understanding of nature. Crookes considered that he had applied all his scientific skepticism to examining Home, and he was left without an explanation of the remarkable demonstrations he witnessed. What Crookes was lacking was an appreciation of the depths of deception that individuals will descend to in order to maintain their

standing. If Crookes had employed another wizard as a witness to Home's phenomenal feats then he might have reserved judgement on the psychic force! In partial historical justification of Crookes and other leading scientists who believed in paranormal phenomena (like Oliver Lodge, 1851–1940), it should be noted that at that time James Clerk Maxwell (1831–1879) and Heinrich Hertz (1857–1894) were providing theoretical and experimental evidence of the transmission via electromagnetic waves, a phenomenon that might have appeared akin to the transmission of a psychical force. On the other hand, it is also worth noting that Crookes and Lodge (as well as Conan Doyle) had suffered great personal losses and could have seen spiritualism and contact with the recently deceased as a means of assuaging their grief.

Crookes used the quotation about Galvani and the frog's dancing-master as an opening quotation in the second of his 1871 articles without specifying the origin, other than being by Galvani (Crookes, 1871b, p. 471). It could have been created by Crookes or copied from a previous source. In our investigation of possible antecedents, we have not been able to identify an older text where the statement appears fully in the form used by Crookes. As almost always happens with famous quotations, it is possible to trace sources from which Crookes (or a predecessor) might have derived important inspiration.

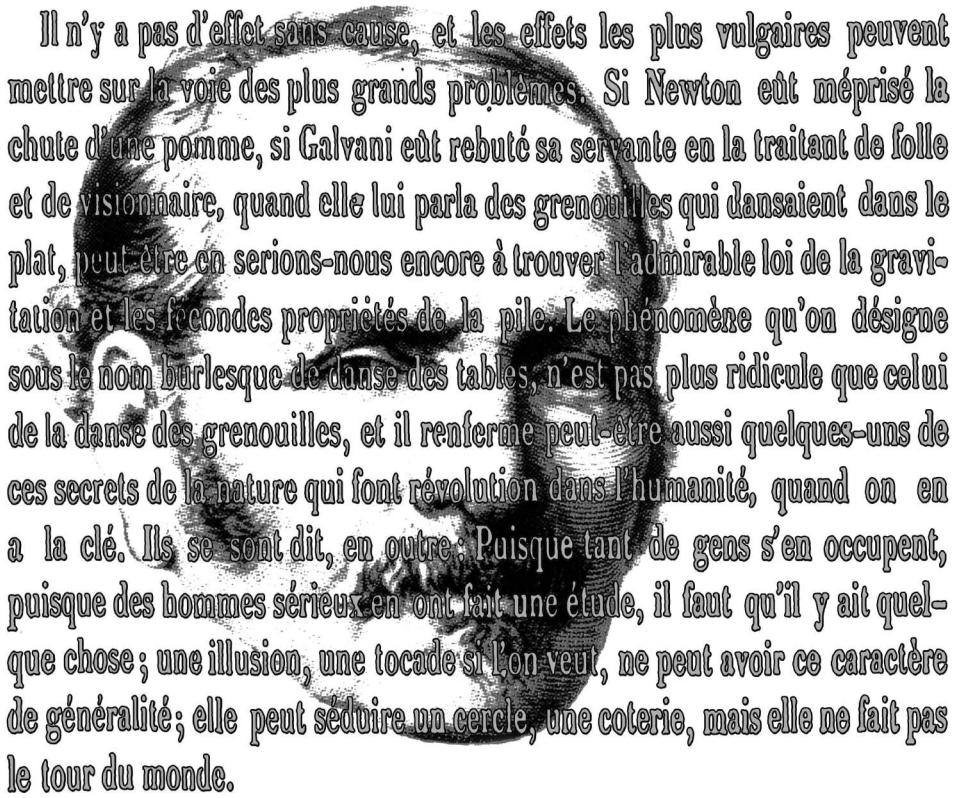
Spiritualism and *Tables Tournantes*

We find similar themes, and also somewhat similar wordings, in the texts of one of the fathers of spiritualism, Allan Kardec (1804–1869; Fig. 4), the *spiritistic* pseudonym of Hippolyte Léon Denizard Rivail, who is considered to be the founder of spiritualism. Among Kardec's feats is the publication of the *Revue Spirite*, the (still active) official journal of the *Conseil Spirite International*. With rhetorical skill worthy of Flammarion, Kardec quoted Galvani (placing him next to Newton) as an example of the positive consequences of scientific curiosity stimulated in great minds by events that leave less perceptive people unmoved. Here is what Kardec wrote in 1859, in an article first published in the *Revue Spirite* (and printed in a different form in the same year in a volume entitled: *Qu'est-ce que le spiritisme*? and many times reproduced afterwards); The French version is shown in Figure 4 and the English version is:

> If Newton had disregarded the fall of an apple, if Galvani had dismissed his servant as a lunatic and dreamer when he told him about the frogs that danced on the plate, perhaps we should not have discovered the wonderful law of universal gravitation and the numerous properties of the electric battery. The phenomena sarcastically labeled as the "dance of the tables" is no more ridiculous than the "dance of the frogs," and it too perhaps contains those secrets of nature that will *revolutionize humankind* once it possesses the key. (Kardec, 2010, p. 78)

Here the *danse des grenouilles* is put together with *danse des tables*, and one of the phrases used in a somewhat derogatory manner to indicate the movement of tables during spiritualist séances. Those *tables tournantes* about which Kardec would say (with explicit reference to Galileo): "et pourtant elles se meuvent!" (but they do move).

Together with the evocation of dead persons and resuscitation, the *tables tournantes* and their related phenomena (various movements including levitation, production of sounds by which spirits try to communicate) were one of the most debated themes in the field of spiritualism in the mid-nineteenth century. Reference to Galvani and his experiments was



Il n'y a pas d'effet sans cause, et les effets les plus vulgaires peuvent mettre sur la voie des plus grands problèmes. Si Newton eût méprisé la chute d'une pomme, si Galvani eût rebuté sa servante en la traitant de folle et de visionnaire, quand elle lui parla des grenouilles qui dansaient dans le plat, peut-être en serions-nous encore à trouver l'admirable loi de la gravitation et les fécondes propriétés de la pile. Le phénomène qu'on désigne sous le nom burlesque de danse des tables, n'est pas plus ridicule que celui de la danse des grenouilles, et il renferme peut-être aussi quelques-uns de ces secrets de la nature qui font révolution dans l'humanité, quand on en a la clé. Ils se sont dit, en outre : Puisque tant de gens s'en occupent, puisque des hommes sérieux en ont fait une étude, il faut qu'il y ait quelque chose ; une illusion, une tocade si l'on veut, ne peut avoir ce caractère de généralité ; elle peut séduire un cercle, une coterie, mais elle ne fait pas le tour du monde.

Figure 4. The text from the 1859 *Revue Spirite* (p. 151) where Kardec mentions the *dance des grenouilles* and the *danse des tables*, together with his portrait. (Nicholas Wade)

made in this context not only with relation to the metaphorical assimilation of the table movement to the frog's dance but also with regard to the motif of the incredulity toward new phenomena. There were other dimensions pertaining more closely to Galvani's theory of nerve conduction and muscle contraction as being due to the agency of an electric fluid accumulated within muscle fibers as in a Leyden jar. This fluid that Galvani called "animal electricity" was afterwards referred to more commonly as galvanism, a term also used to designate the electric fluid involved in the action of the electric battery presented to the public by Alessandro Volta (1745–1827) in 1800.

Far from being due to supernatural agencies, the phenomena of the *tables tournantes* could be due to a similar fluid, appropriately directed by the will, acting by direct contact or of by diffusion at a distance. This was particularly the case for individuals endowed with strong psychic powers and capable of controlling the course and emission of this fluid. Here is how the matter was put by Count Agénor de Gasparin (1810–1871), a French born writer, politician, and protestant theologian, who in 1854 wrote a book of about 600 pages on the *Les Tables Tournantes, du Surnaturel en Général et des Esprits* (translated into English in 1857):

> Let us suppose a fluid to be emitted by the experimenters, and principally by some particular one of them; let us suppose that this fluid has a motion, will not rotation result from it? Let us further suppose that this fluid takes the direction

> communicated to it by the will, and that it accumulates in the vicinity of the foot to which the order is addressed, will not the foot rise? Let us suppose that the fluid shrinks from contact with the glass, will not the motion cease when the glass is placed on the centre of the table? And in a case where the glass is nearer one edge than the other, will not the fluid flow back towards the opposite extremity so as to raise it immediately? I do not affirm that this is really so. I say that it may be so, without miracle and without sorcery. Galvanism, which has nothing of the miraculous, gives motion to dead bodies. I do not see why it should be absurd to suppose that another agent should give motion to a bit of wood. (Gasparin, 1857, p. 187)

In another passage of the same volume, besides invoking the image of the Leyden jar (a key element in Galvani's model of animal electricity), Gasparin likened the chain of people around the table participating in the séance to an electric battery, capable of reinforcing the action of the neuroelectric fluid produced by every individual and thus produce the surprising phenomena of the tables:

> And indeed, if we begin at the end, that is to say, with the phenomenon of Turning Tables, we shall find that by application of the theory of the nervous fluid, their various motions cease to be miraculous or diabolical. If my brain, acting like a Leyden jar, emits and directs a fluid current along my nerves, if this fluid is also emitted by the other member of the chain, it is evident that our combined action will soon form a sort of electric battery, the influence of which will be felt conformably to our thought; we shall communicate a rotation, we shall produce, even at a distance, energetic elevations. (Gasparin, 1857, p. 430)

By invoking a particular fluid analogous to galvanism or nervous fluid, Gasparin attempts to provide — as Flammarion would do later — a scientific explanation of the paranormal phenomena, out of any miraculous, evil, or magic interpretations. Even more than his successor, Gasparin makes a clear distinction between the true Biblical miracles (as for instance Lazarus's resuscitation that he openly admits) and the apparently reanimating action of electricity on galvanic frogs. To these last events, he assimilates the various phenomena of the séances. Even more than Kardec and Flammarion, Gasparin played on the theme of the need for scientists to consider the possible veridicality of unexpected and apparently inexplicable happenings and to extend the horizons of the scientific forces supposed to underlie the various manifestation of animate or inanimate nature. He emphatically declared that soon there would be recognition of the new facts of spiritualism as had already occurred to the great discoveries of science and technology.

> Let men of science to be reassured. The point in question is not that of escaping from the order of natural facts, but of introducing therein a new fact, which appears impossible because it is new. All new facts have an odor of magic. Wait awhile and the academies will make room for this, and once located it will seem to us the amplest in the world, as simple as the connection within us of thought and extent, as simple as the return into the ground of the magnetic current of our telegraphs, their circuit being thus completed in a manner utterly inconceivable, as simple as the circulation of the blood, declared impossible and anti-scientific at the time it was announced. (Gasparin, 1857, p. 187)

Against the stubborn incredulity of some prominent exponents of the academic science on the two sides of the English Channel (he cited Michael Faraday in England and Jean Foucauld in France), with an able rhetoric, Gasparin applied to the official scientific community the accusation of intolerance, once attributed to the religious inquisitors:

> Let us take care, the representatives of the exact sciences incur the risk of becoming, as far as is possible at the present day, the inquisitors of our time. [. . .] Absolute authority is intoxicating, and our men of science exercise an absolute authority. If they allow themselves to abuse it, if, persuaded that they possess the only real explanation of the visible world, they shall refuse to examine the new facts that seem not to be covered by this explanation, they will peril their legitimate authority. Facts are stronger than Academies. Repulsed, denied, mocked, they none the less subsist and it is with inexorable obstinacy that they demand their place in the clear light of the sun. They are not to be arrested by opposing to them motions not to receive, prejudiced decisions, or derisive refutations. (Gasparin, 1857, p. 188)

There is little doubt that, for the incisive rhetoric and the arguments he raised in support of an acceptance of spiritualist phenomena, Gasparin represented an antecedent and an inspirer of many subsequent authors. No surprise then that his work is amply quoted by Crookes and Flammarion. We can safely conclude that, in this particular respect, the French aristocrat has historically contributed to the emergence of the Frog's-Dance-Master quotation. There is no evidence, however, that Gasparin is involved in the main part of the myth, that is, that specifically concerning the theme of the dancing frogs. This is because in his writings he never speaks of frogs or dance in the context of galvanic experiments or spiritualism.

Nonetheless, we should not conclude that the frog's dance derived from the pen of Kardec, the founder of spiritualism. The expression appeared in previous texts, like *El Dorado ou les affiches — Lettre d'un provincial*, published in 1813 by Jacques-Barthélemy Salgues. Salgues left his village for Paris where he became strongly attracted by modernity. Among hot air balloons and other wonders of science and technology, Galvani's experiments interested him most. He used an expression that brings us to our theme of dancing frogs: "Le galvanisme occupe surtout mes loisirs; tous les matins je m'amuse à faire danser des grenouilles ; j'ai appris à des têtes de veau à me regarder quand je les mange, et à des langues de boeuf à remuer sur mon assiette" (Galvanism occupies much of my leisure time; every morning I amuse myself by making the frogs dance; I have trained the heads of calves to look at me when I am eating them, and the tongues of beef to move on my plate; Salgues, 1813, p. 57). A passage in which there is an implicit reference to the macabre experiments made in London by Galvani's nephew, Giovanni Aldini (1762–1834), not only on the calf heads but also on the heads and torsos of executed criminals. As is well known, Aldini's experiments provided inspiration for Mary Shelley's *Frankenstein*.

Could we then say that Salgues initiated the dancing frogs expression (although only as a metaphor, without any apocryphal connotation)? Not even that is justified. This is because, in *Monsieur de Roberville* by Charles Pigault-Lebrun, a pamphlet first published in 1809 (reedited many times since and is available today as an eBook for tablets and smartphones), we find our macabre frog's dance. Vignol, a creative inventor is met by the protagonist of the narrative during his adventures; he had just failed in his attempt to transform ordinary wines in *grand cru* vintages. Nevertheless, he did not accept defeat and looked forward to another marvellous invention. With this aim, he accumulated metallic plates in his shop.

Robertville asked him what value the metal had. Vignol answered: "Faire danser les morts. — Oh, voici bien une autre histoire! — Je suis déjà parvenu à faire danser le train de derrière d'une grenouille, et je compte, très- incessamment, faire danser des apoplectiques, des paralytiques, des noyés, des asphyxiés . . . Un bal! un bal! Cela se nommera *galvanisme* " (To make the dead dance. — Oh, this really is a different story! — I have already succeeded in making the backside of a frog dance, and I expect very soon to make the apoplectic, the paralyzed, the drowned and the asphyxiated dance . . . . A dance! A dance! This will be called *galvanisme*; Pigault-Lebrun, 1818, p. 185).

It is possible that Pigault-Lebrun was the first to associate the theme of the dance to Galvani's experiments. Although the matter is still unsettled, with him we are temporally ascending up to the two main sources of the unsupported stereotypes and myths of Galvani. These are the short *Éloge historique de Louis Galvani* (published by Jean-Louis Alibert, between 1801 and 1802) and the prolix *Histoire du Galvanisme* published in four volumes by Pierre Sue between 1802 and 1805. It is in these works — among others — that the story of the frog *bouillon* prepared by Galvani for his wife appeared. There is, however, no mention whatsoever of dancing frogs in either Alibert or Sue.

The Frog's Bouillons

It is of interest to trace the evolution of the story of the galvanic bouillon since its appearance in Alibert and its immediate repetition in Sue. It shows how the transmission of unsupported stories or rhetorical fictions created by writers, historians, or scientists can be similar to the spread of gossip. In both cases, credulity and superficiality (or other even less noble attitudes) have the effect that, as the story is handed down to the next chain in the line of transmission, it is usually modified or enriched with new, imaginative elements. Seen from another perspective, the transmission of stories like those of Galvani's healthy broth and dancing frogs can be considered as a factual demonstration of spread and persistence of ideas or attitudes, envisioned by Richard Dawkins with his "meme" theory, as analogous to the spread and persistence of a "selfish gene" along natural evolution (Dawkins, 1976).

At its origin in Alibert, the notice on the frog's broth was given in a footnote and appeared in the plural form of *bouillons*:

> On rapporte qu'à cette époque l'épouse de Galvani prenoit des bouillons de grenouilles pour le rétablissement de sa santé, qui étoit très-foible. Son mari qui, comme nous l'avons dit, l'aimoit avec passion, s'occupoit lui- même du soin de les lui préparer. Cet événement particulier donna lieu au premier phénomène qui conduit au Galvanisme. Combien d'autres découvertes n'ont pas été pareillement due qu'au hasard! (People say that at this time Galvani's wife took the frog's broth in order to recover her health, which was very poor. Her husband, as we have already said, loved her passionately, and prepared the broth with his own hands. This particular event was the basis of the first phenomena that led to Galvanism. How many other discoveries are similarly due to chance! (Alibert, 1801/1802, pp. 219–220)

Note that here the broth was for Galvani's wife, who was supposed to be "very weak," and it was being prepared by the doctor himself. This could account for the fact that, by manipulating the frogs' legs, Galvani might have made the chance observation that would lead him to his path of discovery. In the case of Sue, the references to *bouillons* were even

more succinct: there was neither indication of who had prepared the frogs nor for whom the broth was made.

More than a century later, in 1908, along this evolutionary line we find, in a French technical magazine on electricity (*L'Électricien*), an interesting variation that unexpectedly brings us back to the theme of the dance. Here we discover that the reason why a Bologna lady (in this version not explicitly Galvani's wife) was treated with the broth was that she had got the flu possibly from an excess of dancing: "une dame de Bologne se trouvant légèrement enrhumée (peut-être à la suite d'un bal) alla trouver un célèbre médecin de cette ville, Galvani, qui lui ordonna un bouillon de grenouilles comme tisane émolliente" (A Bolognese lady who caught a slight chill [perhaps following dancing at a ball] went to the doctor of this city, Galvani, who gave her frogs broth as an emollient infusion; Anon, 1908, p. 57). As soon as the theme of the ball is evoked, the creative fantasy of the compiler of this succinct history of electricity becomes suddenly unrestrained. The consequence is a description of what is supposed to happen to the frogs of the bouillon as soon as they undergo the effect of electricity: "La décharge d'une machine électrique placée à proximité fit exécuter aux défuntes grenouilles des entrechats et des jetés-battus à rendre jalouse une étoile du corps de ballet de l'Opéra. Le même phénomène se produisit lorsqu'on suspendit ces grenouilles avec un file de cuivre à un balcon de fer" (The discharge of an electrical machine placed in close proximity caused the poor frogs to execute entrechants and jetés-battus that would make a star of the ballet corps of the opera jealous. The same phenomenon was produced when the frogs were suspended with copper wire from an iron railing; Anon, 1908, p. 58).

The allusion to the frog's legs that contract after being suspended by copper wires from an iron balcony has to do with an important experiment made by Galvani (Fig. 5) in his electrical research. This experiment was of decisive importance leading him to conceive the existence of intrinsic animal electricity as a property of the excitable fibers. At the beginning of his experiments on frogs, Galvani studied the effect of external electricity (both the artificial type produced by electric machines and the natural variety associated with thunder storms) and noticed the extreme sensitivity of the frog preparation to electrical stimuli.

It was after about six years (in 1786) that he happened to perform experiments where frog preparations contracted without any apparent source of external electricity. These experiments are narrated in the third part of the memoir published in 1791 in the *Commentaries* of the Bologna Science Institute (Galvani, 1791). They were initially based on the chance observation of the contractions elicited in the frogs suspended from the iron railing of a balcony when the copper hooks used to hang the preparations touched the iron of the balcony. What Galvani says that he was investigating is the possible stimulating action of the atmospheric electricity on a calm day. Nothing happened until he started touching the preparations provoking the closure of the electric circuit between nerves and muscle tissue through the metals (Piccolino, 1998; Piccolino & Bresadola, 2003, 2012; Bresadola, 2011).

In Alibert and Sue, the narrative of Galvani's endeavor is totally extraneous to the mention of the *bouillons de grenouilles*. However, along the transmission line of these stories (or myths), some variations occur. The frogs of the suspended preparations start to be identified with those used to prepare the famous bouillon (or bouillons). The metallic support could be the railings of the balcony or the metallic frame of a window (or whatever). The actor in the scene could be Galvani himself, his wife, or a servant of the house. In some of the versions, the person suspending the frog's legs is the one who moved and provoked the contact leading to the contractions. In others, it was the wind that induced

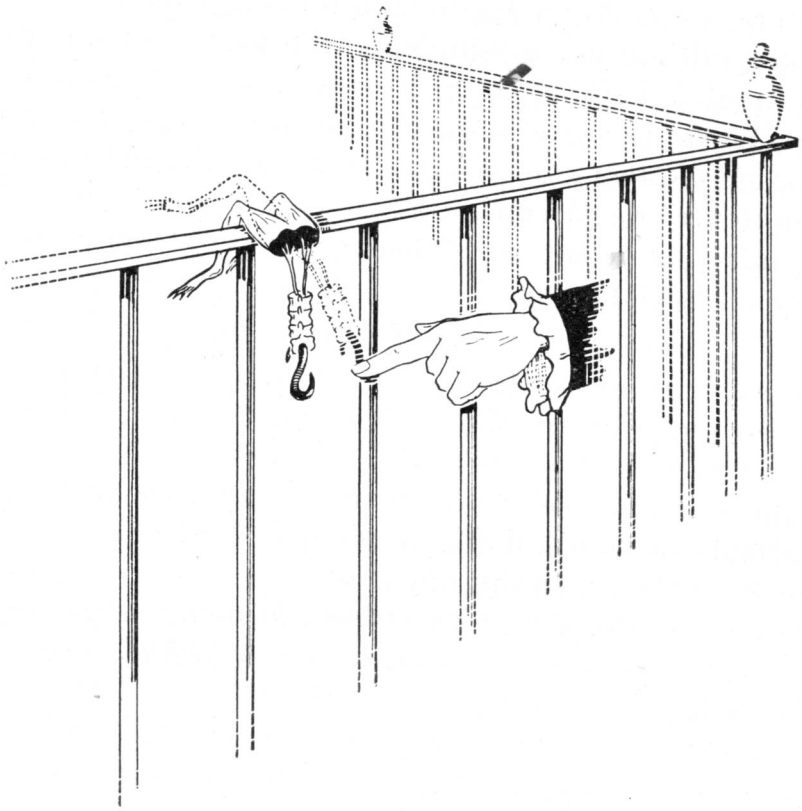


Figure 5. An illustration from Sirol (1939) of Galvani's hooked frog preparations draped over metal railings.

the chance movement leading to the circuit closure and to contractions. No one speculated about the necessity of suspending pieces of frogs outside before preparing them for the beneficial broth. Eventually the relation between the broth and the suspended frogs got lost and the preparations that will happen to contract were simply hanging to be dried, with apparently no purpose. This is what we find in recent *Dictionary of Scientists* published in English between 1994 and 2000 by important publishing houses (Larousse, Cambridge University Press, Helicon; Muir, 1994; Millar, 1996; Daintith & Gjertsen, 1999; Porter & Bailey Ogilvie, 2000). Together with the frog dance, these and other unsupported stories can be found slavishly repeated not only in encyclopedias and popular science publications but also in more scientific treatises (Robinson, 1943; Dubin, 2000). It might be the case that this attitude has had a beneficial influence on the vision of science by laymen. They could possibly assist shaping the image of the history of science in a more human or "romantic" way.

There are works, like poems and novels, where the accuracy of the narrated stories is not of primary importance and others, like those pertaining to science (to its history and to history in general) where the accuracy of information and linguistic precision are strict requirements. However, science should not be like creative writing or journalism and follow the maxim that when the myth is better known than the truth then publish the myth. Considered in another way, we could ask ourselves if it was really necessary, in order

to make science seem more interesting, to speak of the dancing frogs in Galvani's case. We would take the contrary view. This is because the doctor of Bologna certainly did not lack some humor in the description of his experiments. For instance, he speaks of frog's legs that seem "to hop" (*saltellare*) at the sudden closure of the electric circuit between nerves and muscles (Galvani, 1967, p. 165) or when stimulated by the electricity of a torpedo (Galvani, 1797, p. 75). With reference to his experiment using frogs to detect the electricity of this fish, Galvani annotated in his pocketbook: "it was for me a joyful performance (*spettacolo*) to see all of them moving at once, and I would say hopping together" (Galvani, 1797, p. 75; Galvani, 1937). Here is Galvani's account of the experiments in which the circuit between the muscle and the nerve of a frog preparation was closed by advancing the leg to a metallic surface:

> As soon this leg touches the surface, the muscle suddenly contracts, and the leg stirs and moves up; soon afterwards, by relaxing spontaneously and falling down, the leg, as soon as it touches the surface, for the same reason moves up. And so on at any new contact, it continues to alternatively move up and fall down. It seems thus — to the wonder and amusement of the observers — that this leg behaves as a kind of electric pendulum. (Galvani, 1791, p. 380)

An actual occurrence, like that of the electric pendulum, should be as stimulating as that of the dancing frogs of the apocryphal quotation. This is similar to the image of the "electric carillon" evoked in relation to another important experiment: through appropriate manipulations, Galvani was able to obtain the contractions with the direct contact between nerve and muscle tissues, in the absence of any metallic conductor. The scene was described by Galvani in a work published anonymously in 1794 with these words: "One would see the muscle contractions, and the leg moving up as soon the contact is established between the spinal cord and the muscle surface, and often to make as a kind of electric, animal *carillon*, totally similar to that described by Galvani in his *Commentary*" (see Gherardi, 1841, p. 241).

Conclusion

The story we relate is not concerned with myths that arose from an inadequate understanding of phenomena or from willful championing of partisan positions. Rather, our interest was in myths of attribution that are repeated even in the face of evidence that should prevent their perpetuation. One of the functions of those who examine history of science is to identify the myths with the hope that they will be dispelled. Thus, this cautionary tale should not be considered as an historical oddity. The false quotation attributed to Galvani might not seem of great scientific importance but it poses a general problem about the propagation of scientific information that highlights its social dimensions. The same can be said about the psychic expeditions of Crookes, Flammarion, and their like-minded colleagues: Science cannot be pursued without regard to the cognitive dimensions of human motivation, be these in the search for truth or the subtleties of deception. Whether the myths were intentionally manufactured or reflected shoddy scholarship they will live on if they serve the purposes of the relaters rather than the supposed originator. Psychological experiments have established that once erroneous information has been communicated it is rarely removed by corrections (Wilkes, 1997). The quotation attributed to Galvani has been and

is still used by those whose ideas seem unbelievable to their contemporaries. The Internet provides an ideal spawning ground for magnifying misinformation.

A similar travesty applied to the interpretation of a pair of drawings by a compatriot of Galvani, but one living two centuries earlier. This was Jacopo Chimenti (1551–1640) who made two sketches that were mischievously considered to have been intended for a stereoscope (see Wade, 2003). The initial misattribution is repeated to this day, and it seems impervious to the impressive weight of contrary evidence. It is a consequence of associating theories with their protagonists and continues to be a feature of the scientific enterprise. In this regard, it is appropriate to quote the editor of the *British Journal of Photography*, George Shadbolt, in August 1860, when the Chimenti controversy was in its infancy:

> It is very unfortunate that when an announcement of any supposed fact is once made, and subsequently proved to be erroneous, it is almost impossible to correct the false impression as thoroughly as is desirable, because there must always exist many persons who read the assertion but not the contradiction, while those who see the contradiction without the previous erroneous statement can play but a very unimportant part in its rectification. (Shadbolt, 1860, p. 232)

This leads to the depressing conclusion that Galvani's frogs will continue to dance to tunes composed by others. In addition to the dancing frogs, in the apocryphal quotation there is mention of forces of nature, too. One could then wonder if Galvani (the true one) really spoke of forces in his writings. It is surely so, and in the Latin form the word "forces" appears in the title itself of Galvani's main work, the Commentary on *De viribus electricitatis in motu musculari*, published in 1791. He also spoke of spirits. It is indeed with the reference to the conception of spirits that, with Galvani's experiments, classical science made a leap from Galenic physiology toward modernity. As the sagacious reader has undoubtedly appreciated, Galvani's spirits had nothing to do with those of Kardec, Crookes, or Flammarion.

A final comment concerning the role of chance in Galvani's discoveries may be appropriate here. As a matter of fact, chance has indeed played importantly in Galvani's achievements, to such an extent that he himself stressed its importance at the beginning of the description of his results in his *Commentary*. Here he wrote that he had put a prepared frog on a table where there was an electric machine. He says that he had done that *omnia mihi alia proponens* (with a totally different purpose; Galvani, 1791, p. 364). One of his collaborators touched the crural nerves of the frog with a lancet and suddenly noticed very strong contractions in the frog's legs. Another told him that the contractions seemed to happen just at the moment that a spark was produced from the discharge of the electric machine. This machine was located rather far away from the frog. Galvani remarked again on the role of chance by saying that all that had happened while he was thinking about totally different matters and reflecting to himself (*alia omnino molientem*, *ac mecum ipso cogitantem*). Then he added: "I was then inflamed by an incredible ardour and by the desire to experience it and to put in the light what was hidden in the thing" (*Hic ego incredibili sum studio, & cupiditate incensus idem experiundi, & quod occultum in re esset in lucem proferendi*; Galvani, 1791, p. 364).

There is certainly a role for chance in this scene at the beginning of Galvani's masterpiece and there is also an evident representation of the scientist who became excited by the sight of a new phenomenon. We must, notice, however, that in Galvani's home there was an electrical laboratory, and there were around him several collaborators involved in

electrical experiments on frogs, with various instruments for animal dissection. We know, moreover, that at the moment of the chance observation described at the beginning of the *Commentary*, he had been actively pursuing these electrical experiments from more than two months (from his laboratory protocols we know that the spark experiment was carried out on January 17, 1781, while the first extant protocol is dated November 6, 1780). If chance had a role in Galvani's discovery, it was then the kind of chance that is presented to a prepared mind, in a suitable context, pursuing a particular investigation, and certainly not simply that encountered by a practitioner who happens to prepare a frog's broth for his wife or for a lady coming from a ball.

Galvani will probably remain the "frog's dancing master" and the fortuitous brew of frog bouillons will continue to fill popular science books, but the reality was certainly different. What makes this myth particularly poignant is that one of us was considered to have been involved in its propagation!

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