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The Battery as a Tool of Genius in the Work of Humphry Davy

English chemist Humphry Davy (1778-1829) began his researches with Volta's battery in June of 1800. He was 21 years old, brimming with ambition, and eager to delve into this remarkable new discovery. Even at that early stage, the fact that a configuration of two metals and a fluid could generate a continuous stream of electricity struck Davy as highly incongruous with known phenomena. Some day, he suspected, the battery would profoundly transform chemical understanding. It was of course Davy himself who used the battery most effectively in exploring chemical nature. Most notably, Davy established a new science, electrochemistry, in 1806 based on series of brilliant experiments with the battery. In the following year he used the powers of the battery to discover the remarkable new metals, potassium and sodium.

The focus of this paper is less upon the details of those great achievements and more upon Davy's own vision of the battery. For Davy, the battery was more than an instrument for extending the researcher's investigative abilities. It was also an instrument which, by virtue of its tremendous and perhaps even infinite electrical powers, required tremendous powers of genius to command and direct. Davy considered himself to be just such a genius.

Davy's sense of his own genius had been shaped through encounters early in his career with the Romantic poets Coleridge, Southey, and Wordsworth. Like Coleridge and Wordsworth, Davy conceived of genius in neoplatonic terms as something "supernaturally infused into the mind, or self-born into it".[1] Davy defined the genius as one whose spark burns brightest, as one possessing copious, even excessive powers, powers "more than he is able to develop".[2] Davy could not agree with the poets, however, that the locus of genius is imagination. For Coleridge and Wordsworth, the genius's highly active powers of imagination provided him with extraordinary capabilities of apprehending the life in nature and of accessing absolute truths pertaining to God, the universe, and the human soul alike. Davy, following British scientific epistemology, could not allow any such subjective

[1] DAVY (1858), p. 115.
[2] DAVY (1839-40), I, p. 15.

access to the truth or any other constitutive role for imagination in science.

Davy devised an image of scientific genius which reinterpreted key elements of Romantic poetic genius to accommodate the sorts of activities he himself engaged in as an experimental philosopher.[3] Whereas Wordsworth wrote of an inborn creative urge, Davy wrote of an inborn striving after knowledge which drives the genius to seek out the fundamental elements and the overarching unity of nature. Whereas genius for Wordsworth could best be cultivated through intimate communion with an almost sentient nature, for Davy it was best cultivated through the pursuit of intellectual and physical mastery over nature especially with the sagacious use of artifice and machinery. Whereas Wordsworth portrayed the poet's life as a heroic journey of mind through psychological challenge and adversity, Davy recast the motif of Romantic quest with the scientific discoverer as hero striving to conquer the uncharted, infinitely diverse territory of nature guided only by intellectual power and skill with experiment. In all, this was the Romantic image of genius as extraordinary personality. In Davy's reinterpretation, however, the genius was a conqueror of nature, a discover of laws, and a commander of instruments.

Davy's statements on the nature of scientific genius can be found throughout his popular lectures, personal notebooks, and metaphysical writings. The very best expression of Davy's vision of genius, however, was his own exploits with the battery. The remainder of this paper examines how Davy deployed the battery as an extension of his own powers of genius in order to delve deeper than anyone before him into the true nature of matter and forces. As we will see, Davy truly was the embodiment of his own ideals of scientific genius.

Davy's researches with the battery can be fully understood only in the light of his deep dissatisfaction with the state of chemical knowledge. Davy did initially accept most tenets of Lavoisier's chemical system including his theories of acids, combustion and calcination, and he approved of Lavoisier's overall rationalization of chemistry. Lavoisier's system, however, neglected active powers and essentially dismissed any inquiry into the true chemical elements.[4] Davy believed that once chemists had identified and investigated that most simple, universal matter and its associated attractive and repulsive powers that the true classification, logic, and quantification of chemistry would soon follow.[5] This ideal for chemistry, Davy admitted, was far off. The battery, however, seemed to present a key for unlocking the mysteries which would someday make this ideal realizable.

In 1806 Davy began to forcibly address these issues. In that year Davy presented to the Royal Society his remarkable Bakerian lecture which essentially established the science of electrochemistry.[6] Davy can only touch on the diverse researches

[3] SHARROCK (1961).
[4] LAVOISIER (1790), p. XXIV.
[5] DAVY manuscripts, ca. 1802, 20a, pp. 91-2.
[6] DAVY (1839-40), V, pp. 1-56.

behind this lecture in this paper. Suffice to say, at a time when electricity and chemical affinity were understood in terms of a plethora of disjointed empirical data and speculations about subtle fluids or Newtonian forces, Davy's achievement was to perform extensive series of experiments to empirically and inductively establish, as best he could, correlations between electrical and chemical phenomena. Perhaps most strikingly, Davy performed extensive research on decomposition and transfer (or electrolysis) using the voltaic electricity of the battery in order to examine the competing actions of chemical affinity and voltaic attraction. Using an ingenious apparatus Davy was able to better determine at what point a substance actually broke apart in response to the forces emanating from the poles of the battery and then trace the transfer of its components to either pole of the battery.[7] Based on these experiments and an array of other findings, Davy offered theories of the battery's operation and of voltaic decomposition.[8] He also put forth his famous suggestion that electricity and chemical affinity are identical.[9] Davy was not the first to suggest this identity. What so astonished his audience was the strong experimental foundation he gave to this claim and the logic by which he tied his empirical researches together.

In November 1807 Davy stunned the scientific world again with his second Bakerian lecture to the Royal Society.[10] In this lecture, the promise of his 1806 Bakerian lecture was realized. In 1806, Davy had established that the powers of the battery, in decomposing water, did not at the same time somehow generate new chemical substances.[11] With this conclusive demonstration, the battery became a reliable instrument of chemical analysis. Davy put the battery's analyzing powers to the test on the fixed alkalies, potash and soda. Chemists had long suspected that the fixed alkalies as well as the various earths were compound substances even though those substances had always resisted analysis. Davy encountered considerable difficulties in trying to decompose potash with the electricity of the battery. It was only after connecting slightly moistened potash with the battery that the potash fused and then decomposed into oxygen at one pole of the battery and a metallic "peculiar inflammable principle" at the other.[12] After exploring the chemical and physical properties of this extremely reactive basis of potash (and likewise of the basis of soda) Davy concluded that, despite its unusually low specific gravity, it is rightfully classed among the metals. He named the new substances potassium and sodium.

Davy's achievement was spectacular on several counts. He had discovered two

[7] *Ibid.*, pp. 20-31.
[8] For the most detailed account of these researches see RUSSELL (1959). See also KNIGHT (1978); LEVERE (1971); ZIEMACKI (1975).
[9] DAVY (1839-40), V, p. 40.
[10] *Ibid.*, pp. 57-101.
[11] *Ibid.*, pp. 2-12.
[12] *Ibid.*, p. 61.

highly unusual metals and, perhaps more importantly, had made those discoveries using the voltaic battery. The analytic powers of the battery had been originally demonstrated in 1800 by Nicholson and Carlisle on water. Now Davy had transformed the battery into an instrument of discovery. Never before had such powers of analysis and discovery been available to the chemist. Potassium and sodium stood as a testament to the potential profundity of the new knowledge generated by the battery. The new metals themselves were striking enough with their low specific gravity and exceptional reactivity. That the fixed alkalies proved to be metallic oxides was equally surprising. Most chemists, including Davy, had expected that the fixed alkalis were composed of hydrogen and nitrogen in analogy to another alkali, ammonia.[13] Even more puzzling, oxygen, which had been designated the principle of acidity by Lavoisier, was a component in two of the strongest alkalies known.

In Davy's eyes, the newly-discovered metals and the promise of even profounder discoveries threw all of chemistry into question. After announcing his findings on potash and soda, Davy outlined his sense of where chemistry was headed.[14] Oxygen seemed to be an even more fundamental substance than Lavoisier had ever realized. Not only was oxygen apparently a component of acids and alkalis alike but, based on his experiences of manipulating and analyzing matter with the battery, oxygen seemed to be present in the negative component of all chemical compounds.[15] Chemical analogy, or the assumption that similar chemical compounds contain similar components, also suggested a bigger role for oxygen. The earths, as long expected from analogy with known metallic oxides, would probably be proven by voltaic analysis to be metallic oxides. Chemical analogy suggested that the alkaline earths, like the fixed alkalies, would reveal themselves to be highly combustible metallic substances when combined with oxygen. Davy noted a "chain of resemblances" among the earths hinting at a series or order among the metals themselves.[16] Perhaps, he suggested in a footnote, the phlogistic hypothesis is true and metals will be shown to be compounds of unknown bases with hydrogen or some phlogiston-like component of hydrogen.[17] Even seemingly well-established facts fell into question. Ammonia, which had long been assumed a compound of nitrogen and hydrogen, might actually contain a small quantity of oxygen in analogy to the oxygen in the fixed alkalies.

This plethora of hypotheses in the 1807 Bakerian lecture contained the seeds of his experimental program of the next several years. Davy had already submitted ammonia to the pile and confirmed (erroneously) his hypothesis that it contained

[13] *Ibid.*, p. 99.
[14] *Ibid.*, pp. 89-101.
[15] *Ibid.*, p. 100.
[16] *Ibid.*, p. 99.
[17] *Ibid.*, pp. 89-90.

oxygen.[18] The compositions of ammonia and nitrogen were to become central to Davy's research. He was expecting to find some fundamental matter, as yet never discerned, through the analyzing powers of the battery. The battery, so much improved in its power and design in only a few years, was an instrument capable of immense, perhaps infinite, increase in power as more was learned. As the battery's powers increased, so increased its ability to conquer the affinities bonding chemical compounds. Newly-discovered substances such as potassium possessed of exceptionally strong affinities would become in their own right powerful instruments of chemical analysis. Incrementally, the chemist's tools, gained through the establishment of power over nature, would increase in power and allow him to overcome obstacles to knowing Nature's true order. The battery had opened daunting prospects for the chemist of genius and vision. Davy relished such a challenge. "Nature is inexhaustible, her objects are boundless," Davy asserted;

> And we cannot be too grateful for that wonderful constitution of the external universe, by which it is rendered an inexhaustible source of interest to the inexhaustible human mind; by which it is so admirably adapted to keep awake that [...] noble kind of ambition which continually tends to exalt the intellectual being; that flame of life, unquenchable even in the fountains of knowledge.[19]

Infinite as that challenge might be, Davy indicated in 1807 that even the rudimentary discoveries with the battery were pointing to a beautiful order and simplicity in nature. Oxygen and perhaps hydrogen, associated with negative and positive forces, seemed to be fundamental. Or at least the polar powers accompanying them were fundamental. Chemical analogies among the earths and alkalies might reflect a common constituent to be found upon decompounding metals. In any case, the discovery of potassium and sodium had proven the battery able to bring a knowledge of "the true elements of bodies".[20]

Davy's famous electrochemical researches were performed in the laboratories of the Royal Institution (RI) in London where he had secured an appointment as lecturer and chemist in 1801. Davy had conducted his famous decomposition of potash and soda by hooking together three of the RI's batteries.[21] This configuration of over 270 double plates had certainly served him well. Yet these batteries had become seriously depleted from over-use.[22] In May of 1808, the RI provided Davy with a trough battery of 600 six-inch square double plates which, he claimed, was "at least four times more powerful as any that has hitherto been constructed".[23]

[18] *Ibid.*, p. 92.
[19] DAVY manuscripts (1809), 4b7, p. 11; ID. (1839-40), VII, p. 351.
[20] DAVY (1839-40), V, p. 57.
[21] *Ibid.*, pp. 58-9.
[22] *Ibid.*, p. 106.
[23] *Ibid.*, p. 108; *ibid.*, VIII, p. 282.

Davy used the new battery to decompose several of the alkaline earths (barytes, strontites, lime, and magnesia) to discover additional new metals. His researches were less decisive with the earths silex, glucine, zircone, and alumine.[24] Davy also attempted to determine the true nature of a number of substances, most importantly ammonia and nitrogen. As mentioned, in analogy with the fixed alkalies potash and soda Davy inferred that ammonia, the volatile alkali, also must contain oxygen. Davy was not the only chemist to consider this analogy. Gay-Lussac and Thenard in France and Berzelius and Pontin in Sweden also were pursuing this line of questioning. The other half of the analogy between the fixed and volatile alkalies was the metallic component. Berzelius reported to Davy that he and Pontin had succeeded in creating an amalgam of ammonia and mercury.[25] Davy, after performing his own experiments on ammonia and mercury, concluded on the basis of the ability of ammonia to form a metallic amalgam and on analogy with the fixed alkalis, that ammonia is somehow metallic: "It is scarcely possible to conceive that a substance which forms with mercury so perfect an amalgam, would not be metallic in its own nature; and on this idea to assist the discussion concerning it, it may be conveniently termed ammonium".[26]

Davy suspected that ammonium with its loose combination of nitrogen and hydrogen would prove to be the key to understanding the entire class of metals. One finds in his papers a dizzying array of hypotheses involving ammonium and its constituents. Are hydrogen and nitrogen aeriform metals? Or would they become metals upon deoxygenization and alkali upon oxygenation? Is water the ponderable matter of nitrogen, oxygen and hydrogen alike? These were only some of the hypotheses Davy was entertaining based largely upon complicated series of experiments.[27] Davy was not the only chemist to entertain many of these hypotheses.[28] Davy stands apart, however, for the range of his speculations, his ease of shifting quickly from one hypothesis to the next, and his relentless energy in testing hypotheses experimentally.

Davy's questions about ammonium, hydrogen and nitrogen involved the whole of chemistry. He suggested that all the metals form a series starting with platina, the purest and most stable metal, then gold, silver, nickel, copper, antimony, arsenic, lead, tin, iron, manganese, zinc, then sodium and potassium, the recently-discovered metals of the earths, then perhaps the metallic bases of substances such as sulphur, phosphorus and nitrogen, and finally ammonium.[29] In this scheme all elemental

[24] *Ibid.*, V, pp. 102-22.
[25] *Ibid.*, pp. 122-3.
[26] *Ibid.*, p. 131.
[27] *Ibid.*, pp. 131, 156-7, 142-52.
[28] Some of these hypotheses had been put forth by chemists such as Priestley and Cavendish in different contexts or by Berzelius in scrutinizing similar results.
[29] DAVY (1839-40), V, pp. 133, 276.

substances in nature, except for pure oxygen, were metallic and combustible. That this series appeared to display a gradation of physical, electrical, and chemical properties was justification, in Davy's eyes, for analogizing from the known properties of one metal to another. Ammonium, at one end of the scale, apparently was a compound containing hydrogen and therefore the other metals must also be compounds of hydrogen.[30] The phlogistic dream of a metallizing principle seemed within reach.[31] Davy was simultaneously considering several alternate schemes including the possibilities that elemental ammonium "by combining with different quantities of water, and in different states of electricity, formed nitrogen, ammonia, atmospherical air, nitrous oxide, nitrous gas, and nitric acid" or, alternately, ammonium combines with increasing proportions of oxygen to produce hydrogen, ammonia and nitrogen.[32] In both of these schemes, ammonium served as a base to a series of combustible substances energized by oxygen.

In all of these researches Davy knew that he was delving into unknown reaches of chemical nature. To decompose nitrogen, to prove the compound nature of metals, or to discover an electropositive substance more fundamental than hydrogen would be to approach the true, elemental nature of matter and to overcome nature's most powerful forces. Alchemists and natural philosophers had long hypothesized about such things. It was only Davy, however, who had through ingenuity, imagination, and dexterity managed to arrest protean nature long enough to witness some of the interplay between matter and force and to cull some of its more elusive substances. In order to fully pursue his speculations and continue his researches, Davy required the very highest voltaic powers possible. Experience with the battery was demonstrating the truth of Newton's supposition that the very simplest compounds are bound by the strongest forces. Nature, Davy told his audience, became more and more refractory the deeper one delved. Davy quickly decided that the battery of 600 double plates was simply inadequate for his researches.

In July of 1808, only two months after the battery of 600 had been completed, Davy put before the managers of the RI a request for a new battery. The electrical battery of Volta, Davy stated, had opened "a new path to discovery" yet in order to fully realize the battery's philosophical promises "the increase of the size of the apparatus is absolutely necessary". Davy had also learned that, under orders from the Emperor Napoleon himself, Gay-Lussac and Thenard were constructing numerous batteries at the Ecole Polytechnique. Davy suggested that the RI managers open a subscription fund for a new battery. The managers immediately agreed and soon placed a book in the steward's office for recording the names of those persons who wished to donate funds towards the enterprise of building the world's largest battery.[33]

[30] *Ibid.*, p. 133.
[31] SIEGFRIED (1964); ZIEMACKI (1975), ch. 7.
[32] DAVY (1839-40), V, pp. 137-8.
[33] PARIS (1831), pp. 199-200.

Davy employed the full force of his rhetorical gifts in lobbying for the battery fund. Like Bacon before him, Davy compared science to the great voyages of discovery with their promises of empire. Electrical phenomena were like an unknown continent, "a country unexplored, but noble and fertile in aspect, a land of promise in philosophy".[34] Like the voyaging mariners, the wielders of batteries would eventually reap "so rich a harvest of discovery" to bring the "greatest improvements in Chemistry and Natural Philosophy, and the useful, arts connected with them" as well as "intellectual power, [...] the true object of intellectual discovery".[35] Eventually, empire could be established over nature, an empire of the human mind more enduring and more exalted than any empire established by military force.[36]

Against the backdrop of the Napoleonic wars, Davy portrayed scientific achievement in nationalistic terms and the battery as the crucial piece of artillery. French rivals in electrochemistry, funded by a blood-thirsty autocrat, were encroaching on what was rightfully a British science. Davy construed the scientific struggle between the British and French in almost mythic terms with the nation's will measured by scientific conquest:

> The scientific glory of a country may be considered, in some measure, as an indication of its innate strengt [...] there is one spirit of enterprise, vigour, and conquest, in science, arts, and arms [...] the same dignified feeling, which urges men to endeavour to gain dominion over nature, will preserve them from the humiliation of slavery.[37]

Behind this remarkable rhetoric lies Davy's own deeply-held aspirations and ideals. Discovery, empire over nature, intellectual power, material progress, national glory – these were key pieces of Davy's personal vision of science. Davy had already proven to the world the battery's capabilities of yielding tremendous new knowledge. Now, in campaigning for funds to build the world's largest battery, Davy portrayed the battery as the source of an entire constellation of powers. Not surprisingly, Davy's audiences responded quickly with donations totaling over £ 1,000.[38] In December 1809 Davy presented the full apparatus, a battery of 2,000 six-inch-square double plates.[39]

The battery was truly emblematic of Davy's science. As Davy later described it, Volta's invention of this apparatus had been an "alarm bell" rousing experimenters across Europe.[40] Even in 1800, Davy recognized that the battery would usher in a new understanding of chemical nature. Over the next decade, Davy transformed the battery into the ultimate tool of Romantic science, a tool for penetrating the

[34] DAVY (1839-40), VIII, pp. 282-3.
[35] PARIS (1831), p. 200; DAVY (1839-40), VIII, p. 361.
[36] DAVY (1839-40), VIII, p. 358.
[37] *Ibid.*, pp. 359-60.
[38] *Ibid.*, V, p. 283.
[39] DAVY (1839-40), VIII, p. 347; DAVY manuscripts (1809), 3a9, pp. 15-16.
[40] DAVY (1839-40), VIII, p. 271.

innermost reaches of matter and in turn for revealing the grand unity of nature. It was the combination of experimental brilliance and searching yet pointed questions which allowed Davy to leap ahead of a legion of competitors.

The contrasts between Lavoisier's use of the scale versus Davy's use of the battery highlight the Romantic aspects of Davy's science. Whereas Lavoisier used his trademark scale to perform highly precise re-executions of mostly well-known reactions and experiments, Davy directed the battery towards exploring the unknown reaches of chemical nature. In Davy's hands the battery became a tool for manipulating nature, slowing it down, and watching its behaviour. Using the unparalleled powers of the battery Davy could pull matter apart to unlock the barriers to its inner recesses so as to reveal some of its fundamental nature and even divulge something of the mysterious forces bonding and moving that matter. To uncover the true elements and powers at the root of all chemical change was the sole route to discovering the true order of nature, an order, Davy assumed, of utter simplicity and beauty which would stand in stark contrast to the artificial, false, and highly unsatisfactory order imposed by Lavoisier. Davy derisively declared Lavoisier an "arranging genius" who had merely "classed the changes" while leaving unknown "the laws by which those changes are governed".[41] Lavoisier's scale, an instrument of balance and precision, seemed to offer only a clearer inventory of known facts. It was a narrow sort of knowledge, diverting attention away from the true business of science.

If Lavoisier's genius was for arranging, Davy's genius is perhaps best characterized as alchemical. Science was for Davy an expression and development of personal power, just as with the alchemists of yore. Davy's work with the battery captures this alchemical underpinning to Davy's science. The power of the battery, although harnessed from nature, was really an extension of the power of genius, an instrument "exalting" his powers and "bringing new natural bodies under the dominion of chemistry".[42] The divine spark of genius, reinforced and extended by the powerful sparks of the battery, was set against the powers of nature. Davy demanded batteries of 600 and then 2000 plates just at those times when he was brimming with ambitious imaginings which were leading him into highly recalcitrant recesses of nature. He required a power which could match both the boldness of his imagination and the as-yet unrelenting powers guarding nature's secrets. It was a contest of power against power. Yet wielding the battery always involved more than brute force. The use of "novel instruments" is "only gradually acquired", Davy stated.[43] The battery and the chemical instruments it provided such as potassium possessed such strong powers that they were exceedingly difficult for the chemist to tame much less direct towards his own ends. Using these powers to

[41] DAVY manuscripts, ca. 1802, 20a, p. 215.
[42] DAVY manuscripts (1808), 2d4, p. 16.
[43] DAVY (1839-40), V, p. 141.

engage with nature required the utmost finesse, responsiveness, and knowledge of both the powers he was seeking to direct and the nature he was seeking to conquer.

Davy used the giant battery to further pursue his inquiries into the nature of nitrogen, ammonium, and other substances.[44] Initially his results seemed to confirm his hypotheses that nitrogen and ammonia both contain oxygen. After numerous series of extremely painstaking experiments, however, his results suggested the oxygen in both cases to be a contaminant. Lack of decisive results also led Davy to conclude that neither nitrogen nor hydrogen is metallic. The anti-phlogistic system of chemistry, he conceded in 1809, remained the best interpretation of chemical nature.[45]

Chemical nature had refused to submit to the powers of Davy's giant battery. Surely it was deeply disappointing for Davy, as well as for his public which had anticipated additional spectacular findings, that the giant battery of the RI had yielded no profound discoveries regarding the nature of metals or a more fundamental matter.[46] One can almost sense in some of Davy's writings just how perplexed and frustrated he felt.[47] Davy did not drop his ideas on nitrogen, ammonia, hydrogen or the metals even though his researches had been unsuccessful. He simply contended that these hypotheses were beyond the powers of existing instruments.[48]

Davy did go on to make additional brilliant discoveries with his giant batteries, most notably his discovery of chlorine. But his hopes for discovering a new phlogiston or a metallizing principle were unrealizable. Davy left the RI in 1812. He continued performing significant researches but only sporadically. After about 1816 poor health and other concerns kept him largely out of the laboratory. For all his novel discoveries, his relentless researches with powerful instruments, and his convincing demonstration of an electrical basis of chemistry, Davy left behind no law, school of thought, or coherent system bearing his name.[49] Perhaps Davy had reached too far in his electrochemical researches, always seeking to pull apart some substance so as to crack open the whole of chemistry and create an entirely new unified vision. For all his spectacular successes throughout his career Davy ultimately failed to realize his ambitions of radically reformulating chemistry. Yet this failure was not for lack of trying. And trying was the very crux of Romantic quest. Davy, wielding his giant battery, was the very embodiment of Romantic striving, of grappling with challenge and adversity in the archetypal heroic quest for knowledge and redemption. As Davy himself often said, this struggle for knowledge was an infinite task, and the finite mind could never truly comprehend the workings of God, of the "Infinite Wisdom". The experimental sciences, Davy asserted,

[44] *Ibid.*, pp. 225-83.
[45] *Ibid.*, p. 275.
[46] PARIS (1831), p. 195.
[47] DAVY (1839-40), V, pp. 274 ff.
[48] *Ibid.*, p. 264.
[49] SIEGFRIED (1959), p. 201.

> have given the true progression to the mind; they have appeared as a work begun, but not perfected. There is no spirit or feeling of imitation in them, which uniformly cramps the best energies of the mind; but one of desire for extending them: and discovery is the great stimulus to exertion, is the highest stimulus to inquiry; and the title of discoverer is the most honourable that can be bestowed on a scientific man.[50]

In all intellectual endeavor the challenges never end and successes can be elusive. Yet there is always "glory" in the effort.[51]

[50] DAVY (1839-40), I, p. 154.
[51] *Ibid.*, VIII, p. 183.

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