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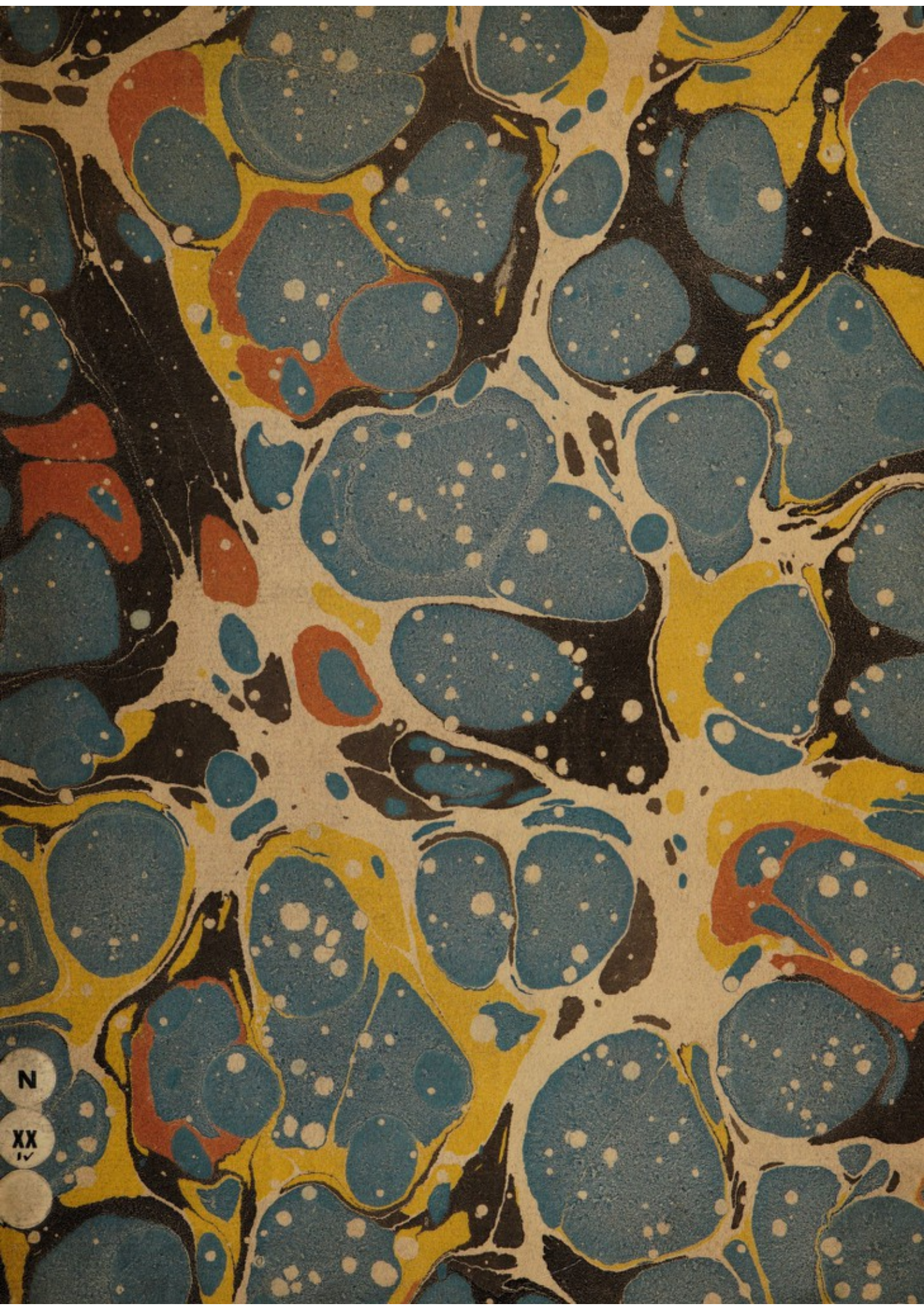

A

DISCOURSE

ON THE

TORPEDO,

DELIVERED AT THE

Anniverſary Meeting of the ROYAL SOCIETY,
November 30, 1774.

By Sir JOHN PRINGLE, Baronet,
PRESIDENT.

PUBLISHED BY THEIR ORDER.

LONDON:
Printed for the ROYAL SOCIETY.
MDCCLXXV.

GENTLEMEN,

THE diſpoſal of the annual prize-medal, founded on the benefaction of ſir GODFREY COPLEY, baronet, having for ſome years paſt devolved upon your Preſident and Council, they have hitherto been fortunate in executing their truſt in ſuch a manner as to receive your approbation. Indeed, the ſtrict regard for the honour of the Society, and the deference due to the opinions of the other learned members, have been ſo much the objects of their attention, that they could not well fail to be directed by them to ſuch of your publications as were more particularly deſerving your favourable notice; and they flatter themſelves, that they ſhall not now be leſs ſucceſsful than on former occaſions. For, if you call to mind the various Papers of experiments in the laſt volume of your Tranſactions, you may remember that though you warmly acknowledged the merit of many

of them, yet it was with peculiar pleaſure you liſtened to that from Mr. WALSH, upon the torpedo, on account of the new and very ſtriking circumſtances contained in that communication, and of the pains and time beſtowed by that gentleman on this inquiry.

But, in order to your more freely ſealing the choice of your council with your ſuffrages, permit me, GENTLEMEN, firſt to lay before you a ſhort abſtract of what had been done in this branch of natural hiſtory, antecedent to Mr. WALSH's experiments; and then to remind you of a few of his principal ones, that, while we do juſtice to our worthy brother, none may be defrauded of the praiſe due to their labour.

THE torpedo, or cramp-fiſh, a ſpecies of the ray, being a common inhabitant of the Mediterranean, was early known to the Greeks. We find it firſt mentioned in a book anciently aſcribed to HIPPOCRATES, indeed only as an eſculent fiſh; but the name alone (νάρκη) is ſufficient to aſcertain the knowledge the ancients then had of its torporific qualities. And PLATO, nearly contemporary with HIPPOCRATES, certainly knew of them, as

appears

appears by the humorous compariſon he makes of SOCRATES to that animal, which he puts into the mouth of MENON, in his dialogue of that name. And his celebrated diſciple in phyſics, ARISTOTLE, particularly treats of it in his Hiſtory of Animals. The torpedo (ſays he) hides itſelf in the ſand or ooze, and whilſt the other fiſhes ſwim over it, and touch it, he benumbs them, ſo as to catch them and feed upon them: as a proof, the mullet, the ſwifteſt of the watery race, is found in his ſtomach.

But though ARISTOTLE knew that the touch of the torpedo ſtupified other fiſhes, he ſeems not to have known that this extraordinary effect could be tranſmitted to other animals not in immediate contact with it, but by the interpoſition of a ſtick, a rope, or water; facts too curious to have been omitted had he ever heard of them. Poſſibly he might have been informed, but rejected the accounts as fabulous (for of all the ancients none appear to have been ſo much on their guard againſt impoſition) or he might have thrown them into ſome part, that has been ſince loſt, of his book called Θαυμάσια Ἀκουσικὰ, *Wonderful Relations*. Yet ARISTOTLE had only the teſtimony of fiſhermen for what he reports of the torpedo: indeed he expreſly ſays ſo. In thoſe days, and for many ages after, the pride of man ſet him above experiments; and

above

above the ſuſpicion, that by ſuch low and mechanical operations he was to diſcover cauſes and learn to reaſon. ARISTOTLE himſelf, that admirable genius, knew not this. Had the great Stagirite heard, that, to underſtand by what principles the torpedo acted, a naturaliſt from Britain had travelled through Gaul to the Atlantic ocean, and on that coaſt had made a hundred experiments upon that fiſh, and with ſucceſs; there is no doubt he would have placed that account among the chief of his *Wonderful Relations*. Lord BACON was the firſt who detected and combated this preſumptuous error, and who, by humbling the vanity of man, exalted his power over the works of nature. He was the firſt who taught, that as *our bread*, ſo our ſcience was to be earned *by the ſweat of our brow*; and the works of this ſociety will, I truſt, be an everlaſting teſtimony of the truth of his doctrine.

THEOPHRASTUS, the learned ſcholar and ſucceſſor of ARISTOTLE, appears to have been better informed concerning the torpedo than his maſter. ATHENÆUS relates, that this philoſopher, in his book on venomous animals, obſerved that the torpedo conveyed this benumbing ſenſation through ſticks and ſpears into the hands of the fiſhermen that held them. And ſince I have quoted ATHENÆUS, though not in a chronological order, I ſhall

add, that he mentions DIPHILUS of Laodicea, for taking notice, in his commentary upon the *Theriaca* of NICANDER, that it was not the whole, but certain parts of the body of the torpedo that occaſioned the torpor. HERO of Alexandria, in his Pneumatics, mentions this fiſh as emitting effluvia through braſs and iron and other ſolid bodies.

PLINY, the laborious and uſeful compiler of ancient natural ſcience, too little a philoſopher himſelf, and too great a lover of the marvellous, has treated this ſubject accordingly. Thus, he ſays, the power of the torpedo may be felt through the length of a rod or a ſpear; which is a fact: but that this fiſh binds the legs of the nimbleſt perſon that treads upon it, is an exaggeration; and it is falſe what he adds, that this animal is alſo able to bind the arms of the ſtrongeſt, at a diſtance.

PLUTARCH, though no profeſſed naturaliſt, yet furniſhes us with a fuller and juſter account of the torpedo. According to him, this creature not only benumbs all thoſe that touch it, but alſo ſtrikes a numbneſs through the net into the hands of the fiſhermen; nay, as ſome report, if it happen to be laid on the ground, alive, thoſe that pour water upon it ſhall be ſenſible of ſome diminution of their feeling. Now whether this laſt fact has

been

been confirmed by later experiments, I have not learnt, but I am inclined to believe it, as not inconſiſtent with Mr. WALSH's principles. PLUTARCH adds, that whilſt the torpedo ſwims around his prey, he emits certain effluvia, like darts *, that firſt affect the water, and then the fiſhes in it; which, being thus diſabled from defending themſelves, or eſcaping, are held as it were in bonds, or frozen up.

From ÆLIAN, who writes a Hiſtory of Animals, we might expect more information on this ſubject than from any other; but we are much diſappointed. This author has been ſatisfied with reciting a few of the common reports, and adding others too abſurd to deſerve repetition. It is remarkable, that theſe two profeſſed writers of natural hiſtory, PLINY and ÆLIAN, ſhould of all the ancients give us the lameſt and moſt fabulous accounts of this ſubject of our inquiry.

Paſſing from the philoſophers to the phyſicians, we ſhall receive little more ſatisfaction. Before the days of GALEN the torpedo was applied alive to the part affected, for the cure of an obſtinate head-ach. So it appears from DIOSCORIDES. But GALEN, always reaſoning, and oppoſing empirical practice, aſſigns a cauſe for that ſalutary ef-

* Gr. ὥσπερ βέλη διασπείρει ἀπορροάς.

fect.

fect. His phyſiological ſyſtem was in a great meaſure founded on the four *primary qualities*, *cold*, *hot*, *wet*, and *dry*. He conceived, therefore, that the torpedo acted by a frigorific principle; for as cold occaſions a numbneſs in an animated body, ſo does the ſhock given by that fiſh. Such was the theory and reaſoning of that age; yet, bad as they were, they prevailed in the ſchools of medicine upwards of a thouſand years. GALEN was confirmed in his opinion, by ſeeing, as he himſelf teſtifies, that diſorder removed by the touch of a living torpedo; which being of a cold nature, ſtupified or blunted the acute ſenſe of pain. The followers of this medical chief improved upon their leader. A living torpedo not being always at hand, when a refrigerating medicine was indicated, the deficiency was ſupplied by preparing an oil from the dead animal, which they were aſſured muſt poſſeſs all the virtues of the living one. Upon this conceit we find PAULUS of Ægina, one of the ancients of the Galenic ſchool, recommending this oil for tempering the hot humour of the gout, and for other ailments that required cooling applications.

Now, conſidering what little information we have received from the philoſophers and phyſicians among the ancients, it will ſcarcely be expected, that we ſhould find

more among their poets. Poetry, the creature of the imagination, can ſeldom avail itſelf of ſtrict hiſtory for a ſubject, whether in the natural or political world. The hiſtorians of either can yet ſee but parts of a great ſyſtem, and theſe, in appearance, often crooked and deformed, from not knowing how they are to tally and to be put together, to compoſe the fabric of the univerſe and the hiſtory of man. Such disjointed materials make therefore but indifferent themes for a bard, whoſe aim is to captivate the fancy with ſomething beautiful and finiſhed. In effect, OPPIAN has made no improvement in the hiſtory of the torpedo, though he contrived in his *Halieutica* to write an elegant deſcription of it, without departing much from truth. He not only commemorates the more than poetical powers with which nature has endowed this fiſh; but diſtinguiſhes, like DIPHILUS, the parts where they peculiarly reſide. Theſe parts he calls λαγόνες (the ſides) from which, as OPPIAN imagined, the animal had a faculty of darting upon other fiſhes certain ſubſtances, he terms κερχίδες, but whereof the meaning is obſcure. To the former of theſe expreſſions CLAUDIAN undoubtedly alludes, in a line of thoſe verſes which he copies from OPPIAN, in celebrating the properties of the torpedo:

Sed

Sed latus armavit gelido natura veneno.

But, as the Roman poet has nothing new of his own, I ſhall with him cloſe the relations I have been able to find of this curious fiſh in the monuments of antiquity. We muſt confeſs them to be all unſatisfactory; and the more, as it does not appear, there has been one, GALEN excepted, of all the above mentioned ancient ſages, who had ever ſeen a living torpedo, much leſs who had made experiments on it; and leaſt of all who had diſſected it. The reſult of their inquiries ſerved for little more than a winter's tale. Such, I ſay, are the accounts that I have been able to collect from the ancients, concerning this *wonder of the deep*; omitting only ſuch reports as ſeemed to be either ſuperſtitious or fabulous. But of both ſorts, you may be aſſured, that in thoſe days of credulity, ſo many were impoſed on the world, that we are not to wonder, if there have been men of genius and learning, who, not taking the pains to make experiments themſelves, or ſtrictly to inquire into thoſe made by others, have preſumptuouſly treated the whole affair as a vulgar error.

With the fall of the Roman empire, the hiſtory of animals, imperfect as it was, with all other found learning, ſunk into the darkneſs of the times; nor did it emerge

before the ſixteenth century, an æra ever memorable for the revival of ſcience. Then lived and flouriſhed BELON, RONDELET, SALVIANI, GESNER, and others, who not only reſtored what was anciently known in natural hiſtory, but greatly improved the ſubject. Yet experiments were ſtill rare and feeble, till, in the next century, HARVEY appeared, and began to make them on birds and quadrupeds. Nor did that famous interpreter of nature finiſh his career, and cloſe his eyes in death, before they beheld the riſing ſtate of this Society, and the *Academia del Cimento*, our elder but ſhort-lived ſiſter, already formed. Some of the moſt eminent of that academy judging an inquiry into the truth of what had been recorded concerning the torpedo, to be an object worthy their attention, availed themſelves of their vicinity to a ſea ſtored with that ſort of fiſh, to make the trials. REDI, one of the moſt liberal and enlightened geniuſes of that age, began, and was afterwards aſſiſted by BORELLI and STENO the Dane, his collegues. Laſtly LORENZINI, his ſcholar, engaged in the ſame purſuit, and publiſhed a curious treatiſe upon the ſubject.

REDI's firſt ſtep was by experiments to diſtinguiſh between the real properties of the torpedo, and ſuch as had erroneouſly been aſcribed to it, by the learned, as well

well as by the vulgar of former times. To this reſearch he added the anatomy of the animal; ſo that REDI was alſo the firſt, who with any accuracy deſcribed thoſe crooked ſubſtances, lying on each ſide of the ſpine near the head, which he conſidered as muſcles (from thence named *muſculi falcati)* that projected certain effluvia occaſioning the ſenſation of numbneſs, more or leſs, as the animal was excited to put theſe organs into action. This hypotheſis, of the tranſmiſſion of effluvia, was immediately embraced by LORENZINI, and afterwards by CLAUDE PERRAULT. But the former, not underſtanding how effluvia could paſs from the body of one animal into that of another, without immediate contact, contradicted, we may ſay, the evidence of his ſenſes, by denying the ſenſation he muſt have had upon touching the torpedo with a ſtick, a ſpear, or the like inſtrument; unleſs we ſhould ſuppoſe thoſe ſubjects, on which he made his trials, were too weak for exerting the full energy of their ſpecies.

From the like cauſes alſo erred the excellent BORELLI. But his theory not admitting the emiſſion of benumbing particles, affecting the hand, either in immediate contact with the fiſh, or touching it with a ſtick, or the like, he referred the ſenſation to a certain briſk undulation of the parts touched, which the animal could excite

at

at will. This action he compared to that of a ſtretched cord put into quick vibrations.

Into a ſimilar deception, in the next generation, fell that ornament of his country and of his age, the excellent M. DE REAUMUR, upon reſuming this ſubject. For in the year 1714, being on the coaſt of Poitou, he took that opportunity of making ſome new experiments upon the torpedo, which, with the reſult, he communicated to the R. Academy of Sciences at Paris. His brethren of that illuſtrious ſociety adopted his hypotheſis, as did indeed the Ingenious over all Europe; and ſo natural did it appear to them, that every one wondered it had not been fallen upon before. What then was this new ſyſtem? In effect, one not very different from that of BORELLI; for, inſtead of the undefined vibrating parts of the latter, M. DE REAUMUR ſubſtituted muſcles (the *muſculi falcati* of REDI and LORENZINI) which, by the vivacity of their action, impreſſed on the hand, that touched theſe parts, a ſenſation of numbneſs, owing to the ſtoppage of the progreſſion of the nervous fluid, or a repulſion of the ſame. But, to obviate what might be objected, the celebrated inveſtigator was bound to deny that this impreſſion of numbneſs could be communicated through water, a net, or any other ſoft and yielding ſubſtance; nay,

through a ſtick, except a very ſhort one. In fact, M. DE REAUMUR did deny ſuch tranſmiſſions; and yet it is certain, that the ſhocks from the torpedo are not leſs conducted through ſuch *media*, than thoſe from a charged electrical phial. Shall we then accuſe of want of candour thoſe celebrated authors, BORELLI, LORENZINI, and M. DE REAUMUR? By no means: but let us lament the weakneſs of the human intellect, which, pre-poſſeſſed by ſyſtem, will often not perceive ſuch objects as would ſtrike the ſenſes of any other perſon, nay moſt certainly their own, in a more unprejudiced ſtate of mind! And let us regret that other infirmity, ſo incident to the beſt underſtanding, the too great forwardneſs to account for every appearance in nature, from ſuch principles as are known, without conſidering how many yet remain to be diſcovered! There was a time, and that within the memory of many of my hearers, when thunder and lightning were thought ſufficiently accounted for, from ſulphureous and nitrous vapours mixing with the air. At preſent we doubt of the exiſtence of ſuch vapours in the atmoſphere, and are otherwiſe ſure, that the electrical fluid only is concerned in the formation of that meteor. Now it ſeems this very fluid is the efficient cauſe of the amazing qualities

lities of the torpedo. Nothing could be more unexpected, yet perhaps nothing more true.

The diſcovery of the Leyden phial opened a wide and rich field for the advancement of philoſophy; and to the honour of this ſociety it will ever be remembered, how much they have availed themſelves of that fortunate accident, for interpreting ſome of the more intricate phænomena of nature. A few years after that memorable event, the celebrated profeſſor ALLAMAND, fellow of this ſociety, hearing of a fiſh, in the Dutch ſettlement of Surinam, reſembling a congre eel, but with properties ſimilar to thoſe of the torpedo, engaged his friend M. 'S GRAVESANDE, governor of Eſſequebo, to make the inquiry. That gentleman readily complied, and in the year 1754 wrote M. ALLAMAND a letter on the ſubject, which was ſoon after publiſhed in the ſecond volume of the Tranſactions of the Society at Harlem. M. 'S GRAVESANDE ſays, that the experiment was made on a ſpecies of eel, the Dutch call *ſidder-vis (tremble-fiſh)* and that it produced the ſame effects with electricity, with which he had been well acquainted, by having with his learned correſpondent made many experiments with the electrical phial; nay, that the ſhocks from the fiſh were much more violent, if it happened to be ſtrong and lively of its kind;

kind; for then it would infallibly throw the perſon who touched it to the ground. But M. 's GRAVESANDE adds, that ſuch exertions in this animal were accompanied with no ſparks of fire, as in an electrical machine. Thus far I have abridged M.'s GRAVESANDE's letter. M. ALLAMAND ſubjoins, that he was ſatisfied that this eel muſt be a ſpecies of the gymnotus of ARTEDI, and all our ſubſequent accounts have confirmed his opinion.

In the ſecond part of the ſixth volume of the ſame valuable work, we find, of the ſame animal, a more ample relation extracted from ſome letters of M. VANDER LOTT, dated from Rio Eſſequebo, 1761. This gentleman makes two ſpecies, the black and the reddiſh, though he acknowledges, that, excepting the difference of colour and degree of ſtrength, they are not materially different. In moſt of the experiments with theſe animals, M. VANDER LOTT remarked a wonderful ſimilitude between them and an electrical apparatus: nay, he obſerved, that the ſhock could be given to the finger of a perſon, held at ſome diſtance from the bubble of air, formed by this eel when it riſes to the ſurface of the water in order to breathe; and he concluded, that at ſuch times the electrical matter was diſcharged from its lungs. He mentions another characterizing circumſtance; which is, that

though metals, in general, were conductors to its electrical fluid, yet ſome were found to be ſenſibly better than others for that purpoſe.

About the ſame time that M.'s GRAVESANDE made his diſcovery in America, M. ADANSON, an eminent French naturaliſt, met with the ſame, or a ſimilar fiſh, in the river of Senegal in Africa. He takes notice, that this animal had little relation to any of the known inhabitants of the water. That its body was round, and without ſcales, like an eel, but much thicker in proportion to its length; that it was well known to the natives, and that the French called it *trembleur*, from the effects it produced; not ſo much a numbneſs, like that ariſing from the torpedo, as a very painful trembling in the limbs of thoſe who touched it. He adds, that this effect did not ſenſibly differ from the ſhock given by the Leyden phial, which he had felt; and that it was communicated in the ſame manner by ſimple contact, or by the interpoſition of a ſtick, or an iron rod (five or ſix feet long) ſo as to force the perſon to drop which ever of them he had in his hand.

M. FERMIN, in his Natural Hiſtory of Surinam, publiſhed at Amſterdam, in 1765, obſerves of a fiſh, which the Dutch there call *Beef-aal (tremble-eel)* that one cannot touch

touch it with the hands, or even with a ſtick, without feeling a horrible numbneſs in the arms, up to the ſhoulders. And he farther relates, that making fourteen perſons join each other by the hands, whilſt he graſped the hand of the laſt with one of his, and with the other touched the eel with a ſtick, the whole number felt ſo violent a ſhock, that he could not prevail on them to repeat the experiment. This fiſh, I believe we may with probability ſay, was the ſame ſpecies of gymnotus deſcribed by M. 's GRAVESANDE and M. VANDER LOTT, though the author does not compare its operations to thoſe of the electrical phial.

The earlieſt account, for a diſtinct one, that I have met with of this kind of eel, in that quarter of the world, is by M. RICHER, the aſtronomer, recorded by M. DU HAMEL, in his Hiſtory of the R. Academy of Sciences, for the year 1677. In the iſland of Cayenne, where M. RICHER had made his obſervations, there is a fiſh, ſays M. DU HAMEL, not unlike a congre eel, which touched with the finger, or even with the end of a ſtick, affects the arm with a numbneſs, nay the head with a giddineſs, and the eyes with a dimneſs of ſight, which M. RICHER had himſelf felt upon making the experiment.

If any further evidence were wanting, to aſcertain the electrical nature of this eel in thoſe parts, I would recommend the peruſal of the Eſſay on the Natural Hiſtory of Guiana, by Dr. BANCROFT, member of this Society, where the reader will find ſeveral curious experiments made on this animal by that gentleman. But, as the book is in every body's hands, I ſhall only take notice, that the author confirms M. VANDER LOTT's account, of a ſhock from this animal being communicated through a conſiderable ſpace of air; a circumſtance to which we have nothing ſimilar in the torpedo, though it be a common effect in an electrical diſcharge.

I ſhall not therefore, GENTLEMEN, take up more of your time, with offering you further accounts of theſe curious animals, given us by travellers, and the leſs, as I have met with no original ones, excepting the above, but what from either too much brevity, or manifeſt ſigns of inaccuracy, have left much doubt to what *genera* of fiſhes thoſe electrical ones were to be referred. I ſhould only except that eel which M. DE LA CONDAMINE deſcribes in his voyage down the river of Amazons, that was moſt probably the true electrical gymnotus (ſo commonly found in the rivers of the adjacent country of Guiana) about which we have been juſt diſcourſing. Not ſo that fiſh

which Mr. MOORE found in an African lake near the Gambia; nor that other, which Mr. ATKINS ſaw in the river Sierra-leon, likewiſe in Africa. And it is pretty evident that the electrical fiſh mentioned and delineated, but ſcarcely deſcribed by NIEUHOF, as taken in ſome of the lakes of India, and called by the Dutch *meer-aal (lake-eel)* is no ſpecies of the gymnotus, at leaſt if juſtly drawn, ſince we find there a long fin on the back of that creature, and none on its belly. No more ſhould that fiſh, provided with torporific powers, which PISO found in Brazil, have any other relation to the gymnotus, ſince the author compares it in figure to a ſole. Nor that other, of the ſame country, poſſeſſed of ſimilar qualities, which PISO calls *Piraqué* (MARGRAF, *Puraqué)* if it at all reſembled the figures given of it by theſe travellers and natural hiſtorians. I would paſs the ſame judgement upon the Indian *congrus monſtroſus* of BONTIUS. And I ſhould heſitate about that eel, the ſubject of a Paper, communicated to this Society in the year 1680, by Dr. GALE, from the author Dr. BATEMAN, who had been twenty years a planter in Surinam. All that I would with any degree of certainty conclude, is that among fiſhes the electrical properties are not confined to that ſpecies of ray called the torpedo, nor to that ſpecies of gymnotus called the *gymnotus electricus*, but that nature has endowed

dowed with the ſame powers ſeveral other inhabitants of the waters, though hitherto imperfectly known.

Now, in juſtice to thoſe authors who have firſt mentioned the electric gymnotus, and eſpecially to thoſe who have originally ſurmiſed a ſimilitude between the properties of the torpedo and thoſe of that electrical eel, and between the properties of both and thoſe of the Leyden phial, I have thought proper to commemorate their names on this occaſion; though after all, I have reaſon to believe that our worthy brother has taken the hint of making his experiments from none of them, but ſolely from what he had read concerning the torpedo in writers, who thought of nothing leſs than referring ſuch powers in animals to an electrical origin; nay, who lived, many of them, long before the laws of electricity were known. Nor had the ſurprizing benumbing effects of the electric gymnotus ever been ſo narrowly obſerved, much leſs confronted with an electrical apparatus, as that we could with any preciſion ſay, how far nature had carried the analogy between the two.

To Mr. WALSH therefore we owe not only the firſt, but a numerous ſet of the beſt choſen experiments on the torpedo, for aſcertaining its electrical nature, together with ſome correct and elegant drawings of the intire ani-

mal, and of ſome of its principal organs that appeared upon diſſection. For this latter part of the diſquiſition, the Society, as well as Mr. WALSH, is much beholden to another member, Mr. JOHN HUNTER, who thereby has ſupplied us with an uſeful addition to the anatomical examination of the animal by REDI, STENO, and LORENZINI. And I may moreover acquaint you, that though Mr. WALSH has laid before us an account of his principal experiments, his occupations have not yet permitted him to enumerate every curious particular that occurred to him in the courſe of his reſearch; as I can teſtify, from having been favoured with the peruſal of the journal he had kept of all his tranſactions.

The very firſt experiment of Mr. WALSH diſcovered the electrical quality of that fluid in the torpedo (which had ſo long diſtinguiſhed this fiſh) by his conveying it through the ſame conductors with electricity, ſuch as metals, water, and animal fluids; and by intercepting it by the ſame non-conductors, namely glaſs and ſealing wax. Nor in this circumſtance only did the ſimilitude between the electric and torpedinous fluids appear: one of the moſt brilliant of Mr. WALSH's diſcoveries was, that this animal not only could accumulate in one part a large quantity of electric matter, but was furniſhed with a certain organization diſ-

poſed

poſed in the manner of the Leyden phial. Thus while one ſurface of the electric part (ſuppoſe on the back) was charged with this matter, or, as it is called, was in a poſitive ſtate, the other ſurface (that on the belly) was deprived of it, or was in a negative ſtate; ſo that the equilibrium could be reſtored, by making a communication between the two ſurfaces, by water, the fluids of the human body, or metals. A man preſſing upon one of theſe ſurfaces with one hand, could, with the other, by the mediation of his own fluids, make a circuit for the conveyance, and at the ſame inſtant receive a ſhock; viz. the ſame ſenſation that is impreſſed by the electric matter in paſſing through our arms and body, from the inſide of a charged Leyden phial to its outward coating. We need but attend to the following experiment, which Mr. WALSH made at Rochelle in preſence of the Academy there, to ſee how admirable this circuit is, and how ſimilar to a common electrical one. A living torpedo was laid on a table, upon a wet napkin; round another table ſtood five perſons inſulated; and two braſs wires, each thirteen feet long, were ſuſpended from the cieling by ſilken ſtrings. One of the wires reſted by one end on the wet napkin, the other end was immerſed in a baſon full of water, placed on a ſecond table, on which ſtood four other baſons,

ſons, likewiſe full of water. The firſt perſon put a finger of one hand into the water in which the wire was immerſed, and a finger of the other hand into the ſecond, and ſo on ſucceſſively till all the five perſons communicated with one another by the water in the baſons. In the laſt baſon one end of the ſecond wire was dipped, and with the other end Mr. WALSH touched the back of the torpedo, when the five perſons felt a ſhock, differing in nothing from that of the Leyden experiment, except in being weaker. Mr. WALSH, who was not in the circle of conduction, felt nothing. This was ſeveral times ſucceſsfully repeated, even with eight perſons; and the experiment being related by M. DE SEIGNETTE, mayor of the city, and one of the ſecretaries of the Academy of Sciences of Rochelle, and publiſhed by him in the French Gazette, the account becomes the more authenticated. For though we place full confidence in the candour and veracity of our worthy brother, yet in the eyes of the public the evidence muſt be ſtrengthened by the teſtimony of thoſe, who, but for the ſake of truth and ſcience, were no wiſe intereſted in the matter. We are therefore the more obliged to Mr. WALSH for having made theſe experiments *not in a corner*, but I may ſay, before the world; and in that very country which gave birth to the

celebrated M. DE REAUMUR, whoſe reputation as a philoſopher could not but ſuffer ſome diminution, in proportion to the credit gained at this time by the fortunate ſtranger. And indeed the whole behaviour of the learned academicians, firſt at Rochelle, and afterwards at Paris (when the experiments became known there) was ſuch to their gueſt, as ſhewed them to be on this, as on other occaſions, the true lovers of ſcience, emulous not envious of the reputation of their neighbours.

But though no farther evidence be wanting to authenticate the experiments of Mr. WALSH, yet for the confirmation of the concluſions he draws from them, it is with pleaſure that I can join the teſtimony of our learned and candid brother Dr. INGENHOUSZ, phyſician to their Imperial Majeſties at Vienna, who, being in Italy, when he received a general account of Mr. WALSH's ſucceſs, at my requeſt repaired to Leghorn, to make ſome experiments himſelf upon the torpedo. How far they agreed with, and corroborated, thoſe of Mr. WALSH, I need not mention, as you have ſo lately heard the doctor's letter to me on that ſubject.

Nor ſhall I return to enter into any farther detail of Mr. WALSH's experiments, conſidering what encroachment I have already made on your time, and how ſenſi-

ble you muſt be, that thoſe which I have already reminded you of, have merited the honours you are now conferring upon him. I ſhall only obſerve, that our ingenious brother, having traced the ſimilitude between the operations of the torpedo, and thoſe of an electrical apparatus, he found it ſo ſtrong, as to perſuade him that it was the identical fluid that actuated both the animal and the machine. Yet he remarks, that though the charged phial occaſions attraction and repulſion in ſuch light bodies as the pith-balls, placed near it, and its diſcharge is obtained through a ſpace of air, and accompanied with light and ſound; nothing of this occurs with reſpect to the torpedo. But to theſe objections againſt a perfect agreement between the electrical and torpedinous fluids, Mr. WALSH anſwers, that upon charging a number of large jars with a ſmall quantity of electric matter, and then diſcharging them, that matter will yield the appearances of the torpedo only. It will not now paſs the hundredth part of that inch of air, which in its collected ſtate it would run through with eaſe; the ſpark and ſnap and the attraction and repulſion of the balls will alſo be wanting; nor will a point brought however near, if not juſt in contact, be able to draw off the charge; and yet this diffuſed electric matter, to effect its equilibrium, will inſtantaneouſly paſs

through a conſiderable circuit of different conductors properly connected, and give a ſenſible ſhock to ſuch perſons as compoſe the circle. But where is that large ſurface of diffuſed electricity to be found in the torpedo? Mr. WALSH replies, that from a minute diviſion of parts a large ſurface will ariſe; and that even our naked eye will tell us, that thoſe ſingular tubulated organs of the torpedo conſiſt, like our electric batteries, of many bodies of a priſmatic form, whoſe ſurfaces taken together compoſe a conſiderable area. To this argument we may add, that hitherto no difference has been found, except with regard to more and leſs, between the electric matter which is drawn from the clouds, and that other which pervades all terreſtrial bodies, and is collected by every apparatus. If therefore between lightning itſelf and the charge of a Leyden phial, there is no ſpecific difference, nay ſcarce a variety, as far as is known, why then ſhould we unneceſſarily multiply ſpecies, and ſuppoſe the torpedo provided with one different from that which is every where elſe to be found? But leaving this queſtion to be more thoroughly handled by ſubſequent experiments, let us conclude, that ſuch has been the ſimilitude eſtabliſhed between the electrical fluid of the torpedo, and that of nature at large, that in a phyſical ſenſe they may be conſidered as preciſely the ſame.

Mr.

Mr. HUNTER has well obſerved, and I think is the firſt who has made the obſervation, that the magnitude and number of the nerves beſtowed on theſe electric organs, in proportion to their ſize, muſt appear as extraordinary as their effects; and that, if we except the important organs of our ſenſes, there is no part even of the moſt perfect animal which for its ſize is more liberally ſupplied with nerves; nor yet do theſe nerves of the electric organs ſeem neceſſary for any ſenſation that can belong to them. And with reſpect to action, he obſerves, that there is no part of any animal, however ſtrong and conſtant its action may be, which enjoys ſo large a proportion of them. If then it be probable, that theſe nerves are unneceſſary for the purpoſe either of ſenſation or action, may we not conclude, that they are ſubſervient to the formation, collection, and management of the electrical fluid, eſpecially as it appears from Mr. WALSH's experiments, that the will of the animal commands the electric powers of its body?

If theſe reflections be juſt, we may with ſome probability foretell, that no diſcovery of conſequence will ever be made by future phyſiologiſts, concerning the nature of the nervous fluid, without acknowledging the lights they have borrowed from the experiments of Mr. WALSH upon

upon the living torpedo, and the diſſection of the dead animal by Mr. HUNTER. But whether this will be the individual effect or not, philoſophy by theſe curious and ſucceſsful reſearches has made a valuable acquiſition; ſince we may be aſſured, that whatever tends to diſcloſe the *cauſæ rerum*, the ſecret laws of Nature, cannot ultimately fail of ſubjecting her, more or leſs, to the uſes of life; and of manifeſting, more and more, the wiſdom and power of the Creator in all his works.

MR. WALSH,

IN conſequence of the approbation of the choice made by the Council, ſo unfeignedly expreſſed in the countenance of every gentleman preſent, it remains, that in the name, and by the authority, of the ROYAL SOCIETY OF LONDON, formed for the improvement of Natural Knowledge, I deliver into your hand this Medal, the prize you have ſo meritoriouſly obtained; not doubting, SIR, of your grateful acceptance of ſo honourable and unperiſhing a memorial of their eſteem, and of the ſenſe of their obligations to a perſon, who in ſo diſtinguiſhed a manner has contributed to promote the great ends of their inſtitution. And, in the ſame reſpectable name, let me add,

add, that they are ſo much perſuaded of your abilities to aſſiſt in their grand work, the *Interpretation of Nature*, that they earneſtly call upon you to continue your liberal and ſpirited labours. With pleaſure they underſtand that you have already turned your views to the electric gymnotus, that other wonder of the waters, an animal poſſeſſed of powers ſimilar to thoſe of the torpedo, but of ſuperior energy; and the Society flatter themſelves, that ſo much light will be gained by that inquiry, that you will be enabled ſoon to make a farther diſcovery of the myſteries of Nature. Her veil, fear not, SIR, to approach *. Animated with the preſence of this illuſtrious and ſucceſsful Body, I will venture to affirm, that Nature has no veil, but what time and perſevering experiments may remove. In the inſtance before us, view the progreſs of the powers of the mind; view the philoſophers of the early ages, like the "children of the World" †, amuſed and ſatisfied with the ſtories of the torpedo; as incurious about their authenticity, as about the cauſes of ſuch extraordinary effects. This animal ſerved them for an emblem, or an hieroglyphic, for a figure of ſpeech, or an alluſion of pleaſantry; at beſt as a theme for a copy of verſes. But

* Alluding to that paſſage in Mr. WALSH's Paper, "We here approach to that "veil of Nature, which man cannot remove."

† Lord BACON.

the

the World, rising in years and in wisdom, rejects such trifles. The Interpreters of Nature, in the adult state of Time, make experiments and inductions, distrust their intellects, confide in facts and in their senses: and by these arts drawing aside the veil of Nature, find a mean and groveling animal armed with lightning, that awful and celestial fire, revered by the ancients as the peculiar attribute of the father of their gods.