X. *Experiments and Obſervations on the* Gymnotus Electricus, *or Electrical Eel. By* Hugh Williamſon, *M. D. Communicated by* John Walſh, *Eſq. F. R. S.*

TO JOHN WALSH, ESQ.

SIR, London Feb. 7, 1775.

Redde, Feb. 9, 1775. AS the electrical eel has lately engaged the public attention, and yours in particular, I have taken the liberty of ſending you ſome experiments which I made on that fiſh: they are the ſame that I had the pleaſure of ſhewing you laſt winter, on my arrival from Penſylvania. If you apprehend they may tend to caſt any light on that curious part of natural hiſtory, or to gratify the curioſity of the public, be pleaſed to make any uſe of them you may think proper. Beſides my own ſuperficial acquaintance with the ſubject of electricity, of which I am very conſcious, there are other circumſtances that may help to apologize for the imperfect ſtate in which theſe experiments appear. The eel being ſickened by the change of climate, its owner refuſed to let us take it out of the water, for the purpoſe of making experiments, on reaſonable terms; and there were many experiments which I could not make

make on it in the water, to my own ſatisfaction. While I made theſe experiments, the eel was kept in a large veſſel, ſupported by pieces of dry timber, about three feet above the floor. Perhaps it may deſerve notice, that a ſmall hole being bored in the veſſel in which the eel was ſwimming, one perſon provoked the eel ſo as to receive a ſhock; another perſon at the ſame time, not in contact with him, but holding his finger in the ſtream that ſpouted from the veſſel, received a ſhock alſo in that finger. From this and ſundry other experiments, I am induced to believe, that the *gymnotus* has powers greatly ſuperior to, or rather different from, thoſe of the *torpedo*, which you have examined with ſo much attention. I have the honour to be, SIR,

Your moſt obedient

and very humble ſervant,

HUGH WILLIAMSON.

Philadelphia, Sept. 3, 1773

SOME weeks ago, a ſea-faring man brought to this city a large eel, that had been caught in the province of Guiana, a little to the weſtward of Surinam. It had the extraordinary power of communicating a painful ſenſation, like that of an electrical ſhock, to people who touched it, and of killing its prey at a diſtance. As I have not heard that any other eel of this kind has ever been carried to any of our continental colonies, or that

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any of them have been ſeen in Europe, I ſhall take the liberty, after I have given a ſhort deſcription of the fiſh, to relate ſuch experiments as I made, or aſſiſted in making, in hopes of diſcovering by what means it produced the effects I have mentioned. The eel was three feet ſeven inches long, and about two inches thick near the head. On a tranſient view, it reſembled one of our common eels both in ſhape and colour; but its head was flat and its mouth wide, like that of a cat-fiſh, without teeth. A fin, which was above two inches broad, extended along its belly, from the point of its tail to within ſix inches of its head. This fin was almoſt an inch thick where it adhered to the body; the upper part of it was muſcular, but of a very different texture from the muſcular part of the body; the difference was obvious to the touch, for I had no opportunity of making any obſervations by diſſecting the ſubject. It was a native of freſh water, and breathed at the interval of three or four minutes, by lifting its head to the ſurface.

EXPERIMENTS.

1. On touching the eel with one of my hands, I perceived ſuch a ſenſation in the joints of my fingers as I received on touching a prime conductor or charged phial, when no circle was formed; or ſuch as I have received, when a few ſparks of the electric fluid have been conveyed through my fingers only. 2. On touching the eel more roughly, I perceived a ſimilar effect in my wriſt and elbow. 3. Touching the eel with

with an iron rod, twelve inches long, I perceived the like ſenſation in the joints of the thumb and fingers with which I held the metal. 4. While another perſon provoked the eel by touching it, I put my hand into the water at the diſtance of three feet, and felt ſuch a ſenſation in the joints of my fingers as when I had touched the eel, but not ſo painful. 5. Some ſmall fiſhes were thrown into the water where he was ſwimming; he killed them immediately, and ſwallowed them. 6. A cat-fiſh (a), that was at leaſt one inch and an half thick, was thrown into the water where the eel was ſwimming; he killed it alſo, and attempted to ſwallow it, but could not. 7. In order to diſcover whether the eel killed thoſe fiſh by an emiſſion of the ſame fluid with which he affected my hand when I had touched him, I put my hand into the water, at ſome diſtance from the eel; another cat-fiſh was thrown into the water; the eel ſwam up to it, but preſently turned away, without offering any violence. After ſome time he returned; when, ſeeming to view it for a few ſeconds, he gave it a ſhock, by which it inſtantly turned up its belly, and continued motionleſs; at that very inſtant I felt ſuch a ſenſation in the joints of my fingers as in experiment 4. 8. A third cat-fiſh was thrown into the water, to which the eel gave ſuch a ſhock, that it turned on its ſide, but continued to give ſigns of life. The eel ſeeming to obſerve this, as it was turning away, immediately returned, and ſtruck it quite motionleſs. I could eaſily perceive that the laſt

(a) The Bayre de rio of Marcgrave.

ſhock

ſhock was more ſevere than the former. The eel never attempted to ſwallow any of thoſe fiſh after the firſt, though he killed many of them; and I always obſerved, that when he was going to kill one, he ſwam directly up to it, as if he was going to bite it; that when he came up, he ſometimes pauſed before he gave the ſhock, at other times he gave the ſhock immediately. When we removed any of thoſe cat-fiſh, though apparently dead, into water in another veſſel, they preſently recovered. Fiſh that are ſtunned by a ſmall electrical ſhock were found to recover in the ſame manner. 9. Touching the eel, ſo as to provoke it, with one hand, and at the ſame time holding my other hand in the water, at a ſmall diſtance, a ſhock paſſed through both my arms, as in the caſe of the Leyden experiment. 10. I put the end of a wet ſtick into the water, and holding it with one hand, I touched the eel with the other; a ſhock paſſed through both arms as before. 11. Taking another gentleman in company by the hand, he touched the eel, while I held one of my hands in the water; the ſhock paſſed through us both. 12. Inſtead of putting my hand into the water, at a diſtance from the eel, as in the laſt experiment, I touched its tail, ſo as not to offend it, while my aſſiſtant touched its head more roughly; we both received a ſevere ſhock. 13. Eight or ten perſons, taking hands, ſtood in a circular form; the firſt in the ſeries touched the eel, while the laſt put his hand into the water, at ſome diſtance from it; they all received a gentle ſhock. 14. The above experiment

ment was repeated with no other variation than that the laſt perſon touched the eel's tail, while the firſt touched its head; they all received a ſevere ſhock. 15. Another gentleman and myſelf, holding the extremities of a braſs chain, one of us put his hand into the water, while the other touched the eel, ſo as to offend it; the ſhock paſſed through us both. 16. I wrapped a ſilk handkerchief round my hand, and touched the eel with it, but received no ſhock; although another gentleman felt the ſhock, who, at the ſame time, put his hand into the water, at ſome diſtance from the eel. 17. A great variety of other experiments were made by two perſons, one touching the eel near its head, the other putting his hand into the water, or touching it near the tail, forming a communication at the ſame time between their hands, which were out of the water, by pieces of charcoal, rods of iron or braſs, a piece of dry wood, glaſs, ſilk, &c. The uniform reſult of all thoſe experiments was, that whatever uſes to convey the electrical fluid would alſo convey the fluid diſcharged by the eel; and *vice verſâ*, a braſs chain, that had very many links in it, would not convey it, unleſs when the ſhock was ſevere, or the chain tenſe. 18. One of the company being inſulated on glaſs bottles, received ſeveral ſhocks from the eel; but he exhibited no marks of a *plus* ſtate of electricity, nor would cork-balls, ſuſpended by ſilken threads, give any marks of it, either when they were ſuſpended over the eel's back, or touched by the inſulated perſon at the inſtant he received the ſhock. 19.

A perſon, holding a phial in one hand properly lined and coated for electrical experiments, put his hand to the tail of the fiſh, while an aſſiſtant, holding a ſhort wire in one hand that communicated with the inſide of the phial, graſped the fiſh near its head, ſo as to receive a ſevere ſhock in his hand and arm, but it paſſed no further. 20. Two pieces of braſs wire, about the thickneſs of a crow's quill, were ſcrewed, in oppoſite directions, into a frame of wood, ſo as to come within leſs than the hundredth part of an inch of contact; they were rounded at the point. I held the remote end of one of thoſe wires, while an aſſiſtant held the other; in the mean while, one of us putting his hand into the water near the eel, the other touched it ſo as to receive a ſhock. We repeated this experiment fifteen or twenty times with different ſucceſs: when the points of the wires were even ſcrewed aſunder, to the fiftieth part of an inch, the ſhock never paſſed in the circle; but when they were ſcrewed up within the thickneſs of double-poſt paper, the ſhocks, ſuch of them as were ſevere, would paſs through us both; in which caſe, they doubtleſs leaped from the point of one wire to the other, though we were not ſo fortunate as to render the ſpark generally viſible. But it ſhould be obſerved, that the eel on which we made theſe experiments, was not eaſily provoked, and appeared to be in bad health. I have frequently paſſed my hand along its back and ſides from head to tail, and have lifted part of its body above the water, without tempting it to make any defence. Dr. BANCROFT tells us, that ſuch eels in Guiana

Guiana have ſhocked his hand at the diſtance of ſome inches from the ſurface of the water. Perhaps fire emitted by eels lately taken, might be rendered viſible.

From the above experiments it appears: 1. That the Guiana eel has the power of communicating a painful ſenſation to animals that touch or come near it. 2. That this effect depends entirely on the will of the eel; that it has the power of giving a ſmall ſhock, a ſevere one, or none at all, juſt as circumſtances may require. 3. That the ſhock given, or the painful ſenſation communicated, depends not on the muſcular action of the eel, ſince it ſhocks bodies in certain ſituations at a great diſtance; and ſince particular ſubſtances only will convey the ſhock, while others, equally elaſtic or hard, refuſe to convey it. 4. That the ſhock muſt therefore depend upon ſome fluid, which the eel diſcharges from its body. 5. That as the fluid diſcharged by the eel affects the ſame parts of the human body that are affected by the electric fluid; as it excites ſenſations perfectly ſimilar; as it kills or ſtuns animals in the ſame manner; as it is conveyed by the ſame bodies that convey the electric fluid, and refuſes to be conveyed by other bodies that refuſe to convey the electric fluid, it muſt alſo be the true electrical fluid; and the ſhock given by this eel muſt be the true electrical ſhock.