SIX DISCOURSES,

DELIVERED BY

SIR JOHN PRINGLE, BART.

WHEN PRESIDENT OF THE

ROYAL SOCIETY;

On occaſion of Six Annual Aſſignments of

SIR GODFREY COPLEY's MEDAL.

TO WHICH IS PREFIXED THE

LIFE OF THE AUTHOR.

By ANDREW KIPPIS, D. D. F. R. S. and S. A.

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PREFACE.

SOME time before Sir John Pringle's deceafe, feveral of his friends expreffed a wifh that he would collect into a volume the Six Difcourfes he had delivered, upon occafion of fo many annual affignments of Sir Godfrey Copley's Medal. This he declined doing, during his own life; but was difpofed to have them publifhed, in the manner that was requefted, after his death: for which exprefs purpofe, he committed a copy of them into my hands, a few days before he fet out for Edinburgh, in 1781. But, notwithftanding my authority from Sir John Pringle, as the Difcourfes had been originally printed under the ſanction, and by the command, of the Royal Society, I did not think myſelf juſtified in republiſhing them, without the permiſſion of that learned Body. Accordingly, I applied to Sir Joſeph Banks, who took up the matter with great readineſs and politeneſs; and, laying it before the Council, it was unanimouſly agreed that I ſhould have their conſent and approbation in the execution of my deſign. For the condeſcenſion and favour thus obligingly ſhewn to me, both by the Preſident and the Council, I here deſire their acceptance of my grateful acknowledgments.

Many of the materials from which the following Narrative is compoſed, have been furniſhed me by Sir John Pringle's family and friends. In this reſpect, I am particularly obliged to the attention and care of Sir James Pringle, and Dr. Hope of Edinburgh. Other circumſtances have been collected from ſeveral gentlemen in London; and eſpecially from Dr. William Watſon, Dr. Richard Saunders, and Mr. Stevenſon. With the latter part of our Author's Life I was myſelf well acquainted; having been honoured with his friendſhip for nearly ten years before his deceaſe. When the ſucceeding Account of him had been moſt of it printed off, James Boſwell Eſq. was ſo good as to favour me with a recital of various particulars, drawn from his own intimacy with Sir John Pringle, and from the information of his father, Lord Auchinleck. This communication did not come ſo late, but that I was able to avail myſelf of it, in ſeveral reſpects. Two things are mentioned by Mr.

Boſwell,

Boſwell, that I had not been informed of before; and which, therefore, could not be introduced in their proper places. One is, that Sir John Pringle, after he had ſtudied at the Univerſity of Edinburgh, was intended for the mercantile line, and that he went to Amſterdam for that purpoſe; but that his mind was turned to Phyſic, by accidentally hearing, at Leyden, a lecture of Boerhaave's, which ſtruck him in a remarkable manner. The other is, that he completed his medical ſtudies at Paris. This I ſuſpected to be the caſe; but not being aſſured of it, I did not chooſe to inſert it in my Narration. Where any circumſtances are taken from books, I have referred to my authorities. It will be ſeen that I am under ſome obligations to the Anecdotes of Mr. Bowyer, by my friend

Mr.

Mr. Nichols; to whom Biography, and Biographers in general, are ſo much indebted.

I deſire the Reader to remember, that it hath been my intention to give a Life of Sir John Pringle, with plainneſs and ſimplicity; and not a ſtudied panegyric. The elaborate and oratorical form of the profeſſed Eulogium, which, on certain occaſions, has its uſe and its beauty, I leave to the much abler men, who will undertake it at Paris; and I ſhall eſteem myſelf happy in having had it in my power to provide them with materials for their more elegant narratives. They may depend upon it, that Truth hath been my object; and that I have ſaid nothing concerning Sir John Pringle, which, I believe, will not be acknowledged to be juſt, by thoſe who were beſt acquainted with his character.

THE LIFE OF SIR JOHN PRINGLE, BART.

SIR JOHN PRINGLE was born at Stichel-Houſe, in the county of Roxburgh, North Britain, on the 10th of April, 1707. His father was Sir John Pringle of Stichel, Bart. and his mother, whoſe name was Magdalen Eliott, was ſiſter to Sir Gilbert Eliott of Stobs, Bart. Both the families from which he deſcended were very antient and honourable ones in the ſouth of Scotland, and were in great eſteem for their attachment to the religion and liberties of their country, and for their piety and virtue in private life. He was the youngeſt of ſeveral ſons, three of whom, beſides himſelf, arrived to years of maturity *. His grammatical education he received

* Robert, the eldeſt, ſucceeded to the eſtate and title of the family, and died, not many years ſince, at an advanced age. Gilbert, the ſecond, was an officer in the army; and Walter, the third, who was brought up to the law, was Sheriff of the county of Roxburgh. Sir John Pringle of Stichel had alſo, by his Lady, an only daughter, Margaret, who was married to Sir James Hall, Bart. of Dunglaſs, and was mother to the late Sir John, and grandmother to the preſent Sir James Hall. Robert Pringle, Eſq; a brother of the firſt Sir John Pringle, having quitted his native country, during the tyrannical government of King James the Second, came over with the Prince of Orange at the Revolution, and was appointed Deputy Secretary of State for Scotland. He was afterwards Secretary of War for Great Britain, and, at length, Regiſter General of the Shipping; which poſt he held till his deceaſe. In Carſtares's State-Papers, there are five letters written by him, which ſhew that he was a ſenſible and moderate man, and well verſed in public affairs. He departed this life at Rotterdam, on his return to England from the Spa, on the 13th of September 1736, being eighty years of age. Another brother of the firſt Sir John

 Pringle,

received at home, under a private tutor; and after having made ſuch a progreſs as qualified him for academical ſtudies, he was removed to the univerſity of St. Andrews, where he was put under the immediate care of Mr. Francis Pringle, profeſſor of Greek in the college, and a near relation of his father. Having continued here ſome years, he went to Edinburgh, in October 1727, for the purpoſe of ſtudying phyſic, that being the profeſ-

Pringle, was Sir Walter Pringle, Knight, one of the ſenators of the college of juſtice at Edinburgh, under the title of Lord Newhall. This gentleman was eminently diſtinguiſhed by his abilities and virtues; having been eſteemed, in his time, as an ornament to the bench and the profeſſion of the law, and as the pride and boaſt of his family and country. A character was drawn of him by the late Lord Preſident Arniſton, and publiſhed in the Scots Magazine. He died on the 13th of December, 1736; and an epitaph was written on him by Hamilton of Bangour, which is inſerted in that Author's volume of poems. There is, likewiſe, an engraved Portrait of Sir Walter Pringle.

ſion which he was now determined to follow. At Edinburgh, however, he ſtayed only one year, the reaſon of which was, that he was deſirous of going to Leyden, at that time the moſt celebrated ſchool of medicine in Europe. Dr. Boerhaave, who had ſo eminently contributed to bring that univerſity into reputation, was conſiderably advanced in years; and Mr. Pringle was unwilling, by delay, to expoſe himſelf to the danger of loſing the benefit of that great man's Lectures. We need not ſay that he here maintained the moſt diligent application to his medical ſtudies, and that he made the beſt uſe of the inſtructions given him by the illuſtrious profeſſor upon whom he attended. For Boerhaave he had a high and juſt reſpect: but it was not his diſpoſition and character to become the implicit and ſyſtematic follower of any man, however able and diſtinguiſhed. Whilſt he ſtudied at Leyden, he contracted an inti-

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mate friendſhip with Van Swieten, who afterwards became ſo famous at Vienna, both by his practice and writings. Van Swieten was not only Mr. Pringle's acquaintance and fellow ſtudent at the univerſity, but alſo his phyſician, when he happened to be ſeized there with a fit of ſickneſs. Nevertheleſs, he did not owe his recovery to his friend's advice: for Van Swieten having refuſed to give him the bark, another preſcribed it, and Mr. Pringle was cured. When he had gone through his proper courſe of ſtudies at Leyden, he was admitted, on the 20th of July, 1730, to his Doctor of Phyſic's degree. His inaugural Diſſertation, which, according to cuſtom, was printed, was "de marcore ſenili;" and his diploma was ſigned, beſides the other profeſſors of the univerſity, by Boerhaave, Albinus, and Graveſande; names of great celebrity, not only in the medical world, but among the learned in general.

Upon quitting Leyden, Dr. Pringle ſettled as a phyſician at Edinburgh, where he gained the eſteem of the magiſtrates of the city, and of the profeſſors of the college, by his abilities and good conduct. Though his ſtudies might principally be confined to his own profeſſion, this was not ſo entirely the caſe, but that he could find time for paying a conſiderable degree of attention to other objects, and particularly to thoſe highly important ones, natural religion and morality. Such, it is certain, was his known acquaintance with ethical ſubjects, that, on the 28th of March, 1734, he was appointed, by the magiſtrates and council of the city of Edinburgh, to be joint Profeſſor of Pneumatics and Moral Philoſophy with Mr. Scott, during the ſaid Mr. Scott's life, and ſole Profeſſor thereof after his deceaſe; and, in conſequence of this appointment, Dr. Pringle was admitted, on the ſame day, a member of the univerſity. In diſcharging the duties of this new employment, his text book was PUFFENDORFF *De Officio Hominis et Civis;* and agreeably to the method he purſued through life, of making fact and experiment the baſis of ſcience, he recommended much to his pupils Lord Bacon's works, and particularly the *Novum Organum* of that Father of true Philoſophy. Beſides this, he annually delivered ſeveral lectures on the immateriality and immortality of the ſoul; ſubjects that fell properly within his province, and which were not a little diſcuſſed at that period.

Dr. Pringle continued in the practice of phyſic at Edinburgh, and in performing the obligations of his professorship, till 1742, when he was appointed physician to the Earl of Stair, who then commanded the British army. For this appointment he was chiefly indebted to his friend Dr. Stevenson, an eminent physician at Edinburgh, who had an intimate acquaintance with Lord Stair.

By the interest of this nobleman, Dr. Pringle was constituted, on the 24th of August 1742, physician to the military hospital in Flanders; and it was provided in the commission, that he should receive a salary of twenty shillings a-day, and be entitled to half pay for life. He did not, on this occasion, resign his professorship of Moral Philosophy. The university permitted him to retain it, and Messrs. Muirhead and Cleghorn were allowed to teach in his absence. The same indulgence was granted

him,

him, from year to year, as long as he continued to requeſt it.

The eminent attention which Dr. Pringle paid to his duty as an army phyſician, is a matter that requires no enlargement in this place. It is a fact ſo generally known, and ſo univerſally acknowledged, that it cannot admit of a debate or a doubt; and were there no other teſtimony, it would be amply apparent from every page of his Treatiſe on the Diſeaſes of the Army. One thing, however, deſerves particularly to be mentioned, as it is highly probable that it was owing to his ſuggeſtion. It had hitherto been uſual, for the ſecurity of the ſick, when the enemy was near, to remove them a great way from the camp; the conſequence of which was, that many were loſt before they came under the care of the phyſicians. The Earl of Stair, being ſenſible of this evil, propoſed to the Duke

Duke de Noailles, when the army was encamped at Aſchaffenburg, in 1743, that the hoſpitals on both ſides ſhould be conſidered as ſanctuaries for the ſick, and mutually protected. The French general, who was diſtinguiſhed for his humanity, readily agreed to the propoſal, and took the firſt opportunity of ſhewing a proper regard to his engagement. For, after the battle of Dettingen, when the Britiſh hoſpital was at Feckenheim, a village upon the Maine, at a diſtance from the camp, the Duke de Noailles, having occaſion to ſend a detachment to another village upon the oppoſite bank, and apprehending that this might alarm the ſick, he ſent to acquaint them, that he had given expreſs orders to his troops not to diſturb them. This agreement was ſtrictly obſerved on both ſides during that campaign *.

* Preface to the Obſervations on the Diſeaſes of the Army, p. 8. Seventh edition.

At

At the battle of Dettingen, Dr. Pringle was in a coach with Lord Carteret during the whole time of the engagement, and the ſituation they were placed in was dangerous. They had been taken at unawares, and were kept betwixt the fire of the line in front, a French battery on the left, and a wood full of huſſars on the right. The coach was occaſionally ſhifted, to avoid being in the eye of the battery.

Soon after this event, Dr. Pringle met with no ſmall affliction in the retirement of his great friend, the Earl of Stair, from the army. He offered to reſign with his noble patron: but that generous and liberal minded commander not permitting him to think of it for a moment, he was obliged to content himſelf with teſtifying his reſpect and gratitude to his Lordſhip, by accompanying him forty miles on his re-

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turn to England; after which he took leave of him with the utmoſt regret.

But though Dr. Pringle was thus deprived of the immediate protection of a nobleman who knew and eſteemed his worth, his conduct in the duties of his ſtation procured him effectual ſupport. He attended the army, in Flanders, through the campaign of 1744, and ſo powerfully recommended himſelf to the Duke of Cumberland, that, in the ſpring following, on the 11th of March, he had a commiſſion from his Royal Highneſs, appointing him Phyſician General to his Majeſty's forces in the Low Countries, and parts beyond the ſeas: and on the next day he received a ſecond commiſſion from the Duke, by which he was conſtituted Phyſician to the Royal hoſpitals in the ſame countries.

Hitherto Dr. Pringle had not been certain whether he might not find reaſon to

return

return to the duties of his ſtation at Edinburgh, and to his medical practice in that city. But no ſooner was he aſſured of the promotions we have juſt mentioned, than he thougbt proper to reſign his Profeſſorſhip of Pneumatics and Moral Philoſophy. His letter to this purpoſe, addreſſed to Dr. Wiſhart, Principal of the college, is dated on the 5th of March, 1744-5; in which, with many expreſſions of gratitude, reſpect, and affection to the univerſity, he declares that he gives up his charge without condition or limitation.

In 1745, he was with the army in Flanders, but was recalled from that country, in the latter end of the year, to attend the forces which were to be ſent againſt the Rebels in Scotland. At this time he had the honour of being choſen a Fellow of the Royal Society. The election was on the 30th of October, and the

Society had reafon to be pleafed with the addition of a member, who was earneftly devoted to the purfuit of fcience in general, and who had the reputation and intereft of natural and experimental philofophy particularly at heart. How well he merited the diftinction conferred upon him, will hereafter appear.

Dr. Pringle, at the beginning of the year 1746, accompanied, in his official capacity, the Duke of Cumberland in his expedition againft the Rebels, and remained with the forces, after the battle of Culloden, till their return to England, in the middle of Auguft. We do not find that he was in Flanders during any part of that year. In 1747 and 1748, he again attended the army abroad; and in the autumn of 1748, he embarked with the forces for England, upon the conclufion of the treaty of Aix la Chapelle. From that

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time he principally refided in London, where, from his known fkill and experience, and the reputation he had acquired, he might reafonably expect to fucceed as a phyfician. It was to his knowledge, his application, and his attention alone, that he trufted for making his way in the metropolis. If any little artifices are ever made ufe of, in the city of London, to excite popularity, and to promote medical practice, Dr. Pringle was the laft man to adopt fuch artifices. If he could not have built his fuccefs on the bafis of fubftantial merit, he would not have fucceeded at all. We cannot but think that fuch a conduct is highly deferving of approbation and applaufe. In every profeffion of life, there is no fatisfaction that is equal to the confcioufnefs of inward worth, and of a mind fuperior to the various contrivances for obtaining the notice and favour of mankind

kind, to which insufficiency, vanity, or covetousness sometimes have recourse.

In the month of April, 1749, Dr. Pringle was appointed Physician in Ordinary to his Royal Highness the Duke of Cumberland *. In 1750, he published, in a letter to Dr. Mead, " Observations on the Jail or Hospital Fever." This piece, which passed through two editions, and was occasioned by the jail-distemper that broke out at that time in the city of London, was well received by the medical world, though he himself afterwards considered it as having been hastily written. After supplying some things that were omitted, and rectifying certain mistakes that were made in it, he included it in his grand work on the Diseases of the Army, where it con-

* Gent. Mag. Vol. xix. p. 189.

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ſtitutes the ſeventh chapter of the third part of that Treatiſe.

It was in the ſame year, that Dr. Pringle began to communicate to the Royal Society his famous ‘ Experiments upon Septic and ‘ Antiſeptic Subſtances, with Remarks re‑ ‘ lating to their Uſe in the Theory of ‘ Medicine.’ Theſe Experiments, which comprehended ſeveral Papers, were read at different meetings of the Society; the firſt in June, and the two next in the November following: three more in the courſe of the year 1751; and the laſt, in February, 1752. Only the three firſt Numbers were printed in the Philoſophical Tranſactions; the reaſon of which was, that Dr. Pringle had ſubjoined the whole, by way of Appendix, to his ‘ Obſervations on the Diſ‑ ‘ eaſes of the Army;’ for it is a general rule with the Royal Society, to inſert, in their Journals, none of thoſe Papers which, having been read before them, are afterwards publifhed by the Authors themfelves.

The Experiments upon Septic and Antifeptic Subftances, which have accompanied every fubfequent edition of the treatife juft mentioned, procured for our ingenious Phyfician the honour of Sir Godfrey Copley's gold medal. Befides this, they gained him a high and juft reputation, as an experimental philofopher; and, perhaps, have not a little contributed to promote that ardent fpirit of enquiry into the chemical powers and properties of Nature, which hath lately been productive of fuch wonderful difcoveries.

But though the Papers now fpecified were Dr. Pringle's chief communications to the Royal Society; the communications that were the moft important in themfelves, and on which his philofophical fame was

principally

principally founded; they were not the sole evidences of his solicitude, whilst only a private member of that learned Body, to carry on the purposes of its institution. Not again to resume the subject, we shall here mention several instances besides of his attention to Natural Knowledge, which have occurred to us, in looking over the Philosophical Transactions, and other publications.

In February, 1753, he presented to the Society an 'Account of several Persons 'seized with the Gaol Fever by working 'in Newgate, and of the Manner by which 'the Infection was communicated to one 'entire Family.' This is a very curious Paper; and it was deemed of such importance by the excellent Dr. Stephen Hales, that he requested the Author's permission to have it published, for the common good of the kingdom, in the Gentleman's Magazine; where it was accordingly printed, previoufly to its appearance in the Tranfactions *. Dr. Pringle's next communication was, ' A remarkable Cafe of Fragility, ' Flexibility, and Diffolution of the Bones †.' In the forty-ninth volume of the Tranfactions, we meet with accounts which he had given of an earthquake felt at Bruffels; of another at Glafgow and Dunbarton ‡; and of the agitation of the waters, on the firft of November, 1756, in Scotland and at Hamburgh §. The fifteenth volume contains Obfervations, by him, on the Cafe of Lord Walpole, of Woolterton; and a Relation of the Virtues of Soap, in diffolving the Stone, as experienced by the Reverend

* Gentleman's Magazine, vol. xxiii. p. 71—74. Philofophical Tranfactions, vol. xlviii. part i. p. 42—54.

† Ibid. p. 297—301.

‡ The greater part of the Paper is by Dr. Whyt.

§ Vol. xlix. part ii. p. 509—511. 546, 547. 550, 551.

Mr.

Mr. Matthew Simſon *. The next volume is enriched with two of the Doctor's Articles, of conſiderable length, as well as value. In the firſt, he hath collected, digeſted, and related the different accounts that had been given of a very extraordinary fiery meteor, which appeared on Sunday, the 26th of November 1758, between eight and nine at night; and, in the ſecond, he hath made a variety of remarks upon the whole, wherein is diſplayed no ſmall degree of philoſophical ſagacity †. It would be tedious to mention the various Papers, which, both before and after he became Preſident of the Royal Society, were tranſmitted through his hands. The merit of theſe Papers muſt principally and diſtinctively reſt with the Gentlemen by whom they were drawn up; though there

* Vol. l. part. i. p. 205—209. 219. 221.

† Vol. li. part i. p. 218—274.

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can be no doubt, but that ſome of them were prepared in conſequence of his particular requeſt, and might probably derive a conſiderable portion of their accuracy and perfection from the hints which he had ſuggeſted. Beſides his communications in the Philoſophical Tranſactions, he wrote, in the Edinburgh Medical Eſſays, volume the fifth, an Account of the Succeſs of the Vitrum ceratum Antimonii.

On the 14th of April, 1752, Dr. Pringle married Charlotte, the ſecond daughter of Dr. Oliver, an eminent phyſician at Bath, and who had long been at the head of his profeſſion in that city. This connection did not laſt long; the lady dying in the ſpace of a few years.

Nearly about the time of his marriage, Dr. Pringle gave to the Public the firſt edition of his ' Obſervations on the Diſeaſes ' of the Army.' It was reprinted, in the year following, with ſome additions. To the third edition, which was greatly improved from the farther experience the Author had gained by attending the camps, for three ſeaſons, in England, an Appendix was annexed, in anſwer to ſome remarks that Profeſſor De Haen, of Vienna, and M. Gaber, of Turin, had made on the Work. The like attention was paid to the improvement of the Treatiſe, in every ſubſequent edition. From more mature reflection, from the additional experience afforded by his private practice, and from his intercourſe with the medical gentlemen who had been employed in the hoſpitals abroad, in different climates, during the late war,—Dr. Pringle had an opportunity of expreſſing, with greater confidence, ſome of his former obſervations; and of omitting others, which he had advanced without ſufficient foundation. The work is divided into three parts; the firſt of which, being principally hiſtorical, may be read with pleaſure by every gentleman. The latter parts lie more within the province of phyſicians. They alone are the beſt judges of the merit of the performance; and to its merit the moſt deciſive and ample teſtimonies have been given. It hath gone through ſeven editions at home; and, abroad, it has been tranſlated into the French, the German, and the Italian languages. Scarcely any medical writer hath mentioned it, without ſome tribute of applauſe. Ludwig, in the ſecond volume of his 'Commentarii 'de Rebus in Scientia Naturali et Medi-'cina geſtis,' ſpeaks of it highly; and gives an account of it, which comprehends ſixteen pages. The celebrated and eminent Baron Van Haller, in his Bibliotheca Anatomica *, with a particular reference to the

* Tom. ii. p. 235.

treatiſe

treatiſe we are ſpeaking of, ſtiles the author ' Vir illuſtris — de omnibus bonis artibus ' benè meritus.'

It would be eaſy to produce a number of encomiums of a ſimilar kind; but it is the leſs neceſſary to multiply them, as the excellence of Dr. Pringle's Work is ſo generally acknowledged. It is allowed to be a claſſical book in the phyſical line; and that it hath placed the Writer of it in a rank with the famous Sydenham. Like Sydenham, too, he hath become eminent, not by the quantity, but the value of his productions; and hath afforded a happy inſtance of the great and deſerved fame, which may ſometimes ariſe from a ſingle performance. If it would not carry us too far out of our way, it might be an amuſing ſpeculation, to conſider the different paths which great men have purſued in their literary courſe; and how happily ſome few, both among the ancients and the moderns, have attained a high degree of glory, by only one, or, at leaſt, a ſmall number of compoſitions.

The reputation that Dr. Pringle gained by his ‘ Obſervations on the Diſeaſes of ‘ the Army,’ was not of a kind which is ever likely to diminiſh. He was happy in the choice of his ſubject, which, though it ought long ago to have been completely handled, had ſcarcely hitherto been touched upon ; and, though improvements will, no doubt, be made, and perhaps have been made, in the courſe of practice, as medical knowledge becomes more and more cultivated, the Work will always be held in eſteem, as having been founded on the ſolid baſis of experience, and not of theory. Its fate will be very different from that of many ſyſtems, which, though they have raiſed the fabricators of them to a

great

great temporary celebrity, have ſpeedily ſunk into oblivion, if not into contempt. Various inſtances might be mentioned of perſons, whoſe hypotheſes, notwithſtanding their having been the applauſe and wonder of their day, are now, if not forgotten, totally diſregarded. But we have no deſign of exalting our Author by other men's diſgrace.

The utility of Dr. Pringle's Treatiſe was of ſtill greater importance than its reputation. From the time that he was appointed a Phyſician to the Army, it ſeems to have been his grand object, to leſſen, as far as lay in his power, the calamities of war: nor was he without conſiderable ſucceſs in his noble and benevolent deſign. It cannot be doubted, but that the treatment he hath recommended, from his own obſervation and experience, hath been adopted by the able and judicious practitioners who have ſucceeded

ſucceeded him; and that hence many lives have been preſerved, which would otherwiſe have been loſt to the community.

The benefits which may be derived from our Author's Obſervations on the Diſeaſes of the Army, are not ſolely confined to gentlemen of the medical profeſſion. Commanders may learn from them, and eſpecially from the concluding chapter of the ſecond part of the Treatiſe, to determine, with ſome degree of certainty, what force may, at any time, be relied upon for ſervice; the effects of ſhort or long campaigns upon the health of the ſoldiers; the difference between taking the field early, and going late into winter quarters; with other calculations, founded upon ſuch materials as are furniſhed by war. General Melville, a gentleman who unites with his military abilities, the ſpirit of philoſophy, and the ſpirit of humanity, was enabled, when

Governor

Governor of the Neutral Iſlands, to be ſingularly uſeful, in conſequence of the inſtructions he had received from Dr. Pringle's book, and from perſonal converſation with him. By taking care to have his men always lodged in large, open, and airy apartments; and by rapidly ſhifting their quarters from the low, damp, and marſhy parts of the country, to the dry and hilly grounds, ſo as never to let his forces remain long enough in the ſwampy places, to be injured by the noxious air of ſuch places, the General was the happy inſtrument of ſaving the lives of ſeven hundred ſoldiers. A more honourable teſtimony cannot be given to the utility of the principles and rules which had been laid down by our Author.

In 1753, Dr. Pringle was choſen one of the Council of the Royal Society. Though he had not, for ſome years, been called abroad, he ſtill held his place of Phyſician to the Army; and, in the war that began in 1755, attended the camps, in England, during three ſeaſons. This enabled him, from farther experience, to correct ſome of his former obſervations, and to give additional perfection to the third edition of his great Work. In 1758, he entirely quitted the ſervice of the Army; and being now determined to fix wholly in London, he was admitted a Licentiate of the College of Phyſicians, on the fifth of July, in the ſame year. The reaſon why this matter was ſo long delayed, might probably be, his not having hitherto come to a final reſolution, with regard to his ſettlement in the Metropolis.

After the acceſſion of King George the Third to the throne of Great Britain, Dr. Pringle was appointed, in 1761, Phyſician to the Queen's Houſehold; and this ho-

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nour was ſucceeded, by his being conſtituted, in 1763, Phyſician Extraordinary to her Majeſty. On the twelfth of April, in the ſame year, he had been choſen a Member of the Academy of Sciences at Haarlem; and, on the twenty-fifth of June following, he was elected a Fellow of the Royal College of Phyſicians, London. In the ſucceeding November, he was returned on the ballot, a ſecond time, one of the Council of the Royal Society; and, in 1764, on the deceaſe of Dr. Wollaſton, he was made Phyſician in Ordinary to the Queen. On the thirteenth of February 1766, he was elected a foreign member, in the phyſical line *, of the Royal Society of Sciences at Goettingen; and, on the fifth of June, in that year, his Majeſty was graciouſly pleaſed to teſtify his ſenſe of Dr. Pringle's abilities and merit, by raiſing him to the dignity of a Baronet of Great Britain.

* Collega exterus Claſſis Phyſicæ.

On

On the eighteenth of July 1768, Sir John Pringle was appointed Phyſician in Ordinary to her late Royal Highneſs the Princeſs Dowager of Wales; to which office a ſalary was annexed of one hundred pounds a year. In 1770, he was choſen, a third time, into the Council of the Royal Society; as he was, likewiſe, a fourth time, for the year 1772. Upon the thirtieth of November, in that year, in conſequence of the death of James Weſt Eſquire *, he was elected

* James Weſt Eſq. had ſucceeded the Earl of Morton, as Preſident of the Society. He was the ſon of Richard Weſt Eſquire; and is underſtood to have been deſcended from Thomas Weſt, Lord Delawar, who lived in the reign of King James the Firſt. Mr. James Weſt was educated at Baliol College, Oxford; where he was admitted to the degree of Maſter of Arts, on the twenty-third of June, 1726. In 1741, he was choſen Repreſentative of the Borough of St. Albans; which borough he continued to ſerve, during ſeveral parliaments. Being appointed one of the Joint Secretaries of the Treaſury, he remained in that office many years; having held it till 1762. When, in 1765, his old friend and patron, the Duke of New-caſtle,

elected prefident of that illuftrious and learned Body. His election to this high ftation, though he had fo refpectable a

caftle, reverted to fome degree of power, by being conftituted, during the fhort period of the Rockingham adminiftration, Lord Privy Seal, his Grace obtained for him an annual penfion of two thoufand pounds. Mr. Weft was an early member of the Society of Antiquaries, and at length one of its Vice-Prefidents. Having been chofen a Fellow of the Royal Society, he became, in a courfe of time, Treafurer to that Body; and, at laft, as we have already feen, was raifed to the Chair. Though he was a man of general learning, we do not recollect that he was eminently diftinguifhed by his acquaintance with Philofophical or Natural Knowledge. It admits of no doubt, that, in this refpect, he was greatly excelled by moft of the Prefidents who went before him, and by thofe who were his fucceffors. As a Collector, he had great merit. He had a large and valuable collection of manufcripts relative to the Hiftory of England, which was fold, after his deceafe, to the Earl of Shelburne. His books, his prints and drawings, his coins and medals, his pictures, and other mifcellaneous articles and curiofities, were all of them difpofed of by auction, in 1773: and the fale of the whole employed fifty-five days. Mr. Weft died on the fecond of July, 1772. (Nichols's Anecdotes of Mr. Bowyer, p. 101, 102.)

character, as the late Sir James Porter, for his opponent, was carried by a very considerable majority. This was undoubtedly the higheſt honour that Sir John Pringle ever received; an honour with which his other literary diſtinctions could not be compared. He was fully ſenſible of the eminent mark of eſteem which the Royal Society had conferred upon him; and he was, at the ſame time, deeply convinced, that his new ſituation was not only a ſituation of dignity, but of the greateſt truſt and importance. Accordingly, it was his determination to diſcharge the duties of it with all the attention, aſſiduity, and zeal, of which he was capable.

It was at a very auſpicious time that Sir John Pringle was called upon to preſide over the Royal Society. A wonderful ardour for philoſophical ſcience, and for the advancement

ment of Natural Knowledge, had, of late years, diſplayed itſelf through Europe, and had appeared with particular advantage in our own country. Britons, to ſay the leaſt of them, had had their full ſhare in the diſcoveries of magnetiſm and electricity, in botanical enquiries and reſearches, and in the purſuit of other important objects. The ſpirit of experimental inveſtigation into every part and property of Nature, was high; and nothing could be more agreeable to the genius of Sir John Pringle, than to cheriſh ſuch a ſpirit. He endeavoured to do it by all the methods that were in his power; and he happily ſtruck upon a new way to diſtinction and uſefulneſs, by the diſcourſes which were delivered by him on the annual aſſignment of Sir Godfrey Copley's Medal.

This gentleman had originally bequeathed five guineas, to be given, at each anniverſary meeting of the Royal Society, by the determination of the Preſident and Council, to the perſon who had been the author of the beſt Paper of Experimental Obſervations for the year paſt. In proceſs of time, this pecuniary reward, which could never be an important conſideration to a man of an enlarged and philoſophical mind, however narrow his circumſtances might be, was changed into the more liberal form of a gold medal; in which form it is become a truly honourable mark of diſtinction, and a juſt and laudable object of ambition. It was, no doubt, always uſual with the Preſident, on the delivery of the Medal, to pay ſome compliment to the gentleman on whom it was beſtowed; but the cuſtom of making a ſet ſpeech on the occaſion, and of entering into the hiſtory of that part of philoſophy to which the experiments related, was firſt introduced by Mr. Martin Folkes. The Diſcourſes, however, which he and his ſucceſſors delivered, were very ſhort, and were only inſerted in the minute-books of the Society. None of them had ever been printed before Sir John Pringle was raiſed to the Chair. The firſt ſpeech that was made by him being much more elaborate and extended than uſual, the publication of it was deſired; and with this requeſt it is ſaid that he was the more ready to comply, as an abſurd account of what he had delivered had appeared in a newſpaper.

Sir John Pringle was very happy in the ſubject of his primary Diſcourſe. The diſcoveries in magnetiſm and electricity had been ſucceeded by the enquiries into the various ſpecies of air. In theſe enquiries, Dr. Prieſtley, who had already greatly diſtinguiſhed himſelf by his electrical experiments, and his other philoſophical purſuits and labours, took the principal lead. A

Paper of his, entitled, ' Obfervations on ' different Kinds of Air,' having been read before the Society in March 1772, was adjudged to be deferving of the Gold Medal; and Sir John Pringle embraced with pleafure the occafion of celebrating the important communications of his Friend, and of relating, with accuracy and fidelity, what had previoufly been difcovered upon the fubject. At the clofe of the fpeech, he earneftly requefted Dr. Prieftley to continue his liberal and valuable enquiries; and we need not fay how eminently he hath fulfilled this requeft. The aftonifhing difcoveries he hath fince made, and is ftill making, have fet his name far above all praife.

It was not, we believe, intended, when Sir John Pringle's firft fpeech was printed, that the example fhould be followed: but the fecond Difcourfe was fo well received

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by the Royal Society, that the publication of it was unanimoufly requefted. Both the Difcourfe itfelf, and the fubject on which it was delivered, merited fuch a diftinction. The compofition of the fecond fpeech is evidently fuperior to that of the former one; Sir John having probably been animated by the favourable reception of his firft effort. His account of the Torpedo, and of Mr. Walfh's ingenious and admirable experiments relative to the electrical properties of that extraordinary fifh, is fingularly curious. The whole Difcourfe abounds with ancient and modern learning, and exhibits Sir John Pringle's knowledge in Natural Hiftory, as well as in Medicine, to great advantage.

The third time that he was called upon to difplay his abilities at the delivery of Sir Godfrey Copley's Medal, was on an eminently beautiful and important occafion.

This was no leſs than Mr. (now Dr.) Maſkelyne's ſucceſsful attempt completely to eſtabliſh Sir Iſaac Newton's ſyſtem of the univerſe, by his ' Obſervations made on ' the Mountain Schehallien, for finding its ' Attraction.' Sir John Pringle laid hold of this opportunity to give a perſpicuous and accurate relation of the ſeveral hypotheſes of the ancients, with regard to the revolutions of the heavenly bodies, and of the noble diſcoveries with which Copernicus enriched the aſtronomical world. He then traces the progreſs of the grand principle of Gravitation, down to Sir Iſaac's illuſtrious confirmation of it; to which he adds a conciſe narrative of Meſſrs. Bouguer's and Condamine's experiment at Chimboraco, and of Mr. Maſkelyne's at Schehallien. If any doubts ſtill remained, with reſpect to the truth of the Newtonian Syſtem, they are now totally removed. Dr. Maſkelyne, who has otherwiſe largely con-

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tributed to the advancement of philoſophical ſcience, hath had the ſingular honour of eſtabliſhing ſo firmly the doctrine of univerſal attraction by this finiſhing ſtep of analyſis, that the moſt ſcrupulous can no longer heſitate to embrace a principle that gives life to aſtronomy, by accounting for the various motions and appearances of the hoſts of heaven.

Sir John Pringle had reaſon to be peculiarly ſatisfied with the ſubject of his fourth Diſcourſe; that ſubject being perfectly congenial to his diſpoſition and ſtudies. His own life had been much employed in pointing out the means which tended not only to cure, but to prevent, the diſeaſes of mankind; and it is probable, from his intimate friendſhip with Captain Cook, that he might ſuggeſt to that ſagacious commander ſome of the rules which he followed, in order to preſerve the health of the

crew

crew of his Majeſty's ſhip the Reſolution, during her voyage round the world. Whether this was the caſe, or whether the method purſued by the Captain, to attain ſo ſalutary an end, was the reſult alone of his own reflections, the ſucceſs of it was aſtoniſhing. Captain Cook, with a company of an hundred and eighteen men, performed a voyage of three years and eighteen days, throughout all the climates, from fifty-two degrees North to ſeventy-one degrees South, with the loſs of only one man by ſickneſs. By precautions equally wiſe and ſimple, he rendered the circumnavigation of the globe, ſo far as health is concerned, quite a harmleſs object. It is no wonder that Sir John Pringle ſhould celebrate, with affection, the conduct of his friend; who, beſides his admirable ſkill in preſerving the lives and health of his ſailors, had not only diſcovered, but ſurveyed, vaſt tracts of new coaſts; had diſpelled the

illuſion

illuſion of a *Terra Auſtralis Incognita*, and fixed the bounds of the habitable earth, as well as thoſe of the navigable ocean, in the Southern hemiſphere. Indeed, no one could be more juſtly entitled to applauſe than that man, who, independently of his other claims to diſtinction, had been able, by the practice of a few plain rules, reſulting from the union of good ſenſe, humanity, and experience, to render himſelf an eminent benefactor to his fellow-creatures. Captain Cook was not preſent to receive the honour of the Gold Medal. He was gone out upon the voyage from which he never returned. In this laſt voyage, he was equally ſucceſsful in maintaining the health of his men; and he determined the point, which had ſo long been conteſted, whether there is a practicable North-Weſt paſſage from Europe to the Eaſt Indies. But though, in theſe reſpects, he attained the objects he had in view, it muſt ever be

reflected

reflected upon with regret, that, in an unfortunate quarrel with the inhabitants of a remote iſland, the world was deprived of this great navigator, whoſe excellence and fame will be tranſmitted to the lateſt poſterity.

Sir John Pringle, in his next annual diſſertation, had an opportunity of diſplaying his knowledge in a way in which it had not hitherto appeared. The Diſcourſe took its riſe from the Prize Medal's being adjudged to Mr. Mudge, then an eminent ſurgeon at Plymouth, upon account of his valuable Paper, containing directions for making the beſt compoſition for the metals of reflecting teleſcopes, together with a deſcription of the proceſs for grinding, poliſhing, and giving the great ſpeculum the true parabolic form. Sir John hath accurately related a variety of particulars, concerning the invention of reflecting teleſcopes,

ſcopes, the ſubſequent improvements of theſe inſtruments, and the ſtate in which Mr. Mudge found them, when he firſt ſet about working them to a greater perfection, till he had truly realized the expectation of Sir Iſaac Newton, who, above an hundred years ago, preſaged that the Public would one day poſſeſs a parabolic ſpeculum, not accompliſhed by mathematical rules, but by mechanical devices. From this narration our Author naturally riſes, in his thoughts, to the wonders that aſtronomy preſents to our view, and to the admirable advantages which philoſophical ſcience hath derived from the methods that have been purſued for enlarging the powers of viſion.

It is impoſſible to paſs over the ſubject before us, without reflecting on the great acceſſion which has been made to aſtronomical knowledge, and the honour of the Society, ſince Sir John Pringle was Preſi-

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dent. Every reader will immediately understand that I refer to the communications of Mr. Herſchel; who hath carried the magnifying power of teleſcopes to a height far beyond what had hitherto been expected; who hath brought to light a large number of double and triple ſtars; and who hath not only diſcovered, but aſcertained without controverſy, the exiſtence of a new primary planet, beyond the orbit of Saturn, in the Solar Syſtem; to which, in honour of his Royal Patron and Benefactor, he hath given the appellation of the *Georgium Sidus.*

Sir John Pringle's ſixth Diſcourſe, to which he was led by the aſſignment of the Gold Medal to Mr. (now Dr.) Hutton, on account of his curious Paper, entitled, 'The Force of fired Gun-powder, and 'the initial velocity of Cannon-balls, de-

'termined by Experiments,' was on the theory of Gunnery. Though Sir John had ſo long attended the army, this was probably a ſubject to which he had heretofore paid very little attention. We cannot, however, help admiring with what perſpicuity and judgment he hath ſtated the progreſs that was made, from time to time, in the knowledge of Projectiles, and the ſcientific perfection to which his friend, Mr. Hutton, had carried this knowledge. As Sir John Pringle was not one of thoſe who delighted in war, and in the ſhedding of human blood, he was happy in being able to ſhew, that even the ſtudy of Artillery might be uſeful to mankind; and, therefore, this is a topic which he hath not forgotten to mention.

Here ended our Author's Diſcourſes upon the delivery of Sir Godfrey Copley's Medal. If he had continued to preſide in the

the Chair of the Royal Society, he would, no doubt, have found other occaſions of diſplaying his acquaintance with the hiſtory of philoſophy. But the opportunities which he had of ſignalizing himſelf in this reſpect, were important in themſelves, happily varied, and ſufficient to gain him a ſolid and laſting reputation. Perhaps it would not be deſirable that publications of ſuch a nature ſhould be very numerous; ſince, by that means, they might loſe, by degrees, their novelty, their utility, and their acceptance. We do not, therefore, think that, in this particular view, Sir John Pringle ought to be conſidered as a model to his ſucceſſors. It is beſt that each Preſident ſhould diſtinguiſh himſelf in that way which is peculiarly ſuited to his own purſuits and ſtudies; for thus, every valuable object being regarded in its turn, the honour of the Society, and the intereſts of philoſophical and natural

knowledge,

knowledge, will moſt effectually be promoted.

The merit of the Papers that were communicated to the Royal Society, whilſt Sir John Pringle preſided over it, was not confined to thoſe alone which were honoured with the aſſignment of the Gold Medal. Many of the Members diſtinguiſhed themſelves in the ſame period, as is evident from a ſurvey of the Tranſactions; and many names might be mentioned with applauſe: but it would carry us far out of our way to ſpecify all of them; and it would be too delicate a taſk, to ſingle out ſome few, to the excluſion of others. Indeed, the proſperous ſtate in which the Royal Society has long ſubſiſted, and in which it continues to ſubſiſt, muſt be reflected upon with pleaſure by every lover of philoſophical ſcience.

Several marks of literary diſtinction, as we have already ſeen, had been conferred upon Sir John Pringle, before he was raiſed to the Preſident's Chair. But, after that event, they were beſtowed upon him in great abundance: and, not again to reſume the ſubject, I ſhall here collect them together.

Previouſly, however, to theſe honours (excepting his having been choſen a Fellow of the Society of Antiquaries, London), he received the laſt promotion that was given him in his medical capacity; which was, his being appointed, on the fourteenth of November, 1774, Phyſician Extraordinary to his Majeſty. In the year 1776, he was enrolled in the liſt of the members of no leſs than four learned Bodies. Theſe were, the Royal Academy of Sciences at Madrid; the Society, at Amſterdam, for the Promotion of Agriculture; the Royal

Academy of Medical Correſpondence at Paris; and the Imperial Academy of Sciences at St. Peterſburgh. The times of Sir John Pringle's election into theſe eminent ſocieties, according to the order in which I have mentioned them, were on the twelfth of February, in the month of September, and on the twenty-eighth and twenty-ninth of December. Upon the laſt occaſion, he was honoured with the following Letter from Monſieur Euler; which hath been ſelected, out of many others of a ſimilar nature, as an evidence of the regard and eſteem wherein he was held by eminent foreigners.

'Monsieur,

'L'Academie Imperiale des Sciences 'vient de vous recevoir au nombre 'des ſes Aſſociés étrangers, elle a voulù 'vous donner par là, Monſieur, un té-

‘ moignage public du grand cas qu’elle fait ‘ déja dépuis long tems des vos travaux, et ‘ que vous meritez à tant de titres. Mais ‘ ce que réleve encore d’avantage cette re- ‘ ception, et ce qui eſt une diſtinction trop ‘ marqué pour ne pas vous en faire l’ob- ‘ ſervation, c’eſt que votre aggregation a ‘ été proclamée le jour de l’aſſemblée ſo- ‘ lemnelle, par laquelle l’Academie a céle- ‘ bré ſon premier jubilé demi-ſéculaire, ‘ jour qu’elle mettra toujours au nombre ‘ de plus glorieux pour elle, par l’inſigne ‘ faveur de ſa Majeſté le Roi de Pruſſe, et ‘ de ſon Alteſſe Imperial Monſeigneur le ‘ Grand Duc, qui ont bien voulû con- ‘ ſentir, qu’on les aggregeat à cette com- ‘ pagnie.

‘ Je m’applaudis d’être dans ce moment ‘ chargé de vous annoncer, Monſieur, cette ‘ nouvelle; et je ſaiſis, avec empreſſement, ‘ une occaſion auſſi favorable de voux ex-

‘ primer

'primer les ſentiments de la plus parfaite
'conſidération, avec leſquels j'ai l'honneur
'd'être, Monſieur,

'Votre, &c.

(Signed) 'JEAN ALBERT EULER*.'

St. Peterſburgh,
Jan. 10, 1777.

On

* SIR,

'THE Imperial Academy of Sciences, being deſirous of giving a public teſtimony of the high 'eſteem which it has for your learned labours, and of 'its ſenſe of your ſervices to the republic of letters, 'hath admitted you into the number of its foreign 'Members. Your reception into this Body has alſo 'been diſtinguiſhed by one circumſtance, too remarkable, and too honourable for you, to eſcape obſervation. Your admiſſion was publicly announced on a 'day of peculiar ſolemnity; on the day in which the 'Academy celebrated its firſt jubilee, on account of 'its having ſubſiſted half a century; and, at the ſame 'time, when the Academy had the honour of receiving into the number of its Members his Majeſty 'the King of Pruſſia, and his Imperial Highneſs the 'Grand Duke.

'I am extremely happy, Sir, to be appointed to 'communicate to you this information; and gladly

 'embrace

On the fifth of July, 1777, Sir John Pringle was nominated, by his Serene Highneſs the Landgrave of Heſſe, an honorary Member of the Society of Antiquaries at Caſſel. In 1778, he ſucceeded the celebrated Linnæus, as one of the foreign Members of the Royal Academy of Sciences at Paris. This honour is extended by that illuſtrious Body only to eight perſons, on which account it is juſtly eſteemed a moſt eminent mark of diſtinction; and we believe there have been few or no inſtances, wherein it hath been conferred on any other than men of great and acknowledged abilities and reputation. On the eleventh of October, in the ſame year, our Author was choſen a Member of the Medical Society at Hanau. In the ſucceed-

'embrace this favourable opportunity of expreſſing 'thoſe ſentiments of the moſt perfect regard, with 'which I have the honour to be, Sir,

Your &c.

St. Peterſburgh, Jan. 10, 1777.

JEAN ALBERT EULER.

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ing year, on the twenty-ninth of March, he was elected a foreign Member of the Royal Academy of Sciences and Belles Lettres at Naples. The laſt teſtimony of reſpect which was, in this way, beſtowed upon Sir John Pringle, was his being admitted, in 1781, into the number of the Fellows of the newly erected Society of Antiquaries at Edinburgh. The particular deſign of the Society is to inveſtigate the Hiſtory and Antiquities of Scotland: and, from the known characters and literature of the gentlemen who compoſe it, there can be little doubt, but that the end they have in view will ſucceſsfully be accompliſhed. Of this there is the greater reaſon to be confident, as I underſtand, with pleaſure, that the deſtruction of the Scottiſh records, by the cruel policy of king Edward the Firſt, was not ſo univerſal, or ſo general, as hath commonly been ſuppoſed.

It was at a late period of life, when Sir John Pringle was in the ſixty-ſixth year of his age, that he was choſen to be Preſident of the Royal Society. Conſidering, therefore, the extreme attention that was paid by him to the various and important duties of his office, and the great pains he took in the preparation of his Diſcourſes, it was natural to expect that the burthen of his honourable ſtation ſhould grow heavy upon him in a courſe of time. This burthen was increaſed not only by the weight of years, but by the accident of a fall in the area of the back part of his houſe, from which he received conſiderable hurt, and which, in its conſequences, affected his health, and weakened his ſpirits. Such being the ſtate of his body and mind, he began to entertain thoughts of reſigning the Preſident's Chair. It hath been ſaid likewiſe, and believed, that he was much hurt by the diſputes introduced into the

Society,

Society, concerning the queſtion, whether pointed or blunted electrical conductors are the moſt efficacious in preſerving buildings from the pernicious effects of lightning. Of this matter the preſent Writer of his Life can aſſert nothing from perſonal knowledge: for though he was then in the habit of a ſtrict intimacy with Sir John Pringle, he never heard from him any ſuggeſtion of the kind that has been mentioned. Perhaps Sir John Pringle's declining years, and the general ſtate of his health, will form ſufficient reaſons for his reſignation. His intention, however, was diſagreeable to many of his friends, and to many diſtinguiſhed Members of the Royal Society. Accordingly, they earneſtly ſolicited him to continue in the Chair; but, his reſolution being fixed, he reſigned it at the Anniverſary Meeting in 1778. Joſeph Banks Eſq. (now Sir Joſeph Banks, Bart.) was unanimouſly elected Preſident in his

room;

room; a gentleman in the prime and vigour of his life, who had eminently diſtinguiſhed himſelf by his acquaintance with Natural Hiſtory; who had ſailed round the globe, and performed other voyages, in purſuit of that branch of ſcience; who is preparing, at an immenſe expence and labour, the nobleſt and moſt ſplendid botanical Work, which hath ever been preſented to the Public; and who hath amply juſtified the choice that was made of him, by his attention to every part of his duty, and his aſſiduous concern to promote the intereſt and honour of the Society.

Though Sir John Pringle quitted his particular relation to the Royal Society, and did not attend its meetings ſo conſtantly as he had formerly done, he ſtill retained his literary connections in general. His houſe continued to be the reſort of

ingenious

ingenious and philofophical men, whether of his own country, or from abroad; and he was frequent in his vifits to his friends. He was held in particular efteem by eminent and learned foreigners, none of whom came to England without waiting upon him, and paying him the greateft refpect. He treated them, in return, with diftinguifhed civility and regard. When a number of gentlemen met at his table, foreigners were ufually a part of the company; and it would have been an uncommon thing not to have feen fome of them at his Sunday evening converfations. I remember well, that, one night, the perfons prefent, being eight in number, were each of them of a different nation; if Sir John Pringle, a Scotchman, and myfelf, an Englifhman, could be fo confidered. The fix others confifted of a Dutchman, a German, a Frenchman, a Spaniard, an Italian, and a Ruffian. Though we were thus di-

verfified

verſified in country, education, modes of life, and principles of religion, no obſtructions hence aroſe to mutual harmony, pleaſure, and improvement.

Sir John Pringle's infirmities increaſing, he hoped that he might receive an advantage from an excurſion to Scotland, and ſpending the ſummer there; which he did in the year 1780, and principally at Edinburgh. He had probably then formed ſome deſign of fixing his reſidence in that city. However this may have been, he was ſo well pleaſed with a place to which he had been habituated in his younger days, and with the reſpect ſhewn him by his friends, that he purchaſed a houſe there, whither he intended to return in the following ſpring. When he came back to London, in the Autumn of the year above mentioned, he ſet about preparing to put his ſcheme in execution. Accordingly,

having

having firſt diſpoſed of the greateſt part of his library, he ſold his houſe in Pall-Mall, in April, 1781, and ſome few days after removed to Edinburgh. In this city he was treated, by perſons of all ranks, with every mark of diſtinction. But Edinburgh was not now to him what it had been in early life. The vivacity of ſpirits, which, in the days of youth, ſpreads ſuch a charm on the objects that ſurround us, was fled. Many, if not moſt, of Sir John Pringle's old friends and contemporaries, were dead; and, though ſome of them remained, they could not meet together with the ſame ſtrength of conſtitution, the ſame ardour of purſuit, the ſame animation of hope, which they had formerly poſſeſſed. The younger men of eminence paid him the ſincereſt teſtimonies of eſteem and regard; but it was too late in life for him to form new habits of cloſe and intimate friendſhip. He found, like-

wiſe,

wiſe, the air of Edinburgh too ſharp and cold for his frame, which had long been peculiarly ſenſible to the ſeverities of weather. Theſe evils were exaggerated by his increaſing infirmities, and, perhaps, by that reſtleſſneſs of mind, which, in the midſt of bodily complaints, is ſtill hoping to derive ſome benefit from a change of place. He determined, therefore, to return once more to London, where he arrived in the beginning of September.

Before Sir John Pringle entirely quitted Edinburgh, he requeſted his friend, Dr. John Hope, to preſent ten volumes, folio, of Medical and Phyſical Obſervations, in manuſcript, to the Royal College of Phyſicians in that city. This benefaction was conferred on two conditions; firſt, that the Obſervations ſhould not be publiſhed; and ſecondly, that they ſhould not be lent out of the library on any pretence whatever.

ever. A meeting of the College being ſummoned upon the occaſion, Sir John's donation was accepted with much gratitude; and a reſolution paſſed to comply with the terms on which it was beſtowed. He was, at the ſame time, preparing two other volumes to be given to the Univerſity, containing the formulas referred to in his annotations.

Sir John Pringle, upon his arrival at the Metropolis, found his ſpirits ſomewhat revived. He was greatly pleaſed with reviſiting his London friends; and he was received by them with equal cordiality and affection. His Sunday evening converſations were honoured with the attendance of many reſpectable men; and, on the other nights of the week, he had the pleaſure of ſpending a couple of hours with ſuch friends as Lord Charles Cavendiſh, Mr. Cavendiſh, the Biſhop of Exeter (Dr. Roſs), Dr. Heberden, Dr. Watſon, Sir George Baker, Dr. Richard Saunders, Peter Holford Eſquire, Iſrael Mauduit Eſquire, and occaſionally a few gentlemen beſides. This was at a Society that had long been eſtabliſhed, of which Sir John Pringle had been many years a Member; and which had met, for ſome time paſt, at Mr. Watſon's, a grocer, in the Strand. Sir John's connection with this Society, and his conſtant attendance upon it, formed, to the laſt, one of his principal entertainments. The morning was chiefly employed by him in receiving and returning the viſits of his various acquaintance; and he had frequently a ſmall and ſelect party to dine with him, at his apartments in King's Street, St. James's Square. All this while, his ſtrength declined with a rapidity which did not permit his friends to hope that his life would long be continued. On Monday evening, the

fourteenth

fourteenth of January, 1782, being with the ſociety at Watſon's, he was ſeized with a fit, from which he never recovered. He was accompanied home by Dr. Saunders, for whom he had the higheſt regard, and in whom he had, in every reſpect, juſtly placed the moſt unreſerved confidence. The Doctor afterwards attended him with unwearied aſſiduity, but, to any medical purpoſe, entirely in vain; for he departed this life on the Friday following, being the eighteenth day of the month, in the ſeventy-fifth year of his age; and the account of his death was every where received, in a manner which ſhewed the high ſenſe that was entertained of his merit. On the ſeventh of February, he was interred in St. James's church, with great funeral ſolemnity, and with a very honourable attendance of eminent and reſpectable friends. As a teſtimony of regard to his memory, at the firſt meeting of the College of Phyſicians at

Edinburgh after his deceafe, all the Members appeared in deep mourning.

Sir John Pringle, by long practice, had acquired a handfome fortune, which he difpofed of with great prudence and propriety. The bulk of it, as might naturally and reafonably be expected, he bequeathed to his worthy nephew and heir, Sir James Pringle, of Stichel, Bart. whom he appointed his fole executor. But the whole was not immediately to come to Sir James; for a fum equal, I believe, to feven hundred pounds a-year, was appropriated to annuities, revertible to that gentleman, at the deceafe of the annuitants. By this means, Sir John exhibited an important proof of his regard and affection for feveral of his valuable relations. He provided, likewife, for two fervants, who had lived with him a confiderable time; and he left legacies to fome particular friends, among

whom

whom the Writer of this Life had the honour of receiving a teſtimony of his remembrance and eſteem.

Sir John Pringle's eminent character as a practical phyſician, as well as a medical author, is ſo well known, and ſo univerſally acknowledged, that an enlargement upon it cannot be neceſſary. He was diſtinguiſhed, in this reſpect, by his attention and ſagacity. For the recovery of his patients he was anxiouſly concerned; and his anxiety might, perhaps, be increaſed from his conviction, that the art of Phyſic, though eminently uſeful, muſt ever, from unavoidable cauſes, be attended with a certain degree of uncertainty. His care was rewarded with much ſucceſs in the courſe of his practice. In the exerciſe of his profeſſion, he was not rapacious; being ready, on various occaſions, to give his advice without pecuniary views. This he never denied to the poor; and, from many of his friends in better circumſtances, and who were well able to afford the cuſtomary gratifications, he refuſed to accept of fees.

The turn of Sir John Pringle's mind led him chiefly to the love of ſcience, which he built on the firm baſis of fact. With regard to philoſophy in general, he was as averſe to theory, unſupported by experiments, as he was with reſpect to medicine in particular. Lord Bacon was his favourite author; and to the method of inveſtigation, recommended by that great man, he ſteadily adhered. Such being his intellectual character, it will not be thought ſurpriſing, that he had a diſlike to Plato. The ſpeculations of that ſublime and ingenious, that elegant and beautiful, but at the ſame time fanciful writer, were by no means ſuited to the ſober ſpirit of enquiry cultivated by Sir

John Pringle. Indeed, whatever attention he might have paid, in his earlier days, and when he was Profeffor of Ethics at Edinburgh, to metaphyfical difquifitions, he loft all regard for them in the latter part of his life; and, though fome of his moft valued friends had engaged in difcuffions of this kind, with very different views of things *, he did not choofe to revert to the ftudies of his youth, but contented himfelf with the opinions he had then formed.

I fhall not conceal from my readers, that Sir John Pringle had not much fondnefs for poetry †. He had not even any diftinguifhed

* Dr. Price, Dr. Prieftley, and Lord Monboddo.

† That he was, however, himfelf the fubject of poetical commendation, will appear from the following fhort Latin Ode, which was addreffed to him, in 1753, by Dr. Theobald:

guiſhed reliſh for the immortal Shakſpeare: at leaſt, he had too high a ſenſibility of the defects of that illuſtrious Bard, to give him the proper degree of eſtimation. The Writer of this account, who is one of the warmeſt admirers of our great Dramatiſt and Maſter of human nature, cannot men-

' Ode, Viro ingenio pariter ac docto, JOHANNI
' PRINGLE, M. D. et S. R. S. ſacra.

' DIVA Romana cata temperare
' Barbiton Cantu, O habilis modorum
' Artifex, feſtis mihi nuper horis
' Sæpe vocata!

' Fida PRINGELLI modulos coruſco
' Ede ſacratos merito, colendi
' Semper et culti, celebri revincti
' Tempore ſerto.

' Inclytis nulli viget is ſecundus
' Laudibus, tu ſive animum benignum
' Reſpicis, ſeu quo Medicum refulget
' Clarus honorem.

' Concini dignus meliore plectro,
' Fac, ut haud ſurda hoc bibat aure carmen,
' Conditum parva licet arte, grato at
' Pectore textum.'

(Nichols's Anecdotes of Bowyer, p. 601.)

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tion it in commendation of his Friend, that he was defective in poetical tafte; but he thinks it proper to be recorded, from a regard to truth, and to ftate a fact which indicates the diverfity there is in the underftandings, purfuits, and feelings of the ableft men. The mind of Sir John Pringle was too clofely occupied by philofophical enquiries, to have much leifure or inclination for attending to the operations of the imagination. Whether this be confidered as a defect in him or not, it was certainly a lofs in point of real pleafure. A relifh for poetry, and for thofe other compofitions by which the fancy is amufed, affords a delightful relaxation, after more fevere inveftigations. It tends to produce a cheerfulnefs and hilarity of fpirits, which may poffibly not a little contribute to health, as well as to entertainment. Studies of this nature not only *adolefcentiam alunt*, but *feuectutem oblectant.* Nay, old age may derive a particular advantage from them, as they are calculated, by furnifhing agreeable and lively pictures to the imagination, to foothe the infirmities, and lighten the burdens, of that period.

Sir John Pringle had not, in his youth, been neglectful of philological enquiries; and, after having omitted them for a time, he returned to them again; fo far, at leaft, as to endeavour to obtain a more exact knowledge of the Greek tongue, probably with a view to a better underftanding of the New Teftament. He paid a great attention to the French language; and it is faid, that he was fond of Voltaire's critical writings. How far this might contribute to the honour of Sir John's tafte, I fhall not decide. However juft that eminent Frenchman's obfervations may have been on fome fubjects of criticifm, the truly

ingenious

ingenious and excellent Mrs. Montagu hath amply ſhewn, that he was abſolutely unequal to the taſk of determining concerning the merit of Shakſpeare. Among all his other purſuits, Sir John Pringle never forgot the ſtudy of the Engliſh language. This he regarded as a matter of ſo much conſequence, that he took uncommon pains with reſpect to the ſtyle of his compoſitions; and it cannot be denied, that he excels in perſpicuity, correctneſs, and propriety of expreſſion.

Though our Author was not fond of Poetry, there was a ſiſter art for which he had a great affection, and that was Muſic. Of this art he was not merely an admirer, but became ſo far a practitioner in it, as to be a performer on the violincello, at a weekly concert, given by a ſociety of gentlemen at Edinburgh. Muſic, if not too eagerly purſued, or permitted to engroſs an

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undue proportion of time, is a fine relief to the mind of a literary man. It is often neglected, as perſons advance in years; and this, I believe, was the caſe with my Friend.

Beſides a cloſe application to medical and philoſophical ſcience, Sir John Pringle, during the latter part of his life, devoted much time to the ſtudy of divinity. This was with him a very favourite and intereſting object. He read many commentators on Scripture, and eſpecially on the New Teſtament, of which he was anxious to obtain an exact and critical knowledge. In this purſuit, the learned and judicious Biſhop Pearce's Commentary and Notes gave him particular pleaſure, and were greatly ſuited to his taſte. He correſponded frequently with Michaelis on theological ſubjects; and that celebrated Profeſſor addreſſed to him ſome letters on Daniel's

Prophecy of the Seventy Weeks, which Sir John thought worthy of being publiſhed in this country. Accordingly, he was at conſiderable pains, and ſome expence, in the publication, which appeared, in 1773, under the following title: 'Joannis Davi-'dis Michaelis, Prof. Ordin. Philoſ. et Soc. 'Reg. Scient. Goettingenſis Collegæ, Epiſ-'tolæ, de LXX Hebdomadibus Danielis, ad 'D. Joannem Pringle, Baronettum: pri-'mò privatim miſſæ, nunc vero utriuſque 'conſenſu publicè editæ.' 8vo*.

Sir John Pringle was likewiſe a diligent and frequent reader of ſermons; which form a valuable part of Engliſh literature. Indeed, taken in their full extent, they conſtitute a much more valuable part of Engliſh literature, than, perhaps, is commonly imagined. For, independently of

* Nichols's Biographical and Literary Anecdotes of William Bowyer, p. 446, 447. Ibid. p. 601.

their

their theological merit, in explaining the doctrines of Natural and Revealed Religion, and throwing light on paſſages of Scripture, we ſhall ſcarcely any where meet with a richer treaſure of practical obſervation, or with reflections on life and manners, that are better calculated to improve the underſtanding, mend the heart, and regulate the conduct.

If, from the intellectual, we paſs on to the moral character of Sir John Pringle, we ſhall find that the ruling feature of it was integrity. By this principle he was uniformly actuated in the whole of his behaviour. All his acquaintance will with one voice agree, that there never was an honeſter man. He was equally diſtinguiſhed by his ſobriety. He told Mr. James Boſwell, that he had never in his life been intoxicated with liquor; which muſt be allowed to have been a very lauda-

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ble proof of the circumſpection maintained by him, in the variety of company that he had kept, both at home and abroad.

In his friendſhips, Sir John Pringle was ardent and ſteady. The intimacies which were formed by him, in the early part of his life, at Edinburgh, continued unbroken to the deceaſe of the gentlemen with whom they were made; and were kept up by a regular correſpondence, and by all the good offices that lay in his power. One of his oldeſt and moſt particular friends, was Mr. Alexander Boſwell, afterwards Senator of the College of Juſtice, by the title of Lord Auchinleck. Some unhappy differences having taken place between Lord Auchinleck, and his ſon Mr. James Boſwell, the ingenious, worthy, and well-known author of the Account of Corſica, Sir John Pringle was the benevolent and ſucceſsful mediator in procuring a reconciliation. In

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allufion to this circumftance, he expreffed himfelf, in a letter to Mr. James Bofwell, written in 1773, in the following terms: 'I fhall be glad to ferve you. But remember, in all cafes of oppofition, I fhall be 'on the minifterial fide; I mean, on that 'of your father, my oldeft and beft friend. 'You may inherit after him (if I fhould 'furvive him) my firft affections; but they 'cannot be alienated during his life.'

With relation to Sir John Pringle's external manner of deportment, he paid a very refpectful attention to thofe who were honoured with his friendfhip and efteem, and to fuch ftrangers as came to him well recommended. Foreigners, in particular, had great reafon to be fatisfied with the uncommon pains which he took to fhew them every mark of civility and regard. He had, however, at times, fomewhat of a drynefs and referve in his behaviour, which had the appearance of coldneſs; and this was the caſe, when he was not perfectly pleaſed with the perſons who were introduced to him, or who happened to be in his company. His ſenſe of integrity and dignity would not permit him to adopt that falſe and ſuperficial politeneſs, which treats all men alike, though ever ſo different in point of real eſtimation and merit, with the ſame ſhew of cordiality and kindneſs. He was above aſſuming the profeſſions, without the reality of reſpect.

Dr. Johnſon hath thought it proper to be recorded of Pope, that, when he wanted to ſleep, he ‘ nodded in company;’ and that he once ſlumbered at his own table, while the Prince of Wales was talking of poetry. Sir John Pringle had this infirmity, eſpecially in the latter part of his life. It chiefly appeared in the evening, and admits of a very eaſy and juſtifiable ſolution.

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He had for many years been ſo remarkably troubled for want of reſt, that there was ſcarcely a ſingle night, in which he did not lie awake for ſeveral hours. He had this nocturnal wakefulneſs to a degree that rendered it a great affliction; and, therefore, it is not ſurpriſing, that he ſhould occaſionally be overcome by drowſineſs. Neither can it be thought ſtrange, that the ſame cauſe ſhould have ſome effect upon his ſpirits. It was the principal, perhaps the ſole reaſon, of a certain weariſomeneſs and reſtleſſneſs that hung about him, and which he ſought to remove by changes of ſituation.

On the religious character of Sir John Pringle it will be neceſſary more particularly to enlarge; becauſe, ſuch is the temper of the preſent age, that what is the greateſt glory of any man, is often imputed to him as a weakneſs. The princi-

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ples of piety and virtue, which were early inſtilled into our Author by a ſtrict education, do not appear ever to have loſt their influence upon the general conduct of his life. Nevertheleſs, when he travelled abroad in the world, his belief of the Chriſtian Revelation was ſo far unſettled, that he became a ſceptic with regard to it, if not a profeſſed Deiſt. One cauſe of this, was the wrong notions he had formed concerning the genuine doctrines of the New Teſtament; and it will eaſily be ſuppoſed, that he was encouraged in his ſcruples by the company he met with both in England and in foreign parts. But it was not in the diſpoſition of Sir John Pringle, to reſt ſatisfied in his doubts and difficulties, with reſpect to a matter of ſuch high importance. He was too great a lover of truth, not to make Religion the object of his ſerious enquiry. As he ſcorned to be an implicit believer, he was equally averſe to the being an implicit unbeliever; which is the caſe of large numbers, who reject Chriſtianity with as little knowledge, and as little examination, as the moſt determined bigots embrace the abſurdeſt ſyſtem that ever was invented. The reſult of his inveſtigation was, a full conviction of the divine original and authority of the Goſpel. The evidence of Revelation appeared to him to be ſolid and invincible; and the nature of it to be ſuch, as demanded his warmeſt acceptance. What contributed entirely to remove the objections which had formerly lain upon his mind, was, his being perfectly ſatisfied, that our holy religion did not contain ſome doctrines which have commonly been thought to belong to it. There were three points that, in this view, appeared to him of great importance; and the removal of his difficulties, with regard to them, effaced every impreſſion he might have received to the diſadvantage of Chriſt-

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ianity. He became fully convinced, by his ſtudy of the Scriptures, that the Athanaſian doctrine of the Trinity made no part of them; but that they uniformly concurred in aſſerting the unity and ſupremacy of the God and Father of Mankind. He was equally convinced, that they did not confine the mercy of the Supreme Being to a few, excluſively of others; and that they did not hold out any thing, with reſpect to the extent and duration of the future puniſhment of the wicked, which could in the leaſt be conſidered as an impeachment of the divine juſtice, rectitude, and goodneſs. In theſe ſentiments, he agreed with ſome of the wiſeſt and beſt men the world hath ever produced, ſome who have reflected the greateſt honour on human nature. He was another inſtance of thoſe illuſtrious philoſophers, who have not been aſhamed of religion; and added another name to the catalogue of the excellent and judicious perſons, who have gloried in being RATIONAL CHRISTIANS *.

As

* A late writer, whoſe chief praiſe ariſes from the elegance and vivacity of his compoſition, hath treated the rational Chriſtians with great contempt and ſeverity, and, I may add, with the higheſt degree of injuſtice. (Diſquiſitions on ſeveral Subjects, p. 101—118.) He charges them with pretending to be Chriſtians, without believing; a charge which I have no heſitation in aſſerting to be abſolutely contrary to truth. To accuſe them, as he does, of want of ſincerity, and to put them on a level with the Deiſts, can only proceed from the groſſeſt ignorance, or from worſe motives; which I would not willingly impute to any gentleman of character. There are none who are more firmly perſuaded of the truth of the goſpel, none who are more clearly convinced of its divine original, none who are more entirely ſatisfied with the weight and variety of its evidence, none who more ſincerely rejoice in its invaluable contents, than rational Chriſtians. To men of this character the world is indebted for the fulleſt and ableſt vindications of the Old and New Teſtament, againſt the attacks of Infidelity. From the men of this character have proceeded thoſe works in ſupport of Natural and Revealed Religion, which will ſtand the teſt of ages, and againſt which the efforts of Scepticiſm will be directed in vain. Locke and Clarke, Hoadly and Sykes, Butler and Jortin, Chandler and Foſter, Leland and

Lardner,

As Sir John Pringle was thus firmly perfuaded of the truth of the Gofpel, he lived under

Lardner, Abernethy and Duchal, together with various other names that might be mentioned, were all of them rational Chriftians. I prefume that few of the able defenders of Revelation, which this country has produced, would have chofen to be called *irrational* Chriftians. It is unfortunate for fuch an irrational Chriftian as the Author of the Difquifitions, that his mode of writing hath occafioned many perfons, who are ftrangers to his character, to imagine that he is an infidel in difguife, and that his defign is to expofe our holy religion to contempt. For my own part, I have no doubt of the fincerity of his belief, and of the good intentions of his publications; but I think, at the fame time, that the manner in which thefe intentions have been difplayed, is remarkably injudicious. With regard to rational Chriftians, if there be fome doctrines, that have commonly been received, to which they do not give their affent, this doth not arife from the pride of human reafon, but from their firm perfuafion, that fuch doctrines are not to be found in the Scriptures. The Writer of the prefent Note can fincerely affert, that this is his own cafe. Being entirely convinced of the truth of Revelation, after a full, and, he trufts, a fair inveftigation of the matter, the fole object of his enquiry is, What does the Bible contain? what are the real dictates and declarations of our Lord and his apoftles? Thofe rational under its influence. He was animated with a ſtrong ſenſe of piety to the Supreme Being,

rational Chriſtians, who are ſuppoſed to depart the moſt from the ſtandards of faith generally eſtabliſhed, uniformly agree in maintaining a high ſenſe of the invaluable bleſſings derived from the Goſpel. They are ſatisfied that theſe bleſſings were beſtowed in a ſupernatural manner, by the God and Father of Mercies; that Jeſus Chriſt is the diſpenſer of them; and that they conſiſt of knowledge, pardon, purity, and everlaſting happineſs. They believe that eternal life is not only revealed by our Saviour, but abſolutely aſcertained by his death and reſurrection. This is a point, the importance of which no words can expreſs. With what juſtice, then, can any one degrade into the rank of Deiſts, the men who are fully perſuaded, that 'the gift of God is eternal life, through Jeſus Chriſt 'our Lord?' Every man, who knows the world, muſt be ſenſible, that the far greater part of thoſe who diſcard Revealed Religion, have little or no expectation of a future ſtate. But there is not a ſingle perſon, among ſuch as are called Rational Chriſtians, who will not ſay, with the warmeſt gratitude, 'This 'is the record, that God hath given to us eternal life, 'and this life is in his Son.'

It is an obſervation of great moment, and which, therefore, deſerves to be attended to, that the believers in Chriſtianity do not differ ſo much in their ſentiments

Being, which difplayed itfelf in a regular attendance upon public worfhip, in the

ments concerning the nature and value of the bleffings derived from the Gofpel, as with refpect to fome other queftions. They are all agreed, that, when mankind were ignorant and guilty, corrupt, and liable to a fentence of eternal death, the Saviour appeared, to communicate fpiritual inftruction, to beftow upon them the forgivenefs of fin, to purify their hearts and regulate their conduct, and to raife them up to everlafting felicity and glory. Of the unfpeakable excellence, and immenfe greatnefs, of thefe benefits, Chriftians are alike fenfible, and alike afcribe them to the Revelation of Jefus, however they may vary in their opinions concerning the caufes, or the effects of the caufes, which brought men into their wretched condition; and whatever ideas they may have formed concerning the dignity of the Perfon by whom the bleffings of the Gofpel are conveyed, and the peculiar operation of his fufferings. Were it, therefore, ever fo certain, that the rational Chriftians are miftaken in their fentiments, the charge brought againft them by the Writer of the Difquifitions, would ftill be equally uncandid and ill-founded. He is not the only Author who has preferred againft them the fame accufation. Others have reprefented them as being no better than Deifts: but fuch manifeft ignorance, bigotry, and injuftice, ought long ago to have been banifhed from this kingdom.

exercise of private devotion, and in an endeavour to discharge all the obligations of virtue. Such being the tenour of his life and conduct, and deriving great consolation from Christianity, as an institution of mercy, he rejoiced in a sense of the Divine favour, and in the hope of future happiness. Nevertheless, whether from a constitutional timidity of temper, or from early impressions, or from the state of his body, the approaches of death were met by him with some degree of apprehension. This was not an apprehension with regard to its consequences, but a certain kind of awfulness with relation to the thing itself; a disposition which has been experienced by many worthy persons. The wakefulness before mentioned, with which our Author was afflicted for so many years, will, perhaps, satisfactorily account for this failure of spirits; and to the same cause it may be ascribed, if, in any other respect, he did

not

not ſuſtain the infirmities of age with that full fortitude and dignity of mind, which, though always deſirable, cannot, even by the beſt characters, always be attained.

Sir John Pringle's literary and other connections were ſo very numerous, that only a ſmall part of them can here be ſpecified. Several of his learned and philoſophical acquaintance have already been occaſionally mentioned; and if, in adding a few more names to the liſt, I ſhould be guilty of any improper omiſſions, it will, I hope, be imputed to what alone it is owing, either to a want of information or recollection, or to the difficulty of choice, amidſt ſuch a variety of objects. In early life, our Author entered into a cloſe friendſhip with the moſt diſtinguiſhed perſons of the city of Edinburgh; and with ſome

of

of them he maintained a regular correſpondence *. The eminent philoſopher, Maclaurin, was his intimate friend; of whoſe memory he expreſſes himſelf, in one of his Diſcourſes, with peculiar affection, and whom he always ſpoke of, in converſation, with the higheſt marks of eſteem and regard. When he returned to Edinburgh, with the purpoſe of ending his days in that city, there were ſtill living, of his old acquaintance, Dr. George Wiſhart, Sir Alexander Dick, Dr. Hope, Dr. Steddman,

* Sir Alexander Dick has preſerved a ſeries of letters from Sir John Pringle, being forty-ſeven in number. They diſplay the excellence of his character in a full light, and ſhew the warmth and ſteadineſs of his friendſhip. They contain, likewiſe, many valuable articles in Medicine and Natural Philoſophy, accurately and pleaſingly expreſſed. His letters to Lord Auchinleck (whom he calls his firſt and beſt of friends), to Mr. James Boſwell, to Dr. Steddman, and other gentlemen, exhibit him in the ſame advantageous point of view.

and,

and, perhaps, ſome others, of whom I have not been particularly informed. The loſs he had ſuſtained, in the deceaſe of ſeveral of his former companions, was in part made up by their ſons; among whom Mr. Boſwell, Mr. Wallace, Mr. Murray (then Solicitor General for Scotland, and now one of the Lords of Seſſion), and Mr. Maclaurin, diſtinguiſhed themſelves in diſplaying every proof of attachment and reſpect to the man, who had been the intimate friend of each of their fathers.

Of Sir John Pringle's acquaintance in England, it would not be eaſy to give a detail. Were I to attempt ſuch a detail, it would include a large number of the moſt worthy and eminent characters, of all profeſſions. His converſation was not confined to medical gentlemen, though his intercourſe with them was very great, but extended to many perſons of rank and conſequence, as well as merit. He liked much to converſe with the liberal-minded clergy, whether of the eſtabliſhment, or among the Diſſenters; and he was honoured with the friendſhip and eſteem of ſome of the moſt excellent and learned prelates of the church. Among the diſtinguiſhed philoſophers of the age, there were few with whom he was not cloſely connected; and he had a particular intimacy with Dr. Franklin, till it was interrupted by the unfortunate public conteſts, which carried that celebrated man to another country, and another ſcene of action.

Without pretending diſtinctly to ſpecify Sir John Pringle's more private friends, who were numerous and highly reſpectable, I muſt be permitted to mention Edward

Maſon

Mafon Efq. (formerly Secretary to his Royal Highnefs William Duke of Cumberland), with whom our Author formed an acquaintance in Germany; which continued, with unbroken efteem and affection, to the end of life. To this gentleman he bequeathed a teftimony of remembrance in his laft will. For feveral years before his deceafe, there was no one in whom he placed fo unreferved a confidence, and for whom he had ftronger regard, than Dr. Richard Saunders. His fenfe of the Doctor's zealous attention and friendfhip was particularly expreffed, by leaving to him his prints and drawings.

It would be impoffible for me to do full juftice to Sir John Pringle's connections with foreigners. There were no perfons who vifited England, if they had any tafte for philofophical fcience, that were not re-

commended

commended to him, and did not cultivate his acquaintance. Befides this, he correfponded with many eminent philofophers and phyficians, whom he had never feen. Whether he ever had an opportunity of being perfonally acquainted with Linnæus, Baron Van Haller, and Tiffot, I do not recollect; but he maintained an epiftolary intercourfe with them, and with almoft every diftinguifhed name in Europe, and efpecially in Germany, France, and Holland. How far, and to whom, his correfpondence extended, might have been more exactly fpecified, if he had not burnt all his letters before his deceafe. The celebrated Abbé Fontana, during the time of his being in England, was much in the company of Sir John Pringle: but there was no foreigner who, at the different periods of his refidence in this country, enjoyed fo great an intimacy with him as Dr. Ingen-

houfz.

houſz. This gentleman was recommended by Sir John to the Empreſs Queen of Hungary, and to the Emperor of Germany, as a proper perſon to inoculate the Imperial and Auſtrian family; in the ſucceſsful performance of which, he attained to diſtinguiſhed emoluments and honours. The high ſenſe which he had of his obligations to our Author, in this and in other reſpects, he has expreſſed in a very handſome dedication, prefixed to his curious 'Experi-'ments upon Vegetables.' This was not the only book dedicated to Sir John Pringle. We have already ſeen, that Michaelis paid him a ſimilar teſtimony of regard; and the ſame was done by Baron Van Haller, in one of his publications. The reputation in which our Author was held abroad, was uncommonly great; and was productive of every mark of attention and eſteem.

Such

Such having been the character and eminence of Sir John Pringle, it was highly proper that his name ſhould be recorded among the Worthies of Weſtminſter Abbey. Accordingly, under the direction, and at the expence, of his Nephew and Heir, a monument is preparing, of which Mr. Nollekens is the ſculptor, and for which an Engliſh inſcription is intended.

If it had been determined to have had a Latin inſcription, there was one, written by a gentleman of the firſt claſſical knowledge and taſte, which would undoubtedly have had the preference. I have obtained leave to inſert it; and it gives me pleaſure that I can conclude my account of Sir John Pringle with ſo elegant and honourable a teſtimony to his memory.

M. S.

M. S.

Viri egregii JOHANNIS PRINGLE Baronetti;
Quem exercitus Britannicus,
Celſiſſima Walliæ Principeſſa,
Regina ſereniſſima,
Ipſius denique Regis Majeſtas,
Medicum ſibi comprobavit
Experientiſſimum, ſagacem, ſtrenuum:
Quem, ſtudiis academicis florentem,
Edinburgenſes olim ſui
In cathedrâ diſciplinæ ethicæ dicatâ
Adhuc juvenem collocârunt:
Quem poſteà, ætate ac ſcientiâ provectum,
Primùm perhonorifico ornavit prœmio,
Deindè ad ſummam apud ſe dignitatem evexit
Societas Regia Londinenſis.
Qualis fuerit medendi artifex,
Quali rerum comprehenſione præditus,
Materiem ſuam multiplicem
Quam ſcientèr explicuerit et illuſtraverit,
Scripta Viri doctiſſimi teſtentur
Per Europam omnem diſſeminata,
Nec forìs minùs quam domi nota.
Quâ autem fide et integritate fuerit,
Quam veri tenax et inimicus fraudi,
Quam conſtans Supremi Numinis cultor,
Ii, quibuſcum vixit,
Teſtes ſunto.

Exceſſit e vitâ, &c.

SIX
DISCOURSES,

DELIVERED BY

SIR JOHN PRINGLE, BART.

BEFORE THE

ROYAL SOCIETY;

On occafion of Six Annual Affignments of

SIR GODFREY COPLEY's MEDAL.

A

D I S C O U R S E

ON THE

DIFFERENT KINDS OF AIR,

DELIVERED AT THE

Anniverſary Meeting of the ROYAL SOCIETY,
November 30, 1773.

By Sir JOHN PRINGLE, Bart. PRESIDENT.

PUBLISHED AT THEIR REQUEST.

A
DISCOURSE
ON THE
DIFFERENT KINDS OF AIR.

GENTLEMEN,

IT is with great ſatisfaction I enter upon this part of my office—to confer, in your name, the prize-medal of the preſent year upon a Member of this Society ſo worthy of that diſtinction.

THE object which Sir GODFREY COPLEY, founder of the benefaction, had in view, and the manner in which the original pecuniary reward was converted into this more liberal form, having been fo lately explained by my honoured predeceffor; I need only obferve, that though your Prefident and Council have been entrufted with the fole power of adjudging this premium, yet they have now, as, I am perfuaded, they have had on former occafions, the greateft folicitude to nominate that perfon, who, in their opinion, would have obtained all your fuffrages.

In confidence of fuch unanimity, it is with fingular pleafure I acquaint you, that the Reverend Joseph Priestley, Doctor of Laws, has been found at this time the beft entitled to fo public a mark of your approbation, on account of the many curious and ufeful experiments contained in his *Obfervations on different Kinds of Air*, read at the Society in March 1772, and inſerted in the laſt complete volume of your Tranſactions *. And indeed, GENTLEMEN, when you reflect on the zeal which our worthy brother has ſhewn to ſerve the Public, and to do credit to your Inſtitution, by his numerous, learned, and valuable communications, you will, I imagine, be inclined to think, that we have been rather ſlow than precipitate in acknowledging ſo much merit.

YOUR time will not allow me to touch on the ſubjects of his former Papers †: nay, I apprehend I ſhall even treſpaſs upon it, by recalling to your memory only a few of thoſe intereſting diſcoveries which Doctor PRIESTLEY has made in theſe *Obſervations:* ſince, in doing juſtice to others as well as to him, it will be proper to remind you of the progreſs that had already been made in

* Vol. lxii.

† In Phil. Tranſ. vol. lviii, lix, lx.

this part of ſcience by men of the greateſt abilities in their time, and by other ingenious perſons ſtill among us.

There is not perhaps any branch of Natural philoſophy that has more engaged the attention of the learned, or been more ſucceſsfully cultivated, than the nature of the common air. The knowledge how indiſpenſable it is to the preſervation of animals, muſt have been coëval with mankind: it was from the beginning, as now, *the breath of life.* It was found likewiſe to be a neceſſary ſupport of fire, and they ſaw that the vegetable creation, deprived of it, languiſhed and died. Nor did the ancient phyſicians fail to diſtinguiſh, at leaſt attempt to diſtinguiſh, between the effects of an air too hot and one too cold, an air too moiſt and one too dry, and between an inſalutary and a wholeſome air.—Thus far the experience, or the theory of all ages.—

But the leſs obvious properties of this element, its gravitation and its elaſticity, with their long train of conſequences, remained unknown, till, about the beginning of the laſt century, Lord BACON and GALILEO, in that dawn of philoſophy which they themſelves diffuſed, began the inquiry. The former, from experiments, aſcertained the elaſticity of the air; and upon that principle conſtructed his *vitrum calendare*, the firſt thermometer *. The latter diſcovered that air had weight; but though that ornament of Italy was not ignorant of the limited ſuction of a pump, yet to account for the riſe of the water ſo far in it, he ſtill had recourſe to Nature's *abhorrence of a void* †.

TORRICELLI, at laſt, the diſciple of GALILEO, by one happy and deciſive ex-

* Bac. Nov. Org. lib. ii. aph. 13.

† Dialog. 1.

periment, diſcovered the preſſure of the atmoſphere; and PASCAL obſerved, that this preſſure varied according to the heights he carried his barometer *. Soon after followed the air-pump, the invention of the celebrated OTTO DE GUERICK; which, though at firſt a rude and imperfect inſtrument, yet, improved by himſelf †, and more by Mr. BOYLE and Dr. HOOK (two of the illuſtrious fathers of this ſociety), it ſoon became, in the hands of Mr. BOYLE, the means of opening the richeſt mines of natural knowledge. In this reſearch, the Hiſtory of the Common Air, he ſeemed ſo far to carry his inquiries, as to leave little to be done by others who ſhould come after him; thoſe parts excepted, depending on geometry and calculation ‡. How ſucceſs-

* Traité ſur l'Equilibre des Liq.

† Gaſpar. Schott. De Arte Mechan. Hydr. Pneumat. Exp. nova Magdeburgh.

‡ Boyle, Phyſico-mechan. Exp. & Mem. for a Gen. Hiſt. of the Air.

fully

fully theſe were executed by Dr. HALLEY and Sir ISAAC NEWTON, I ſcarcely need to mention; nor the ſolid foundation on which thoſe great men eſtabliſhed the rarefaction of the air; and in what proportion, according to its diſtance from the earth *. But it was Sir ISAAC NEWTON alone, who, upon the principle of the air's being compreſſed by the power of gravity, and that of its elaſticity, taught that tremulous bodies would communicate their motion to the air, and thereby excite vibrations in it, ſpreading every where. Thus he diſcovered the efficient cauſe of ſounds †.

BUT, before this period, Mr. BOYLE obſerving, as he himſelf informs us, how much air was concerned in many of the *phænomena* of Nature, and how neceſſary

* Phil. Tranſ. No. 181. p. 104. Abrid. vol. ii. p. 14. Phil. Nat. Princ. Math. lib. ii. prop. 22, 23.

† Phil. Nat. Princ. Mat. lib. ii. prop. 43.

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it was to the exiſtence of animals, became ſolicitous to inquire, whether a fluid of ſo great importance were not producible by art; if ſo, he believed that ſuch air might be ſerviceable in life, particularly in the art of diving, and in *ſubmarine navigation* *. With theſe views that admirable Naturaliſt ſet about making ſome new experiments, and, from a variety of bodies, by different proceſſes, obtained a pneumatical fluid (from ripe fruit, fermenting and effervefcing liquors, and from the putrefaction of animal and vegetable ſubſtances) anſwering, till then, his only criterion of air, in being of a durably elaſtic nature †. Yet after all, Mr. BOYLE found that theſe new productions were eſſentially different from common air, as they preſently extinguiſhed flame, and ſuffocated thoſe animals that

* An attempt of Cornelius Drebell to make a veſſel to row under water with men in it. See Boyle's Works, vol. i. p. 69; vol. iii. p. 174.

† Boyle's Works, vol. iv. p. 236, & ſeq.

attempted

attempted to breathe in them. But though he miſſed finding what he ſo much wanted, his labour was not in vain: philoſophy was enriched with the knowledge of what he called *factitious* or *artificial* air, which has in the end proved as uſeful as he could have wiſhed, in explaining ſeveral natural appearances, and in being ſubſervient to the wants of man.

BUT this diſcovery, however intereſting to the Naturaliſt, and to the Chemiſt in particular *, ſeems to have been little attended to, till, in the beginning of this century, Sir ISAAC NEWTON obſerved, that true permanent air ariſes from fixed bodies by heat and fermentation; and that thoſe aërial particles recede from one another with the greateſt force, which upon contact cohered moſt ſtrongly:—and that denſe bodies by fermentation rarefy into

* Hales, Stat. Eſſ. vol. i. ch. 6. p. 317.

ſeveral

ſeveral ſorts of air; and that this air, by fermentation, and ſometimes without it, returns into denſe bodies*. Excited by ſuch authority, the Reverend Dr. HALES (whoſe amiable as well as philoſophic qualities are ſtill freſh on the minds of ſeveral gentlemen preſent), reſuming thoſe experiments concerning the ſeparation of air from bodies, confirmed and extended the diſcoveries of Mr. BOYLE; ſhewing not only that air entered into the compoſition of moſt bodies, but the very proportion it bore to the reſt of the compound, and that often to an amazing quantity†. Dr. HALES likewiſe examined the mineral waters, thoſe of Pyrmont particularly; and, finding them abounding with air, to that circumſtance he aſcribed the ſpirit and briſkneſs of thoſe fountains. But that excellent author did not ſeem to apprehend, that in this, as in

* Compare Newton's Optics, Quer. 30, 31.

† Stat. Eſſ. vol. i. ch. 6.

other

other inſtances, the air which he produced was not the common air, but, if I may be allowed the expreſſion, the *factitious* air of Nature; as being of the ſame kind with what Mr. BOYLE had extracted from fermenting and effervefcing liquors; nay, the ſame with the *mephitis* or deadly vapour of the ancients, or the *mofeta* of the modern Italians, ſo frequently met with in the caverns, ſprings, and lakes of their country: and the ſame with the *ſtith* or *choak-damp* in our coal-pits, ſo often fatal to the miners. It muſt be owned it was hard to conceive, how theſe ſprings ſhould owe their prime virtues to what, in another manner of application, Dr. HALES ſaw was ſo deſtructive of vitality.

NOW this notion, concerning the impregnation of the mineral waters by the *mephitis*, was, as far as I know, originally ſuggeſted by a foreign Member, Dr. SEIP of Pyrmont,

Pyrmont, firſt in a treatiſe he publiſhed in the German language, and afterwards in a communication to this Society, in the year 1736, in which he deſcribes a ſmall cavern at Pyrmont, ſimilar to the *grotta de' cani*, near Naples *. But when this ingenious author calls that *mephitis* (which is a durably elaſtic fluid *ſui generis*) a *ſulphureous ſteam*, or a *ſulphureo-ſpirituous vapour*, he appears to have been imperfectly acquainted with its nature; which is now found to conſiſt of nothing inflammable or ſulphureous, and to be of a denſity, or ſpecific gravity, conſiderably greater than that of common air.

The fuller diſcovery of this principle we owe to Dr. Brownrigg of Whitehaven, who, about thirty years ago, began clearly to unfold this myſtery. But his curious papers were not then inſerted

* Phil. Tranſ. No. 448. Abridg. vol. viii. p. 659.

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in the Tranfactions, as the too modeft Author had requefted a delay, till he fhould be able to make them more worthy of that honour. In his communication he remarks, ' That a more intimate acquaint-' ance with thofe noxious airs in mines, ' called *damps*, might lead to the difcovery ' of that fubtile principle of mineral waters, ' known by the name of their *fpirit*; that ' the mephitic exhalations, termed the ' *choak-damp*, he had found to be a fluid ' permanently elaftic; and from various ' experiments he had reafon to conclude, ' that it entered the compofition of the ' waters of Pyrmont, Spa, and others; ' imparting to them that pungent tafte, ' from which they were denominated *aci-' dulæ*, and likewife that volatile principle, ' on which their virtues chiefly depend *.'

In order to afcertain a fact of fo much confequence, Dr. Brownrigg took the

* Vid. Phil. Tranf. vol. lv. p. 236. & feq.

opportunity,

opportunity, when at Spa ſeveral years after, to make ſome experiments for this purpoſe; when he had the ſatisfaction to find thoſe waters pregnant with the *artificial* or *factitious* air of Mr. Boyle, the ſame with that of the ſuffocating *grotta* near Naples, and the ſame with the *choak-damp* of our coal-mines; foraſmuch as this air inſtantly extinguiſhed flame, and the life of thoſe animals he had incloſed in it*. The ſucceſs of this worthy Member, in thus far analyzing thoſe waters, encouraged others to purſue the inquiry; and to inveſtigate the manner in which Nature alſo furniſhed them with the chalybeate principle †. Mr. Lane therefore, in conſequence of a converſation with Dr. Watson junior (both of this Society), upon an experiment of Mr. Cavendish's, by which that gentleman had found the me-

* Vid. Phil. Tranſ. vol. lv. p. 218. & ſeq.

† More properly, the *iron-principle.*

phitic

phitic air (ſuch as Dr. BROWNRIGG had detected in Spa-water) ſufficient to diſſolve any calcarious earth *: in conſequence, I ſay, of this converſation, wherein it was ſurmiſed, that the ſame mephitic air might likewiſe diſſolve iron in common water, Mr. LANE made the experiment with air taken from Spa water, and happily ſucceeded †. By this means the nature of the metallic principle, in mineral waters, was clearly explained; and the whole analyſis of thoſe celebrated fountains, ſo often attempted by chemiſts and others, and ſtill eluding their laboured reſearches, was thus, in the moſt ſimple manner, brought to light.

NOTHING now ſeemed to be wanting to the triumph of Art, but an eaſy manner of joining, as there ſhould be occaſion, one or

* Phil. Tranſ. vol. lvii. p. 92. & ſeq.

† Ib. vol. lix. p. 216. & ſeq.

both of theſe principles to common water, in order to improve upon Nature, in the more extenſive uſe of her medicine. This was effected by Dr. PRIESTLEY, after ſome other important diſcoveries had been made in this part of Pneumatics, firſt by Dr. BLACK, Profeſſor of Chemiſtry at Edinburgh, and then by Mr. CAVENDISH of this Society. The former has ſhewn that a particular ſpecies of factitious air (he calls it *fixed*) adheres to all calcarious earths, magneſia, and alcaline ſalts, with different degrees of force; and that this fluid can be ſeparated from theſe ſubſtances, and combined again with them, in the ſame manner as an acid. Upon this diſcovery he explained in a clear and ſimple manner many appearances in chemiſtry, till then deemed the moſt unaccountable. Such was the effervеſcence of abſorbent earths and alkaline ſalts with acids, and the change of the mild calcarious earths into quick lime by by heat (in conſequence of the expulſion of this *fixed* air which neutralizes them) *. I muſt add, that I have been well informed, that, for ſeveral years paſt, the learned Profeſſor has taught, that the air which unites with alkaline ſubſtances is of the ſame nature with the *mephitis*, or ſuffocating air of the *grotta de' cani* and mines; the ſame with what is emitted from vegetables in fermentation; and that in ſome reſpects it agrees with the air which has been injured by the breath of animals, or by the burning of fuel: and laſtly, that the air or elaſtic fluid ariſing from the ſolution of metals by acids is very different from the former.

Mr. Cavendish has made ſeveral valuable additions to theſe diſcoveries, not only with regard to that ſpecies of *factitious* air the Profeſſor had denominated *fixed air*,

* Eſſ. and Obſerv. Phyſ. & Liter. vol. ii. p. 157. & ſeq.

 but

but to other elaſtic fluids. He has with accuracy aſcertained the ſpecific gravity of this fixed air, as expelled from alkaline ſubſtances by acids, or from vegetable matter by fermentation; and has demonſtrated the ſimilarity of airs produced by either of theſe two ways. He has confirmed Dr. BLACK's account of the quantity of the fixed air contained in alkaline ſalts and in alkaline earths. He has ſhewn that this fluid can be mixed with water, and in what proportion; and that it flies off again from the water, upon heating it, or expoſing it to the common air. Laſtly, that this ſpecies of factitious air imparts to the water the power of diſſolving abſorbent earths; the experiment, as I obſerved before, which led to the knowledge, how Nature infuſed the metallic principle into what are commonly called the *chalybeate waters* *.

* Phil. Tranſ. vol. lvi. p. 141. & ſeq.

Of all these facts Dr. PRIESTLEY has carefully availed himself. For having learned from Dr. BLACK that this fixed or mephitic air could in great abundance be procured from chalk, by means of diluted spirit of vitriol *; from Dr. MACBRIDE, that this fluid was of a considerable antiseptic nature †; from Mr. CAVENDISH, that it could, in a large quantity, be absorbed by water ‡; and from Dr. BROWNRIGG, that it was this very air which gave the briskness and chief virtues to the Spa and Pyrmont waters §: Dr. PRIESTLEY, I say, so well instructed, conceived that common water, impregnated with this fluid alone, might be useful in medicine, particularly for sailors on long voyages, for curing or preventing the sea-scurvy. This,

* Ess. and Observ. Phys. & Liter. loc. cit.

† Experim. Ess. *passim*.

‡ Phil. Trans. vol. lvi. p. 161. & seq.

§ Phil. Trans. vol. lv. p. 218. & seq.

we know, is a putrid diſtemper, requiring all the antiſeptic quality of thoſe mineral waters, without the chalybeate principle, which might injure, by over-heating the blood, too much diſpoſed to inflammation. For this purpoſe, he made a ſimple apparatus, for generating this ſpecies of air from chalk, and mixing it with water, in ſuch quantities, and in ſo ſpeedy a manner, that, having exhibited the experiment before this Society, and the College of Phyſicians, it met with ſo much approbation, that, in order the Public might the ſooner reap the benefit of it, he was induced to detach this part of his labours, and in a ſeparate Paper to preſent it to the Admiralty *.

The reſt of his obſervations upon the different kinds of air, addreſſed to the Society,

* A pamphlet intitled, Directions for impregnating Water, &c.

ciety *, contain ſo much matter, that I will not preſume to encroach ſo far on your time, as to offer even a ſhort abſtract of the whole; but ſhall be ſatisfied to ſingle out a few of thoſe many diſcoveries, ſuch as are the moſt ſtriking, either for their immediate uſe in life, like that above; or for the explanation of ſome of the more intereſting appearances in Nature.

I COME, therefore, to another ſpecies of *factitious* air, called the *inflammable*. Till within theſe few years, little more was known, than that this kind of ſubtile fluid was found in mines, in neglected privies, and common ſewers; but chiefly in coal-pits, where it is called the *fire-damp*, making ſometimes formidable exploſions, and indeed often fatal to the miners. I do not recollect that Mr. BOYLE has taken any other notice of it †. But, about forty years

* Phil. Tranſ. vol. lxii.

† Boyle's Works, vol. iii. p. 101.; vol. v. p. 305, 306.

ago,

ago, Sir JAMES LOWTHER, Baronet, favoured the Society with an account, somewhat more particular, of this production of his coal-mines in Cumberland, accompanying it with several bladders filled with that fluid, which, in this house, burnt as readily, as at its source a month before. Yet still this extraordinary substance was considered more as an object of curiosity, than as one of philosophical inquiry, till Mr. CAVENDISH began to make experiments upon it; by which, and the consequences drawn from them, he has added another considerable branch to the doctrine of aërial fluids.

FIRST, he has taught how to produce at will, and in great abundance, this other permanently elastic fluid from three metallic bodies, Zinc, Iron, and Tin, by dissolving them in the diluted vitriolic acid, or spirit of sea-salt. This species of factitious air he has shewn to be surprizingly light,

being

being no more than the tenth part of the weight of common air, and therefore totally different from the *mephitis*, that other ſpecies of factitious air we have been treating of, and which, as was obſerved, is heavier than the air of our atmoſphere. Laſtly, Mr. CAVENDISH has given ſeveral experiments upon the inflammability of various mixtures of this fluid with common air, which are likewiſe new; and, like the reſt, have been made with great preciſion.

NOW, though Dr. PRIESTLEY has alſo improved upon this enquiry, by the addition of a variety of experiments; in particular, by ſhewing how this air becomes miſcible with water, and deprived of its inflammability; by comparing it with other ſpecies of factitious air, in regard to conducting the electrical fluid; by enquiring how far it may be conſidered as common

air,

air, loaded with the principle of fire, called *phlogiſton* by the modern chemiſts; with other curious obſervations on this ſubſtance: yet all theſe, with other kinds of factitious air, as I have already too long detained you, I muſt with regret paſs over; one other ſpecies excepted, as I reckon it among the moſt brilliant of Dr. PRIESTLEY's diſcoveries *.

THIS ſpecies he calls the *nitrous air*, without inſiſting on the propriety of the expreſſion. It was firſt produced from the Walton pyrites, by means of the ſpirit of nitre. Dr. HALES, who made the experi-

* I might have added another new ſpecies of factitious air, which he terms *acid*, firſt taken notice of by Mr. CAVENDISH, and more fully inveſtigated by Dr. PRIESTLEY. This is an elaſtic vapour, expelled by heat from ſpirit of ſalt, and not liable afterwards to be condenſed by cold. Water readily imbibes this air, and by that means becomes a ſtrong ſpirit of ſalt. The ſame acid air, or vapour, he has alſo diſcovered to be a decompoſer of ſubſtances that contain *phlogiſton*, and with them to form a proper inflammable air.

ment,

ment, obſerved that, when joined to common air, an effervefcence enſued, with a turbid red colour of the mixture, and an abſorption of part of the common air *. Dr. PRIESTLEY, extending the experiment to other metallic ſubſtances, obſerved, that the ſame kind of air was by the ſame acid readily procured from iron, copper, braſs, tin, ſilver, quickſilver, biſmuth, and nickel; and that though it conſtantly, when joined to common air, exhibited thoſe appearances mentioned by Dr. HALES, and more conſpicuouſly in proportion to the purity of the common air mixed with it (that is, its fitneſs for reſpiration); yet it made no change with either fixed or inflammable air, or that air tainted by the breath of animals, or the corruption of their bodies. By means of this teſt, he was enabled to judge of the kind, as well

* Stat. Eſſ. vol. ii. p. 280.

as of the degree of injury, done to common air, by candles burning in it; and to perceive a real difference in the air of his ſtudy, after a few perſons had been with him there. Nay, a phial of air having been ſent him from the neighbourhood of a large town, it appeared, upon a comparative trial, to be inferior in quality to that taken up near Leeds, where he then reſided. It was upon ſuch a proſpect of obtaining a criterion for diſtinguiſhing good air from bad, that Lord BACON almoſt in a rapture breaks out: ‘ Theſe are noble ‘ experiments, that can make this diſco‘ very; for they ſerve for a natural divina‘ tion of ſeaſons!’ and again, ‘ They teach ‘ men to chuſe their dwelling for their bet‘ ter health *.’

NOR is this all the uſe of the nitrous air: Dr. PRIESTLEY ſhews it to be one of the

* Nat. Hiſt. Exp. 777.

ſtrongeſt

ſtrongeſt antiſeptics. The fixed air has been proved by Dr. MACBRIDE, as was remarked, to be powerful in this particular; but this ſpecies of factitious air has been found to be of ſuperior efficacy. And as our Author has diſcovered it to be miſcible with water, he has reaſon to believe it may be applied to various purpoſes, ſuch as the preſervation of the more delicate birds, fiſhes, fruits, and anatomical preparations.

I SHALL now conclude with ſhewing from Dr. PRIESTLEY, what reſources Nature has in ſtore againſt the bad effects of corrupted air, which from various cauſes infect our atmoſphere.

IT is well known that flame cannot long ſubſiſt without a renewal of common air. The quantity of that fluid, which even a ſmall flame requires, is ſurpriſing: an ordinary

nary candle *conſumes*, as it is called, about a gallon of air in a minute. Now, conſidering the vaſt conſumption of this vital fluid by fires of all kinds made by man, and by volcanos, it becomes an intereſting enquiry, to aſcertain what change is made in the air by flame; and to diſcover what proviſion there is in Nature, to repair the injury done by this means to our atmoſphere. Dr. PRIESTLEY, after relating the conjectures of others, and not finding them ſatisfactory, was fortunate in falling upon a method of reſtoring air, which had been vitiated by the burning of candles in it. This led the way to the diſcovery of one of the great reſtoratives which Nature employs for this purpoſe, to wit, vegetation. See by what induction he proves his opinion.

IT was natural to imagine, that, ſince the change of common air is neceſſary to vegetable, as well as to animal life, both

plants

plants and animals rendered it foul in the ſame manner, ſo as to become unfit for farther life and vegetation. But when with that expectation the Doctor had put a ſprig of mint, in a growing and vigorous ſtate, under an inverted glaſs jar ſtanding in water, he was agreeably diſappointed to find, that this plant not only continued to live, though in a languiſhing way, for two months, but that the confined air was ſo little corrupted by what had iſſued from the mint, that it would neither extinguiſh a candle, nor kill a ſmall animal which he conveyed into it. What farther evinced the ſalutary nature of the *effluvia* of vegetables; he found that air, vitiated by a candle left in it till it burnt out, was perfectly reſtored to its quality of ſupporting flame, after another ſprig of mint had for ſome time vegetated in it. And to ſhew that the aromatic vapour of that plant had no ſhare in reſtoring this purity to the air, he he obſerved, that vegetables of an offenſive ſmell, and even ſuch as ſcarcely had any ſmell at all, but were of a quick growth, proved the very beſt for this purpoſe. Nay more, the virtue of growing vegetables was found to be an antidote to the baneful quality of air corrupted by animal reſpiration and putrefaction.

We have ſaid, that neither candles will burn, nor animals live, beyond a certain time in a given quantity of air; yet the cauſe of either ſo ſpeedy a death or extinction was unknown; nor was any method diſcovered for rendering that empoiſoned air fit again for reſpiration. Some proviſion however there muſt be in Nature for this purpoſe, as well as for that of ſupporting flame: without ſuch, the whole atmoſphere would in time become unfit for animal life, and the race of men, as well as beaſts, would die of a peſtilential diſtemper.

Yet

Yet we have reaſon to believe, that in our day the air is not leſs proper for breathing in, than it was above two thouſand years ago; that is, as far as we go back in Natural Hiſtory. Now, for this important end, the Doctor has ſuggeſted, to the Divine as well as to the Philoſopher, two grand reſources of Nature: the vegetable creation again is one, and the ſea, and other great bodies of water, are the other.

As to the former, having found that plants wonderfully thrive in putrid air, he began to attempt, by means of growing vegetables, to purify air that had been injured by animal reſpiration and putrefaction; nor was he leſs ſucceſsful than before. Theſe plants were ſure to recover the air to a degree of fitneſs for breathing in it, and that in proportion to their vigour, and the care he took to remove the rotten leaves and branches; which, remaining, would have marred the operation.

With regard to the ſecond reſource of Nature, namely the ocean and other waters, Dr. Priestley having obſerved, that both the air corrupted by the breath of animals, and that vitiated by other putrid matter, was in a good meaſure ſweetened by the ſeptic part infuſing itſelf into water, he concluded, that the ſea, the great lakes and rivers, which cover ſo large a proportion of the globe, muſt be highly uſeful, by abſorbing what is putrid, for the farther purification of the atmoſphere: thus beſtowing what would be noxious to man and other animals, upon the formation of marine and other aquatic plants, or upon other purpoſes yet unknown.

From theſe diſcoveries we are aſſured, that no vegetable grows in vain, but that

from

from the oak of the foreſt to the graſs of the field, every individual plant is ſerviceable to mankind; if not always diſtinguiſhed by ſome private virtue, yet making a part of the whole which cleanſes and purifies our atmoſphere. In this the fragrant roſe and deadly nightſhade co-operate: nor is the herbage, nor the woods that flouriſh in the moſt remote and unpeopled regions, unprofitable to us, nor we to them; conſidering how conſtantly the winds convey to them our vitiated air, for our relief, and for their nouriſhment. And if ever theſe ſalutary gales riſe to ſtorms and hurricanes, let us ſtill trace and revere the ways of a beneficent Being; who not fortuitouſly but with deſign, not in wrath but in mercy, thus ſhakes the waters and the air together, to bury in the deep thoſe putrid and peſtilential *effluvia*, which the vegetables upon the face of the earth had been inſufficient to conſume.

THIS, GENTLEMEN, is what I had to ſay upon the occaſion: perhaps too much; but the fruitfulneſs of the ſubject, with my earneſt deſire of commemorating ſome of the more important experiments and concluſions of Dr. PRIESTLEY, and of thoſe who preceded him in theſe enquiries, will, I hope, plead my excuſe. Nor can I conclude without congratulating this illuſtrious Body, on the poſſeſſion of ſo many members and friends, ſo capable to promote the great ends of this inſtitution; and who have within theſe few years ſo eminently diſtinguiſhed themſelves, by the lights they have thrown, not only upon this, but upon other of the more ſubtile fluids of Nature. You will underſtand, that to theſe diſcoveries upon factitious air, I join thoſe amazing ones upon magnetiſm and electricity, with all the uſes reſulting from them. Here you will recollect the prediction of him, who beſt taught the method of inveſ-

tigating

tigating philoſophical truth, the incomparable Lord BACON, who, with that ſpirit of divination peculiar to exalted genius, aſſured his diſciples, that when men ſhould ceaſe to trifle in framing *hypotheſes*, and building haſty ſyſtems; and ſhould, by a proper induction from ſober and ſevere experiments, attain to the knowledge of the *forms* of things [their more intimate qualities and laws]; they ſhould in the end command Nature, and perform works as much greater than were ſuppoſed practicable by the powers of natural magic, as the real actions of a *Cæſar* ſurpaſſed the fictitious ones of the hero of a romance*. Some earneſt, nor that inconſiderable, of this magnificent promiſe this Society has already obtained. Let thoſe who doubt, view that Needle, which, untouched by any loadſtone, directs the courſe of the Britiſh ma-

* Compare Bac. De Dignit. et Augment. Scient. lib. iii. cap. 5.

riner round the world; or that apparatus, ſo perfectly imitating the long ſuppoſed inimitable lightning; or that other, which diſarms the clouds of that tremendous meteor: or (not to depart from my ſubject) let them ſee how Art can, from chalk only, the leaſt promiſing ſubſtance, generate, or call it unfetter, a copious elaſtic fluid impriſoned in it, the poiſon of man, or his medicine, according to the mode of application; which, though inviſible, yet diſſolves earth and metals, and imparts the ſpirit and virtue to the moſt prized of mineral waters. Yet theſe are but inventions of yeſterday: I would ſtrictly ſay, inventions within the memory of my youngeſt hearer. If to theſe late acquiſitions, ſo honourable to this Society, I add thoſe in Natural Hiſtory, by the zeal and unwearied attention of ſome worthy members, who have extended your correſpondence, and adorned your Muſeum; and by thoſe other gentlemen, who, animated with a noble ſpirit, have, to their laſting honour, undertaken the moſt dangerous and moſt diſtant voyages in purſuit of Natural Knowledge: I ſay, when to the progreſs you are making in Experimental Philoſophy, I add that in the Hiſtory of Nature, every true lover of ſcience will rejoice to think, that your affairs have not, perhaps, at any period, been in a more flouriſhing condition.

Dr. PRIESTLEY,

IT is now time that, in the name and by the authority of the Royal Society of London, inſtituted for the improvement of Natural Knowledge, I preſent you with this Medal, the palm and laurel of this Community; as a faithful and unfading teſtimonial of their regard, and of the juſt ſenſe they have of your merit, and of the perſevering induſtry with which you have promoted the views, and thereby the honour, of this Society. And, in their behalf, I muſt earneſtly requeſt you, to continue your liberal and valuable inquiries, whether by farther proſecuting this ſubject, probably not yet exhauſted, or by inveſtigating the nature of ſome other of the ſubtile fluids of the univerſe. You will remember, that *Fire*, the great inſtrument of the chemiſts, is but little known, even to themſelves; and that it remains a *Query*, what was by the moſt celebrated of philoſophers propoſed as ſuch, whether there be not a certain fluid (he calls it *Æther*), the cauſe of gravity, the cauſe of the various attractions, and of the animal and vital motions*. Theſe, Sir, are indeed large demands: but the Royal Society have

* Newton's Optics, Quer. 18—24.

hitherto

hitherto been fortunate in their pneumatic reſearches. And, were it otherwiſe, they have much to hope from men of your talents and application, and whoſe paſt labours have been crowned with ſo much ſucceſs,

A

DISCOURSE

ON THE

TORPEDO;

DELIVERED AT THE

Anniverſary Meeting of the ROYAL SOCIETY,

November 30, 1774.

By Sir JOHN PRINGLE, Bart. PRESIDENT.

PUBLISHED BY THEIR ORDER.

A

DISCOURSE

ON THE

TORPEDO.

GENTLEMEN,

THE difpofal of the annual Prize-medal, founded on the benefaction of Sir GODFREY COPLEY, Baronet, having for fome years paft devolved upon your Prefident and Council, they have hitherto been fortunate in executing their truft in fuch a manner as to receive your approbation.

bation. 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 moſt deſerving of 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,

But, in order to your more freely fealing the choice of your Council with your fuffrages, permit me, Gentlemen, firft to lay before you a fhort abftract of what had been done in this branch of Natural Hiftory, antecedently to Mr. Walsh's experiments; and then to remind you of a few of his principal ones, that while we do juftice to our worthy brother, none may be defrauded of the praife due to their labour.

THE Torpedo, or cramp-fifh, a fpecies of the ray, being a common inhabitant of the Mediterranean, was early known to the Greeks. We find it firft mentioned in a book anciently afcribed to Hippocrates, though only as an efculent fifh; but the name alone (*νάρκη*) is fufficient to afcertain the knowledge the ancients then had of its

torporific

torporific qualities. And PLATO, nearly contemporary with HIPPOCRATES, certainly knew of them, as appears by the humorous comparifon he makes of SOCRATES to that animal, which he puts into the mouth of MENON, in his dialogue of that name. And his celebrated difciple in phyfics, ARISTOTLE, particularly treats of it in his Hiftory of Animals. The Torpedo (fays he) hides itfelf in the fand or ooze, and, whilft the other fifhes fwim over it, and touch it, he benumbs them, fo as to catch them and feed upon them: as a proof, the mullet, the fwifteft of the watery race, is found in his ftomach.

BUT though ARISTOTLE knew that the touch of the torpedo ftupified other fifhes, he feems not to have known that this extraordinary effect could be tranfmitted to other animals not in immediate contact with it, but by the interpofition of a ftick, 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 Ἀκουστικὰ, *Wonderful Relations*. Yet ARISTOTLE had only the teſtimony of fiſhermen for what he reports of the torpedo: indeed he expreſsly ſays ſo. In thoſe days, and for many ages after, the pride of Man ſet him above experiments; and 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 Stagyrite 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 but 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 that this animal is able to bind the arms of the ſtrongeſt, at a diſtance, is falſe.

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 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

* Gr. ὥσπερ βέλη διασπείρει ἀποῤῥοάς.

water,

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 author; but we are much disappointed. He 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 parts affected,

fected, and particularly for the cure of an obſtinate head-ach, as appears from SCRIBONIUS LARGUS, who lived under CLAUDIUS, and from DIOSCORIDES, who flouriſhed ſoon after. But GALEN, always reaſoning, and oppoſing empirical practice, aſſigns a cauſe for that ſalutary effect. 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 were 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 fol-

lowers

lowers 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 flanks), from which, as OPPIAN imagined, the animal had a faculty of darting upon other fiſhes certain ſubſtances, he terms κερκίδες, but whereof the meaning

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 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 that 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 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 enquire 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 ſound 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 enquiry 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 colleagues. 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 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

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 that 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 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

try

try 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 Royal 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

nervous fluid, or a repulfion of the fame. But, to obviate what might be objected, the celebrated inveftigator was bound to deny that this impreffion of numbnefs could be communicated through water, a net, or any other foft and yielding fubftance; nay, through a ftick, except a very fhort one. In fact, M. DE REAUMUR did deny fuch tranfmiffions; and yet it is certain, that the fhocks from the torpedo are not lefs conducted through fuch *media*, than thofe from a charged electrical phial. Shall we then accufe of want of candour thofe celebrated authors, BORELLI, LORENZINI, and M. DE REAUMUR? By no means: but let us lament the weaknefs of the human intellect, which, prepoffeffed by fyftem, will often not perceive fuch objects as would ftrike the fenfes of any other perfon, nay moft certainly their own, in a more unprejudiced ftate of mind! And let us regret that other infirmity, fo incident

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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 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 enquiry. 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 Haerlem. 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,

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; 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

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 naturalift, met with the fame, or a fimilar fifh, 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 fcales, 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 fo much a numbnefs, like that arifing from the torpedo, as a very painful trembling in the limbs of thofe who touched it. He adds, that this effect did not fenfibly differ from the fhock given by the Leyden Phial, which he had felt; and that it was communicated, in the fame manner, by fimple contact, or by the interpofition of a ftick, or an iron rod (five or fix feet long), fo as to force the perfon to drop whichever of them he had in his hand.

M. FERMIN,

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

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 farther 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,

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

Now,

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 ſurprizingly benumbing effects of the electric gymnotus ever been ſo narrowly obſerved, much leſs confronted with an electrical apparatus, as that we could with any preci-

ſion

ſion 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 entire animal, 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

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 diſpoſed 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

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, 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

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

agreed with, and corroborated thofe of Mr. WALSH, I need not mention, as you have fo lately heard the Doctor's Letter to me on that fubject.

NOR fhall I return to enter into any farther detail of Mr. WALSH's experiments, confidering what encroachment I have already made on your time, and how fenfible you muft be, that thofe which I have already reminded you of, have merited the honours you are now conferring upon him. I fhall only obferve, that our ingenious Brother having traced the fimilitude between the operations of the torpedo and thofe of an electrical apparatus, he found it fo ftrong, as to perfuade him that it was the identical fluid that actuated both the animal and the machine. Yet he remarks, that, though the charged phial occafions attraction and repulfion in fuch light bodies as the pith-balls, placed near it, and its difcharge is obtained through a fpace of air, and accompanied with light and found; nothing of this occurs with refpect to the torpedo. But to thefe objections againft a perfect agreement between the electrical and torpedinous fluids, Mr. WALSH anfwers, that, upon charging a number of large jars with a fmall quantity of electric matter, and then difcharging them, that matter will yield the appearances of the torpedo only. It will not now pafs the hundredth part of that inch of air, which in its collected ftate it would run through with eafe; the fpark and fnap and the attraction and repulfion of the balls will alfo be wanting; nor will a point, brought however near, if not juft in contact, be able to draw off the charge; and yet this diffufed electric matter, to effect its equilibrium, will inftantaneoufly pafs through a confiderable circuit of different conductors properly connected, and give a fenfible 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, excepting 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 ſcarcely 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. Hunter has well obſerved, and I think he 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,

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 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

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, 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

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 the

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

† Lord BACON.

World,

World, rifing in years and in wifdom, rejects fuch trifles. The Interpreters of Nature, in the adult ftate of Time, make experiments and inductions, diftruft their intellects, confide in facts and in their fenfes: and by thefe arts drawing afide the veil of Nature, find a mean and groveling animal armed with lightning, that awful and celeftial fire, revered by the ancients as the peculiar attribute of the father of their gods.

A

DISCOURSE

ON THE

ATTRACTION OF MOUNTAINS;

DELIVERED AT THE

Anniverſary Meeting of the ROYAL SOCIETY,

November 30, 1775.

By Sir JOHN PRINGLE, Bart. PRESIDENT.

PUBLISHED BY THEIR ORDER.

A

DISCOURSE

ON THE

ATTRACTION OF MOUNTAINS.

GENTLEMEN,

THE satisfaction you discovered when a proposal was laid before you, *for measuring the attraction of mountains*, and the manner in which you received the account of what had been done to fulfil that view, were such indications of your applause, that your Council, ever attentive to your

your ſentiments, have adjudged the Prize-medal of this year to the Reverend NEVIL MASKELYNE, his Majeſty's Aſtronomer at Greenwich, the author and conductor of that experiment. The many and valuable communications of our worthy Brother, preceding this inquiry, you have never failed to diſtinguiſh: but theſe his late labours, undertaken at your requeſt, with their ſucceſsful reſult, related in his Paper, intitled, *Obſervations made on the Mountain Schehallien for finding its Attraction*, and inſerted in the ſecond part of the volume of your Tranſactions for this year, ſeemed to lay the Society under ſuch obligations, as your Council preſumed you could not otherwiſe expreſs than by the higheſt mark of your approbation. In conſequence of this reflection, I have, by their authority, cauſed Mr. MASKELYNE's name, with the date of the preſent year, to be engraven on the Medal, in order to perpetuate to him the

the honour you were this day to confer upon him; if, after allowing me to recal to your remembrance ſome of the more intereſting particulars of this diſquiſition, and his operations, you ſhould not refuſe your ſanction to the judgment of your Council.

I SHALL not conſider the ſubject of attraction at large, nor touch upon any ſpecies of it, excepting what in latter times, by the effects, has been diſtinguiſhed by the name of *gravity* or *gravitation*; a property of bodies, perceptible to the vulgar, when things fall to the ground, but long acknowledged by this Society, to be a quality impreſſed by the Creator on all matter, whether of the earth or of the heavens, whether at reſt or in motion: *He commanded, and it was created.*

THE diſcovery of this extenſive principle, the phyſics of aſtronomy, depended

upon

upon a juſt notion of the arrangement and motions of the ſpheres; for, to underſtand their œconomy, it was neceſſary previouſly to know, which of the ſtars were quieſcent, which moved, and in what manner. Whoever therefore found out the true celeſtial ſyſtem, might be ſaid to have paved the way to the knowledge of that ſublime truth, the law by which the natural world is governed. But who were the inventors here? Were they Chaldeans or Ægyptians? Was it PYTHAGORAS, or PHILOLAUS, or any other Greek, either in their own country, or tranſplanted to the mathematical ſchools of Alexandria? I ſhall not enter upon that enquiry, as fruitleſs as obſcure. All that is clear and to our purpoſe, is, that ſome of the ancient Greeks conjectured rightly about the ſtability of the Sun, and the circular motion of the earth; but this was never a general perſuaſion, nor does it ſeem to have been mentioned any more after the age of Ptolemy, who in the ſecond century did not ſo much invent a new ſyſtem, as adopt that which now goes under his name, the prevailing one of his time, and nearly the ſame with that of Aristotle. This, though erroneous, was not, perhaps, incapable of improvements from celeſtial obſervations; but when the philoſophy of the ſchools was united with the Ptolemaic hypotheſis, and both were ſubjected to judicial aſtrology, then was aſtronomy debaſed to the level of the pretended learning of the dark ages that enſued, and increaſed their darkneſs.

But at the appointed time, when it pleaſed the Supreme Diſpenſer of every good gift to reſtore light to a bewildered world, and more particularly to manifeſt his wiſdom in the ſimplicity as well as in the grandeur of his works, he opened the glorious ſcene with the revival of a ſound aſtronomy. COPERNICUS of Thorn (a Poliſh city in the Regal Pruſſia), endowed by Nature with excellent talents, improved by a ſuperior degree of mathematics, and by travelling, became, early in life, diſguſted with the contradictions about the cauſe of the celeſtial phænomena. He had recourſe, as he himſelf informs us *, to every author upon the ſubject, to ſee whether any had been more conſiſtent in explaining the irregular motions of the ſtars, than the mathematical ſchools; but received no ſatisfaction, till firſt, from CICERO, he found that NICETAS had maintained the motion of the earth; and next, from PLUTARCH, that others of the ancients had been of the ſame opinion. CICERO had ſaid that 'NICETAS the Syracuſan (according to THEOPHRASTUS) held that the heavens, the ſun, the moon, the ſtars, in

* Præf. ad Lib. de Revolutionibus Orbium Cœleſtium.

'a word, all the celeſtial bodies, ſtood ſtill, 'and that, excepting the earth, nothing 'moved in the world; but that, whilſt 'the earth with the greateſt celerity turned 'round its axis, the ſame phænomena 'were produced as if it ſtood ſtill, and the 'heavens moved. And this ſome thought 'was alſo PLATO's notion, but ſomewhat 'obſcurely expreſſed *.'

PLUTARCH's words were, 'Others ſup-'poſe the earth to be at reſt; but PHILO-'LAUS, the Pythagorean, that it is carried 'in the ecliptic round the fire, like the 'ſun and the moon. HERACLIDES of 'Pontus, and ECPHANTUS the Pythago-'rean, make the earth move like a wheel 'about its centre, from weſt to eaſt, but 'not to change its place †.

* Cicer. Quæſt. Academic.

† Placit. Philoſ. lib. iii. cap. 3.

FROM theſe quotations, and what COPERNICUS farther ſays*, we find how little diſpoſed that great man was to plume himſelf with the inventions of others: nay, he was rather anxious not only to do juſtice to thoſe who had gone before him, but by their authority to ſcreen himſelf from the cenſure of innovation, abſurdity, and impiety, that awaited the publication of his doctrine. After all, the original genius of COPERNICUS was but little beholden, for the diſcovery of thoſe ſublime truths, to either NICETAS or PLATO, ſince it appears, from CICERO, that theſe two believed both the moon and the planets to be motionleſs. Nor could he be more aſſiſted by PHILOLAUS, who taught that *the earth turned round* a *fire*; but this fire could not be the ſun, becauſe that Ancient compares the motion of the earth about *the fire*, to the revolution of the ſun

* Placit. Philoſ. lib. iii. cap. 3.

and

and moon about the earth. Laſtly, what little light COPERNICUS could draw from HERACLIDES and ECPHANTUS, I ſcarcely need ſay, ſince they, though admitting the diurnal motion of the earth, denied the annual.

BUT if COPERNICUS ſought to do juſtice, why did he not rather cite a clear and expreſs paſſage in the Arenarius of ARCHIMEDES, for the fixed ſtate of the ſun, and for the motion of the earth in a circle round his body? 'What moſt philoſophers 'call the world,' ſays that famous Ancient, 'is a ſphere, of which the centre is that of 'the earth, and whereof the ſemi-diameter 'is equal to a right line joining the centers 'of the earth and the ſun. But ARIS'TARCHUS the Samian, refuting this opi'nion, has advanced an hypotheſis, where'by the world ſhould be many times 'greater than what is here ſaid; for he

 'ſuppoſes

‘ ſuppoſes that the fixed ſtars and the ſun ‘ remain immoveable, and that the earth ‘ is carried in a circle round the ſun, placed ‘ in the middle of its courſe *.’

THUS far ARCHIMEDES, who ſeems not to diſapprove the ſyſtem, but who explains it no farther, as what he had quoted was ſufficient for his purpoſe. It is probable that the penetrating genius of ARISTARCHUS had diſcovered the true arrangement of all the celeſtial bodies, and thereby totally anticipated COPERNICUS; but that circumſtance is no where, that I know of, recorded; and otherwiſe, we ſhould acquit our illuſtrious Reformer of plagiariſm, with regard to ARISTARCHUS, ſince neither the Arenarius of ARCHIMEDES, where that paſſage is found, nor indeed any other of his valuable remains, had ſeen the light before the death of COPERNICUS. This

* Archimed. Arenar. ed. Oxon. 1676.

extraordinary perſon had, even before the meridian of life, completed his diſcoveries, and compriſed them in his book *De Revolutionibus Orbium Cæleſtium*, his only work; but which he had prudently ſuppreſſed, till he had maturely conſidered his ſubject, and had found a neceſſary and powerful patron, the pope himſelf, PAUL III., a lover of aſtronomy, to protect him. Alluding to the admonition of the Poet, he tells the Pontiff, 'he had ſuffered that fruit of 'his labours to ripen, not nine years only, 'but four times nine *.' Conſenting at laſt to the publication, he committed the care of the impreſſion to ſome friends in a diſtant city, from whom he received the finiſhed copy a few hours before he expired †.

FEW compoſitions have deſtroyed more riveted errors, or eſtabliſhed more import-

* Præfat. ad Lib. de Revolut.

† Gaſſend. in Vita Copernic.

ant truths. Here, inftead of an abfolute ftate of reft for the earth, its triple motion is afcertained, the diurnal about its axis, the annual about the fun, and that other, known by the term *preceffion of the equinoxes*; all which, till then, had been referred to the motion of the heavens. He likewife demonftrated the double orbit of the moon; that is, her menftrual motion about the earth, and her annual about the fun. Nor did the wife COPERNICUS ftop here: for, after laying this folid foundation of the celeftial phyfics, he began the fuperftructure, by furmifing a principle of *attraction* to be inherent in all matter. Thus, in refuting the peripatetic notion, that bodies fall to the ground, becaufe, by a law of Nature, every thing heavy tends to the centre of the univerfe (which they fuppofed to be in the centre of the earth), he obferved that 'the earth could not be the 'centre of the orbits of feveral of the pla-

'nets,

'nets, becaufe of the apparent irregularities of their motions, and therefore could not be the centre of the univerfe. Hence, according to thefe philofophers, there muft be more centres than one; and if fo, who could tell the true centre, toward which all bodies were to gravitate? As for gravity (fays he), I confider it as nothing more than a certain natural appetence *(appetentia)*, that the Creator has impreffed upon all the parts of matter, in order to their uniting and coalefcing into a globular form, for their better prefervation; and it is credible that the fame power is alfo inherent in the fun, and moon, and planets, that thofe bodies likewife may conftantly retain that round figure in which we behold them *.' Farther, COPERNICUS looked upon the fun as the chief governing power of the earth and all the other pla-

* De Revolut. Orb. Cœleft. lib. i. cap. 9.

nets;

nets; for, after placing the great luminary in the centre, he cries out with rapture, '*Profectò tanquam in ſolio regali ſol reſidens* '*circumagentem gubernat aſtrorum fami-* '*liam* *.' Nor was this *government* underſtood to be exerciſed by any other power than that of *attraction*; as may be inferred from ſome of the laſt words of the celebrated TYCHO BRAHE, who, perceiving the approach of death, called for the famous KEPLER (then a young man, and his aſſiſtant in his obſervatory at Prague), and after charging him with completing and publiſhing the aſtronomical tables which he was leaving unfiniſhed, thus addreſſed him: 'My friend, although what 'I aſcribe to a voluntary, and, as it were, 'an obſequious motion of the planets 'round the ſun, you attribute to an *at-* '*tractive* energy of that body; yet I muſt 'entreat you, that, in the publication of

* De Revolut. Orb. Cœleſt. lib. i. cap. 10.

'my

'my obſervations, you would explain all 'the celeſtial motions by my hypotheſis, 'rather than by that of COPERNICUS, 'which I know you would otherwiſe in-'cline to follow *.

FROM this paſſage, which I have taken from the life of TYCHO BRAHE, it would ſeem, that though that other excellent aſtronomer was not inſenſible of ſome influencing power of the ſun over the planets, he would not however expreſs it by ſo ſtrong a term as *attraction*. But in what manner KEPLER complied with the requeſt of his dying patron, it is not our preſent purpoſe to mention, and therefore we ſhall only obſerve, that in his own works he conſtantly maintains the doctrine of attraction, and carries it even farther than ever COPERNICUS had done. Thus he calls gravity *a corporeal and mutual affection*

* Gaſſend. in Vit. Tych. Brah. cap. 5.

between

between similar bodies, in order to their union *. Again he remarks with COPERNICUS, against the peripatetics, that ' heavy bodies do not tend to the centre of ' the universe, but to the centre of those ' larger round bodies, of which they make ' a part; so that, if the earth were not ' spherical, things would not fall from all ' points towards its centre. If a stone ' were to be placed at a distance from another stone, in any part of the universe, ' without the sphere of action of a third ' body, like two magnets, they would ' come together in some intermediate point, ' each advancing, in space, in the inverse ' proportion of their quantities of matter. ' Hence, if the moon and the earth were ' not by some power kept asunder in their ' respective orbits, they would move towards one another; the moon making ' fifty-three parts of the way, while the

* Astron. Nov. in Introduct.

' earth

'earth made one, ſuppoſing their denſities
'equal *.'

FROM the ſame principle KEPLER accounted for the general motion of the tides; to wit, by the attraction of the moon, and expreſsly calls it *virtus tractoria quæ in luna eſt* †. He adds, that if the earth did not exert an attractive power over its own waters, they would riſe and ruſh to the moon ‡. Farther, we find him ſuſpecting certain irregularities in the motion of the moon to be owing to the combined action of the earth and ſun upon its body §. Theſe, and other reflections concerning the univerſality of attraction, he accompanies with an ingenious anticipation of a law of Nature, from conjecture only, but which was afterwards made out by experiments. The ſchools had taught, that

* Aſtron. Nov. in Introduct. † Ibid.
‡ Ibid. § Aſtron. Nov. cap. xxxvii.

'ſome

'some bodies were by their nature heavy, 'and so fell to the ground, and that others 'were by their nature light, and therefore 'mounted upwards:' but KEPLER pronounced that 'no bodies whatsoever were 'absolutely light, but only relatively so; 'and, consequently, that all matter was 'subjected to the law of gravitation *.'

HITHERTO the genius of KEPLER had been fortunate, in tracing out that great principle, which hindered the planets from flying off from the sun: But what kept them from falling into that mass of fire, and what power perpetuated their motion in their orbits? Here his sagacity had failed him, and left his imagination to furnish the idea of a system of *vortices* for DESCARTES.

BUT howsoever incomplete these notions were concerning gravitation, yet, in justice

* Astron. Nov. in Introduct.

to

to their diſtinguiſhed authors, COPERNICUS and KEPLER, I thought proper to commemorate them on this occaſion, as none before them had expreſſed themſelves ſo fully, and with ſo much truth, on that curious ſubject: and as none, from their days to thoſe of Dr. HOOKE, made any ſuch improvement, as would apologize for my taking up ſo much more of your time in recalling their ſentiments to your remembrance, let it ſuffice to mention, that the firſt who, in this country, embraced that doctrine, was Dr. GILBERT *, but who did not properly diſtinguiſh between attraction and magnetiſm; and that the next was Lord BACON, who, though not a convert to the *Copernican* ſyſtem, yet acknowledged an attractive power in matter †. In France, we find FERMAT and

* De Magnete.

† Nov. Organ. lib. ii, aphor. 36. 45. 48. Sylv. Sylvar, cent. i, exp. 33.

ROBERVAL,

ROBERVAL, mathematicians of great eminence, of the ſame opinion *; and in Italy, BORELLI, after GALILEO †, who was the firſt in that country who conceived that idea, but far from that preciſion and extenſion we find it in his contemporaries BACON and KEPLER.

BEFORE we paſs from KEPLER, it will be proper to obſerve, that this great improver of aſtronomy did not, perhaps, after all, contribute ſo much to the advancement of this theory, by thoſe conjectures which I have related, as by ſome aſtronomical deductions from TYCHO BRAHE's obſervations, ſince known by the name of KEPLER's *Laws*. The firſt was, that the planets move not in circular, but in elliptical orbits, of a ſmall eccentricity, whereof the centre of the ſun makes one of its *foci*.

* Montucla Hiſt. des Mathem. part iv. liv. viii.

† Syſt. Coſmic.

The ſecond, that the ſame planet deſcribes about the ſun equal areas in equal times. The third, that in different planets, the ſquares of the periodic times are as the cubes of their mean diſtances from the ſun.

SUCH were the preparatives to the true philoſophy, and indeed excellent materials for the architect then unborn. But till Sir ISAAC NEWTON appeared, notwithſtanding the numerous and momentous diſcoveries that had been made in the heavens, by COPERNICUS, TYCHO BRAHE, GALILEO, KEPLER, and others, yet aſtronomy, as Lord BACON complained, ſtill remained but a mathematical ſtudy. The paſſage to which I allude is long; but, as tending to illuſtrate more than one particular relating to my ſubject, I cannot forbear treſpaſſing on your indulgence by the citation. ' Al-' though aſtronomy,' ſays BACON, ' has 'not been founded amiſs upon obſervation 'of the phænomena, yet the ſuperſtructure 'has hitherto kept low and weakly. In 'truth that ſcience preſents to the human 'underſtanding ſuch an object as PROME-'THEUS did of old to JUPITER, when, 'meaning to impoſe upon that deity, he 'offered upon his altar, inſtead of a live 'victim, the hide of a large bullock, 'ſtuffed with ſtraw, leaves, and oſier 'branches. In like manner, aſtronomy 'exhibits the externals of the celeſtial 'bodies, as the cuticular part of heaven, 'fair, indeed, and artificially formed into 'a ſyſtem; but the entrails and the foun-'tains of life are wanting, that is, the 'phyſical cauſes and reaſons; from which, 'and from aſtronomical hypotheſes, a the-'ory ſhould be drawn, not adequate only 'to account for all the phænomena, but 'for the ſubſtance, the motion, and influx 'of the heavens, as they are in Nature.—

'Scarcely is there one to be found, who
'has enquired into the natural caufes,
'either of the fubftance of celeftial matter,
'or into the reafon of the fwiftnefs or
'flownefs of the heavenly bodies acting
'upon one another; or into the various
'degrees of motion of the fame planet, or
'into the motion from eaft to weft, or of
'the contrary direction; nor into the pro-
'greffions, ftations, and retrogradations of
'thofe bodies; nor into the caufes of the
'apogæum and perigæum.—I fay, inqui-
'ries of this kind have fcarcely been at-
'tempted, nor indeed any labour beftowed
'upon the fubject, excepting in the way
'of mathematical obfervations and demon-
'ftrations. So that aftronomy, fuch as it
'now is, can only be reckoned among the
'mathematical arts; not without confider-
'able diminution of its dignity, fince, were
'it to maintain its rights, it might rank
'itfelf as the nobleft branch of philofophy.

'For he that ſhall reject the fictitious di-
'vorces between the ſuperlunary and ſub-
'lunary bodies, and ſhall duly attend to
'the appetences and moſt general affections
'of matter (which both in the earth and
'in the heavens are exceedingly powerful,
'and indeed pervade the univerſe), will
'receive, from what he ſees paſſing on the
'earth, clear information concerning the
'nature of celeſtial bodies; and contrari-
'wiſe, from motions which he ſhall diſco-
'ver in the heavens, will learn many par-
'ticulars relating to the things below, that
'now lie concealed from us. Wherefore
'the phyſical part of aſtronomy we mark
'as *wanting*, and call it the *aſtronomia*
'*viva*, the animated aſtronomy, in oppo-
'ſition to the ſtuffed bullock of PROME-
'THEUS*.'

THE great *deſideratum* was ſupplied, and from the boſom of this Society, in the

* De Dign. & Augm. Scient. l. iii. c. 4.

publication of the *Principia*, the immortal work of NEWTON. There the illuſtrious author evinces truths that had been only ſurmiſed before ; and, after eſtabliſhing by a juſt analyſis the laws of attraction, in a ſynthetical method proceeds to explain by them the motions and appearances of the heavenly bodies. Had not NEWTON lived, BACON might have paſſed for a viſionary ſpeculator ; but ſince the demands of that noble author upon the human intellects have been ſo fully anſwered in the productions of Sir ISAAC NEWTON, ſhall we not revere thoſe powers of his own mind, that could, in that dawn of philoſophy in which he lived, ſo well deſcry what parts were wanting, and what were the means of attaining them?

NEWTON, in a poſthumous treatiſe, *de Syſtemate Mundi*, compoſed before the publication of the *Principia*, and mentioned there, has ſaid, that ‘ ſome of the latter ‘ philoſophers had ſought to account for ‘ the courſe of the planets in their orbits ‘ by the action of certain *vortices*, as KEPLER and DESCARTES ; or by ſome other ‘ principle of impulſe or attraction, as BORELLI, HOOKE, and others of our na‑ ‘ tion.’ From this paſſage it would ſeem that, in thoſe times, there had been more conjectures formed concerning attraction, than what were publiſhed ; for, excepting GILBERT, who vainly attempted to explain the mundane ſyſtem by magnetiſm, and Lord BACON, who never acceded to the *Copernican* hypotheſis*, I have found none of our nation, HOOKE excepted, who, in this way, have left any thing on record

* ‘ Atque harum ſuppoſitionum abſurditas, in mo‑ ‘ tum terræ diurnum, *(quod nobis conſtat falſiſſimum* ‘ *eſſe)* homines impegit.’—Bac. de Dign. & Augm. Scient. lib. iii. cap. iv.

worthy

worthy of your notice. He, indeed, the early, the ingenious, and moſt uſeful member of this Society, advanced, in this reſearch, far beyond all that had gone before him. But I ſhall not enlarge upon his improvements, as you have in your hands his *Cutlerian Lectures*, which contain them, and as I have already but too long dwelt on this part of my ſubject. It will ever redound to the praiſe of HOOKE, that NEWTON has aſſociated him with himſelf in maintaining the true regulating cauſe of the courſe of the planets*. As to BORELLI, though I have found in one of the pieces (a ſcarce one) of that learned Italian, a paſſage that certainly favours attraction; yet as it is neither ſo full nor ſo explicit, upon that point, as ſeveral others which I have cited, I muſt ſuſpect that thoſe parts,

* M. MONTUCLA has done great juſtice to Dr. HOOKE, in this and other particulars, in his excellent work, *Hiſt. de Mathem.* part iv. liv. 8.

which Sir ISAAC had in his eye, have eſcaped my obſervation *.

THE great completer of the doctrine of univerſal gravitation had the ſatisfaction to find, from the reception it met with in this Society, that he had not laboured in vain: nay, perhaps no philoſophical author was ever more admired and followed, in his own time and in his own country, than NEWTON was in theſe kingdoms. With regard to others, 'we are not to wonder,'

* This is the paſſage alluded to: 'Præterea mani-
'feſtum eſt, quemlibet ſive primarium ſive ſecunda-
'rium planetam aliquem inſignem mundi globum,
'quaſi virtutis fontem, circumdare, qui ita eos ſtrin-
'git atque conglutinat, ut ab ipſo nullo pacto abſtra-
'hi poſſint; ſed ipſum, quacunque contendentem,
'perpetuis continuiſque orbibus cogantur conſequi:
'videmus enim Saturnum, Jovem, Martem, Vene-
'rem, atque Mercurium, Solem ipſum,—Medicæa
'Sidera, Jovem,—Hugenianumque Sidus, Saturnum
'circumire, non ſecus, ac circa Telluris Globum
'Luna ipſa revolvitur.'—Joa. Alph. Borelli Theor. Medic. Planetar. ex Cauſis Phyſicis deductæ, lib. i. cap. ii. p. 5. Florent. 1666, 4to.

as

as remarked by his eloquent Eulogiſt, ‘ if
‘ philoſophers, upon the firſt publication
‘ of the *Principia*, took the alarm at the
‘ term *attraction*, as fearing the return of
‘ the *occult qualities*; or if, conſidering the
‘ difficulty of the ſubject, and the few
‘ words employed in explaining it, they
‘ wanted time fully to comprehend it *.’
Theſe obſtacles have been removing by degrees, and the way at laſt has been ſo effectually cleared, that the name of NEWTON is not perhaps held in more eſtimation here, nor his principles more cordially embraced, than in thoſe very ſocieties of the learned abroad, which at firſt ſhewed moſt unbelief, and at whoſe converſion, therefore, we ought moſt to rejoice.

THE Royal Academy of Sciences, whilſt in an uncertain ſtate between the old and new ſyſtem of philoſophy, having, for one

* Eloge de Newton, par M. de Fontenelle.

of

of the decifive experiments, meafured fome degrees of latitude upon an arch of a meridian paffing through Paris, and compared this menfuration with others, inferred the earth to be a fpheroid, with the longeft diameter paffing through its poles; but, fenfible that this operation had not been fo unexceptionably conducted as to fatisfy either the followers of NEWTON or thofe of HUYGENS, who both required a fpheroid flattened at the poles, refolved upon a farther and more accurate trial. With this view, in the year 1735, fome chofen members from that illuftrious Body were fent to the polar circle, and others to the equator; at which places the differences of degrees being greater, the point in difpute might be determined with lefs danger of error. How much to the honour of NEWTON and HUYGENS the refult was, is fufficiently known. All that is neceffary to be mentioned here, is, that, in the year

1738,

1738, whilſt the academicians were ſtill in Peru, it occurred to M. BOUGUER, one of that number, to put the *Newtonian* ſyſtem to another teſt, by enquiring into the attraction of mountains. This idea, which was originally from NEWTON himſelf, M. BOUGUER communicated to his colleague M. DE LA CONDAMINE, who readily aſſiſted in making the trial *. Thoſe gentlemen were perſuaded, that if the whole maſs of the earth were really poſſeſſed of ſuch a property, a high mountain, ſuch as Nature had abundantly provided in that country, would ſhew ſome proportionable degree of it; and that the largeſt of the Andes was indeed but a ſmall object in compariſon of the earth: nevertheleſs they reekoned, by a rough computation, that the attraction of Chimboraço, which they deemed the beſt for their purpoſe, would

* BOUGUER, Figure de la Terre, ſect. 7. DE LA CONDAMINE, Journal du Voyage à l' Equateur.

be

be equal to about the 2000th part of the attraction of the whole earth. Now, here the mountain acting as one, whilſt the earth acted as 2000, the direction of gravity would be viſibly turned out of the vertical line, for as much as this direction would be 1′ and 43″ towards the mountain. But how was this deflexion to be eſtimated? Only by finding the quantity of deviation of the plumb-line from a vertical poſition, by means of ſtars. In order to attain this point, they found it moſt convenient, in their preſent circumſtances, to take the diſtance of ſeveral ſtars from the zenith, at two ſtations, one on the ſouth ſide of Chimboraço, and the other a league and a half to the weſt; that is, at ſuch a diſtance from the firſt ſtation, as that the plumb-line ſhould be but little affected by the mountain. This diſpoſition being made, they proceeded to their operations, of which we have a full and clear account by M.

BOUGUER,

Bouguer, in his valuable treatiſe entitled *Figure de la Terre;* but of M. de la Condamine, we have only a ſhort abſtract of the narrative he preſented to the Academy; which abſtract is contained in his curious *Journal of a Voyage to the Equator.*

From both it appears, that though theſe learned perſons, during the time employed in this experiment (which the inclemency of the air, at that height in the atmoſphere, forced them to make very ſhort),—I ſay, though during this time they ſpared no pains, yet their obſervations not only varied from one another, but ſeemed to be little ſatisfactory to themſelves. M. Bouguer ſays, that, inſtead of 1′ 43″, which the plumb-line ought to have declined from the true vertical line, the total declenſion amounted only to ſeven ſeconds and a half: an effect that fell far ſhort of the

expecta-

expectations of a *Newtonian.* But thoſe candid gentlemen take notice, that, ‘ as on ‘ one hand we are ignorant of the denſity ‘ of the internal parts of the earth, which ‘ may be conſiderably greater than what ‘ appears by its ſurface; ſo, on the other, ‘ Chimboraço, which they believed likely ‘ to be as ſolid as any other parts of the ‘ ſurface of the earth, might nevertheleſs, ‘ in many places, be hollow.’ Nay, M. DE LA CONDAMINE tells us, that ‘ he was ‘ afterwards informed of a tradition in the ‘ country, that this very monntain had ‘ once been a volcano;’ and adds, that ‘ whilſt he and his colleague were about ‘ their experiment, they had actually found ‘ ſome calcined ſtones upon it:’ from which circumſtances he infers, that ‘ if one cannot ‘ juſt draw from this trial an abſolute proof ‘ of the *Newtonian* attraction, one can far ‘ leſs form any concluſion againſt it.’ M. BOUGUER goes farther, and obſerves, that

‘ if

‘ if we will be ſatisfied with the bare fact, ‘ it is certain, from this experiment, that ‘ mountains do act at a diſtance, but that ‘ their action is much leſs than what might ‘ be expected from their bulk.’ He concludes his account in the true ſpirit of a philoſopher, by ſaying, that ‘ as in France, ‘ or in England, a hill may be found of a ‘ ſufficient height for the purpoſe, and ‘ eſpecially if the obſerver would double ‘ the action, by making a ſtation on each ‘ ſide; he ſhould be happy to hear, on his ‘ return to Europe, that the experiment ‘ had been repeated, whether the reſult ‘ tended to confirm his obſervations, or to ‘ throw ſome better light upon that en- ‘ quiry.’ If the Society have fulfilled the views of that worthy man, who thus called upon them, we have to regret that he did not live long enough to ſhare the ſatisfaction with us.

I come now to Mr. Maskelyne's labours, upon which I ſhall not expatiate, as I have already taken up too much of your time, and as I judge it unneceſſary to dwell long upon that part of my ſubject, which you have ſo lately heard in his own words, and which you will have in a few days publiſhed at large in your Tranſactions.

I need only remind you, that the zenith diſtance of a ſtar on the meridian being obſerved at two ſtations under the ſame meridian, one on the ſouth ſide of a mountain, the other on the north; if the plumb-line of the inſtrument be attracted by the mountain out of its vertical poſition, the ſtar will appear too much to the north, by the obſervation at the ſouthern ſtation, and too much to the ſouth, by that at the northern ſtation; and conſequently the difference of the latitudes of the two ſtations will be found, by theſe obſervations, greater

greater than it really is. And if the true difference of their latitudes be determined by meaſuring the diſtance between the two ſtations on the ground, the exceſs of the difference, found by the obſervations of the ſtar, above that found by this meaſurement, muſt have been produced by the attraction of the mountain, and its half will be the effect of ſuch attraction on the plumb-line at each obſervation, ſuppoſing the mountain attracts equally on both ſides.

To perform this experiment, Mr. MASKELYNE made choice of the mountain Schehallien, in Perthſhire in North Britain, of which the direction in length is nearly eaſt and weſt; its height above the ſurrounding valley, at a medium, is about 2000 feet; and its higheſt part, above the level of the ſea, is 3550 feet. As the greateſt attraction of the mountain was to be expected about half way up its ſides (which happened, conveniently for the purpoſe of the experiment, to be pretty ſteep), two ſtations for an obſervatory were accordingly choſen, one on the north, the other on the ſouth ſide of Schehallien. The inſtrument, with which he obſerved the ſtars, was an excellent ſector made by Mr. SISSON; and Mr. MASKELYNE has related at large all the precautions he took both for adjuſting this inſtrument in the meridian at each ſtation, and for ſatisfying himſelf that the line of collimation remained unaltered. From obſervations of ten ſtars near the zenith, he found the apparent difference of the latitudes of the two ſtations to be 54″, 6; and from a meaſurement by triangles, formed from two baſes on different ſides of the mountain, he found the diſtance of their parallels to be 4364 feet, which, in the latitude of Schehallien, viz. 56° 40′, anſwer to an arch of the meridian

ridian of $43''$: this is $11''$, 6 lefs than that found by the fector. Its half, therefore, $5''$, 8, is the mean effect of the attraction of the mountain: and from its magnitude, compared with the bulk of the whole earth, Mr. MASKELYNE difcovered the mean denfity of the earth to be about double that of the mountain.

IN the execution of this interefting experiment, our worthy brother has not only exerted a patience and perfeverance, but a fagacity and judgment, which muft ever redound to his honour. All doubts about an univerfal attraction muft at laft be terminated, and every philofopher, in that refpect, muft now become a *Newtonian*.

IF I have related but two experiments that have been made, the firft by the French academicians, and the other by

 Mr.

Mr. MASKELYNE, it is becaufe no more have come to our knowledge; nor do I believe that more have actually been executed. For if, in occafional menfurations of degrees of the meridian in different parts of Europe, thofe employed have found varieties arife in their meafures, that they could not otherwife account for, than from the attraction of the mountains among which they carried on their operations, and accordingly have referred thofe irregularities to that very caufe; fuch conjectures we admit may be well founded, but the meafurements whence they arife we cannot reckon among the experiments we now treat of.

BUT was not the doctrine of an univerfal attraction fo fully demonftrated by NEWTON, as not to require any farther proofs from experiments? Demonftrated it was, but not to the conviction of every individual. True Philoſophy condeſcends to adapt her inſtructions to different capacities, and is as willing to inform by palpable experiments as by geometrical demonſtrations. But to ſay the truth, ſomething ſeemed wanting here for the ſatisfaction of even the more enlightened minds. Such we reckon thoſe were, who firſt made the trial. And did not HUYGENS himſelf, one of the greateſt philoſophers and geometricians of his age, find difficulties about this principle, even after the publication of NEWTON's *Principia?* Nor do we learn that the doubts of that great man were ever removed*. To ſay nothing of the celebrated LEIBNITZ, and his numerous followers, who to this day are either wholly unbelievers in attraction, or at beſt but ſceptics on that article.

YOU have, therefore, GENTLEMEN, the ſatisfaction to think that you have com-

* Vid. Huygen. Diſſert. de Cauſ. Gravitat.

pleted a great and acceptable work to the ſcientific world; and that, though this has been a coſtly experiment, your gracious PATRON, who ſo liberally furniſhed the means, will highly approve your expending his benefaction ſo much for the advancement of Natural Knowledge and for the benefit of the Public; and will ſo much the more be diſpoſed to ſhew you the like favour on future occaſions.

BUT even thoſe who wanted no freſh proofs of the univerſality of attraction, muſt ſtill partake of the advantages accruing from this experiment, as being not only the firſt that has been made, but the beſt that could be deviſed, for eſtimating the mean denſity of the earth. The operation in Peru was too imperfect for that purpoſe; and had the circumſtances of that trial been more favourable, yet the ſuſpicion of the mountain's having been

once

once a volcano, was a ſufficient reaſon for admitting no evidence from it in this part of our inquiry. But for Schehallien, as its appearance was particularly rocky, and as ſeveral ſpecimens of its rocks have been preſented to the Society, and acknowledged to be mineral ſubſtances that had never paſſed through fire, we may conſider that mountain as one of the proper patterns of the denſity of the ſurface of the earth.

THESE, GENTLEMEN, are the fruits of the operations of Mr. MASKELYNE, during a reſidence of four months in a mean hut, on the ſide of a bleak mountain, and in a climate little favourable to celeſtial obſervations. To theſe inconveniences, however, he ſubmitted with patience and complacency, as he went at your requeſt, and in purſuit of ſcience. You have heard his chief concluſions; but permit me add, that, as this is a new mine opened in the field of Nature, I am confident that theſe will not be the only productions; but that, as in all great and ſucceſsful experiments, there will be, in the proſecution of this ſubject, ſome valuable truths brought to light, of which at preſent we can form no particular conjecture. Mean while we have the pleaſure to find the doctrine of *univerſal gravitation* ſo firmly eſtabliſhed by this finiſhing ſtep of analyſis, that the moſt ſcrupulous now can no longer heſitate to embrace a principle, that gives life to Aſtronomy, by accounting for the various motions and appearances of the Hoſts of Heaven.

MR. MASKELYNE,

THE judgment, SIR, of the Council, in awarding you the Prize, having received the

the ſanction of the Royal Society, I do, in the name and by the authority of that illuſtrious Body, preſent you, their moſt worthy Brother, with this ſincere pledge of their affection; as the laſting token of their acknowledgment for your ſeveral ingenious and uſeful communications, and more particularly for this laſt painful and capital experiment, which adds no ſmall luſtre to their Tranſactions. And after expreſſing their grateful ſentiments for what you have already done for their ſervice, I would farther ſay, that they perſuade themſelves, from your talents, your love of your profeſſion, and your happy period of life, you will continue ſteadily to purſue that path which you have ſo early entered upon, and which ſo ſurely leads to great and uſeful diſcoveries. You have, SIR, in charge the nobleſt branch of Natural Philoſophy: ſuch it has ever been held by this Society, and

and as ſuch it ever has been cheriſhed and cultivated by them. And they flatter themſelves that their cares and ſolicitude have not been fruitleſs; ſince, from their firſt inſtitution to this day, there have never been wanting ſome excellent men in that line, to promote the ſcience, and do honour to this Community. But ſo tranſcendently great is that part of the creation, that though the Divine Author has vouchſafed, in theſe latter days, to open, to the humble and patient inquirers into Nature, the *Cauſes of Things;* yet we muſt ſtill cry with the ancient ſage, *Lo, theſe are part of His ways, but how little a portion is heard of them!* As much then remains to be explored in the celeſtial regions, you are encouraged, SIR, by what has been already attained, to perſevere in theſe hallowed labours, from which have been derived the greateſt improvements in the moſt uſeful arts,

and

and the loudeſt declarations of the power, the wiſdom, and the goodneſs of the Supreme Architect, in the ſpacious and beautiful fabric of the World.

A

DISCOURSE

UPON

SOME LATE IMPROVEMENTS

OF THE MEANS FOR

PRESERVING THE HEALTH OF MARINERS;

DELIVERED AT THE

Anniverſary Meeting of the ROYAL SOCIETY,

November 30, 1776.

By Sir JOHN PRINGLE, Bart. PRESIDENT.

PUBLISHED BY THEIR ORDER.

A

DISCOURSE

UPON

SOME LATE IMPROVEMENTS

OF THE MEANS FOR

PRESERVING THE HEALTH OF MARINERS.

GENTLEMEN,

BEFORE we proceed farther in the businefs of this day, permit me to acquaint you with the judgment of your Council in the difpofal of Sir GODFREY COPLEY's Medal; an office I have undertaken at their requeft, and with the greater fatisfaction, as I am confident you will be

no

leſs unanimous in giving your approbation, than they have been in addreſſing you for it upon this occaſion. For though they were not inſenſible of the juſt title that ſeveral of the Papers, compoſing the preſent volume of your Tranſactions, had to your particular notice, yet they did not heſitate in preferring that which I preſented to you from Captain COOK, giving *An Account of the Method he had taken to preſerve the Health of the Crew of his Majeſty's Ship, the* Reſolution, *during her late Voyage round the World.* Indeed, I imagine that the name alone of ſo worthy a Member of this Society would have inclined you to depart from the ſtrictneſs of your rules, by conferring upon him that honour, though you had received no direct communication from him; conſidering how meritorious in your eyes that perſon muſt appear, who hath not only made the moſt extenſive, but the moſt inſtructive voy-

ages;

ages; who hath not only discovered, but surveyed, vast tracts of new coasts; who hath dispelled the illusion of a *terra australis incognita*, and fixed the bounds of the habitable earth, as well as those of the navigable ocean, in the southern hemisphere.

I SHALL not, however, expatiate on that ample field of praise, but confine my discourse to what was the intention of this honorary premium, namely, to crown that Paper of the year, which should contain the most useful and most successful experimental enquiry. Now what enquiry can be so useful as that, which hath for its object the saving the lives of men? And when shall we find one more successful than that before us? Here are no vain boastings of the empiric, nor ingenious and delusive theories of the dogmatist; but a concise, and artless, and an incontested relation of the means, by which, 'under the 'divine favour, Captain COOK, with a 'company of an hundred and eighteen 'men*, performed a voyage of three years 'and eighteen days, throughout all the 'climates, from fifty-two degrees north to 'feventy-one degrees fouth, with the lofs 'of only one man by ficknefs †.' What muft enhance to us the value of thefe falutary obfervations, is, to fee that the practice hath been no lefs fimple than efficacious.

I WOULD now enquire of the moft converfant in the ftudy of bills of mortality, whether, in the moft healthful climate, and

* There were on board, in all, one hundred and eighteen men, including M. Sparrman and his fervant, but whom they took in at the Cape of Good Hope, and left there upon their return to that place.

† This was a confumption terminating in a dropfy. Mr. Patten, furgeon to the Refolution, who mentioned to me this cafe, obferved that this man began fo early to complain of a cough and other confumptive fymptoms, which had never left him, that his lungs muft have been affected before he came on board.

in

in the beſt condition of life, they have ever found ſo ſmall a number of deaths, in ſuch a number of men, within that ſpace of time? How great and agreeable then muſt our ſurpriſe be, after peruſing the hiſtories of long navigations in former days, when ſo many periſhed by marine diſeaſes, to find the air of the ſea acquitted of all malignity, and, in fine, that a voyage round the world may be undertaken with leſs danger, perhaps, to health, than a common tour in Europe!

But the better to ſee the contraſt between the old and the preſent times, allow me to recal to your memory what you have read of the firſt voyage for the eſtabliſhment of the Eaſt India Company*. The equipment conſiſting of four ſhips,

* This ſquadron, under the command of Lancaster (who was called the General), ſet out in the year 1601. See Purchas's Pilgr. vol. i. p. 147, & ſeq.

with four hundred and eighty men on board, three of theſe veſſels were ſo weakened by the ſcurvy, by the time they had got only three degrees beyond the Line, that the merchants, who had embarked on this adventure, were obliged to do duty as common ſailors; and there died, in all, at ſea, and on ſhore at Soldania, a place of refreſhment on this ſide the Cape of Good Hope, one hundred and five men, which was nearly a fourth part of their complement, before they got farther on their voyage. And hath not Sir RICHARD HAWKINS, who lived in that age, an intelligent as well as brave officer, recorded, that 'in twenty years, during which he 'had uſed the ſea, he could give an account of ten thouſand mariners, who had 'been conſumed by the ſcurvy alone*?' Yet ſo far was this author from miſtaking the diſeaſe, that I have peruſed few who

* PURCHAS's Pilgr. vol. iv. p. 1373, & ſeq.

have

have ſo well deſcribed it. If, then, in thoſe early times, the infancy, I may call them, of the commerce and naval power of England, ſo many were carried off by that bane of ſea-faring people, what muſt have been the deſtruction afterwards, upon the great augmentation of the fleet, and the opening of ſo many new ports to the trade of this country, whilſt ſuch little advancement was made in the nautical part of medicine!

BUT paſſing from theſe old dates to one within the remembrance of many here preſent, when it might have been expected that whatever tended to aggrandize the naval power of Great Britain, and to extend her commerce, would have received the higheſt improvement; yet we ſhall find that, even at that late period, few meaſures had been taken to preſerve the health of ſeamen, more than had been known to our

 uninſtructed

uninſtructed anceſtors. Of this aſſertion, the victorious but mournful expedition of Commodore ANSON affords too convincing a proof. It is well known that, ſoon after paſſing the Straits of Le Maire, the ſcurvy began to appear in his ſquadron; that, by the time the Centurion had advanced but a little way into the South Sea, forty-ſeven had died of it in that ſhip; and that there were few on board who had not, in ſome degree, been affected with the diſtemper, though they had not been quite eight months from England: that, in the ninth month, when ſtanding for the iſland of Juan Fernandez, the Centurion loſt double that number; and that the mortality went on at ſo great a rate (I ſtill ſpeak of the Commodore's ſhip) that, before they arrived there, ſhe had buried two hundred; and at laſt could muſter no more than two quarter-maſters and ſix of the foremaſt-men, in a watch, capable of doing duty.

This was the condition of one of the three ſhips which reached that iſland; the other two ſuffered in proportion.

Nor did the tragedy end here: for after a few months reſpite, the ſame fatal ſickneſs broke out afreſh, and made ſuch havock, that, before the Centurion (which now contained the whole ſurviving crew of the three ſhips) had got to the iſland of Tinian, there died ſometimes eight or ten in a day; inſomuch that, when they had been only two years on their voyage, they had loſt a larger proportion than of four in five of their original number; and, by the account of the hiſtorian, all of them, after their entering the South Sea, of the ſcurvy. I ſay, by the account of the elegant writer of that voyage; for, as he neither was in the medical line himſelf, nor hath authenticated this part of his narrative by appealing to the ſurgeons of the ſhip, or to their

 journals,

journals, I ſhould doubt that this was not ſtrictly the caſe; but rather that, in producing this great mortality, a peſtilential kind of diſtemper was joined to the ſcurvy, which, from the places where it moſt frequently occurs, hath been diſtinguiſhed by the name of *the jail* or *hoſpital fever**. But whether the ſcurvy alone, or this fever combined with it, were the cauſe, it is not at preſent material to enquire; ſince both, ariſing from foul air and other ſources of putrefaction, may now in a great meaſure be obviated by the various means fallen upon ſince Lord ANSON's expedition. For, in juſtice to that prudent as well as brave Commander, it muſt be obſerved, that the arrangements, preparatory to his voyage, were not made by himſelf; that his ſhip

* Dr. MEAD, who had ſeen the original obſervations of two of Commodore ANSON's ſurgeons, ſays, that the ſcurvy, at that time, was accompanied with *putrid fevers*, &c. See his Treatiſe on the Scurvy, p. 98, & ſeq.

was

was ſo deeply laden, as not, except in the calmeſt weather, to admit of opening the gun-ports for the benefit of air; and that nothing appears to have been neglected by him, for preſerving the health of his men, that was then known and practiſed in the navy.

I SHOULD now proceed to enumerate the chief improvements made ſince that time, and which have enabled our ſhips to make ſo many ſucceſsful circumnavigations, as in a manner to efface the impreſſion of former diſaſters; but as I have mentioned the ſickneſs moſt deſtructive to ſailors, and againſt the ravages of which thoſe preſervatives have been mainly contrived, it may be proper briefly to explain its nature, and the rather as, excepting among mariners, it is little underſtood. Firſt, then, I would obſerve, that the ſcurvy is not the diſeaſe which goes by

that

that name on ſhore. The diſtemper commonly, but erroneouſly, in this country, called the *ſcurvy*, belongs to a claſs of diſeaſes totally different from what we are now treating of; and ſo far is the common received opinion, that *that there are few conſtitutions altogether free from a ſcorbutic taint*, from being true, that, unleſs among ſailors and others circumſtanced like them, more particularly with reſpect to thoſe who uſe a ſalt and putrid diet, and eſpecially if they live in foul air and uncleanlineſs, I have reaſon to believe there are few diſorders leſs frequent. This opinion I ſubmitted to the judgment of the Society ſeveral years ago, and I have had no reaſon ſince to alter it. I then ſaid, contrary to what was generally believed, but ſeemingly on the beſt grounds, that the ſea-air was never the cauſe of the ſcurvy, ſince, on board a ſhip on the longeſt voyages, cleanlineſs, ventilation, and freſh proviſions, would

preſerve

preſerve from it; and that upon a ſea-coaſt, free from marſhes, the inhabitants were not liable to that indiſpoſition, though frequently breathing the air from the ſea *. I concluded with joining in ſentiment with thoſe, who aſcribed the ſcurvy to a ſeptic reſolution, that is, a beginning corruption of the whole habit, ſimilar to that of every animal ſubſtance when deprived of life †. This account ſeemed to be ſufficiently verified by the examination of the ſymptoms in the ſcorbutic ſick, and by the appearances in their bodies after death ‡. On that occaſion I remarked, that ſalted meats, after ſome time, become in reality putrid, though they may contiue long palatable by

* Diſeaſes of the Army, part i. ch. 2. Append Pap. 7.

† Ibid.

‡ Woodall's Surgeon's Mate, p. 163. Poupart. Mem. de l' Acad. R. des Sc. A. 1699. Petit, Mal. des Os, tom. ii. p. 446. Mead on the Scurvy, p. 104.

means

means of the ſalt; and that common ſalt, ſuppoſed to be one of the ſtrongeſt preſervatives from corruption, is at beſt but an indifferent one, even in a large quantity; and in a ſmall one, ſuch as we uſe at table with freſh meats, or ſwallow in meats that have been ſalted, ſo far from impeding putrefaction, it rather promotes that proceſs in the body.

THIS poſition concerning the putrefying quality of ſea-ſalt, in certain proportions, hath been ſince confirmed by the experiments of the late Mr. CANTON, Fellow of this Society, in a Paper on the *Cauſe of the Luminous Appearance of Sea-Water**.

IT hath been alleged, that the ſcurvy is much owing to the coldneſs of the air, which checks perſpiration, and on that account is the endemic diſtemper of the

* Phil. Tranſact. vol. lix. p. 446.

northern

northern nations, particularly of thoſe around the Baltic *. The fact is partly true, but, I doubt, not ſo the cauſe. In thoſe regions, by the long and ſevere winters, the cattle, deſtitute of paſture, can barely live, and are therefore unfit for uſe; ſo that the people, for their proviſion during that ſeaſon, are obliged to ſlaughter them by the end of autumn, and to ſalt them for above half the year. This putrid diet, then, on which they muſt ſo long ſubſiſt, and to which the inhabitants of the South are not reduced, ſeems to be the chief cauſe of the diſeaſe. And if we reflect that the lower people of the North have few or no greens nor fruit in the winter, little or no fermented liquors, and often live in damp, foul, and ill-aired houſes, it is eaſy to conceive how they ſhould become liable to the ſame diſorder with ſeamen; whilſt others,

* BARTHOLIN. Med. Danor. Domeſtic. p. 98.

of

of as high a latitude, but who live in a different manner, keep free from it. Thus we are informed, by LINNÆUS, that the Laplanders, one of the moſt hyperborean nations, know nothing of the ſcurvy*; for which no other reaſon can be aſſigned than their never eating putrid and ſalted meats, nor indeed ſalt with any thing, but their uſing all the winter the freſh fleſh of their rein-deer.

THIS exemption of the Laplanders from the general diſtemper of the North, is the more obſervable, as they ſeldom taſte vegetables, bread never, as we farther learn from that celebrated author. Yet, in the very provinces which border on Lapland, where they uſe bread, but ſcarcely any other vegetable, and eat ſalted meats, they are as much troubled with the ſcurvy as in

* LINNÆI Flora Lapponica, p. 8, 9.

any other country*. But let us incidentally remark, that the late improvements in agriculture, gardening, and in the other arts of life, by extending their influence to the remoteſt parts of Europe, and to the loweſt people, begin ſenſibly to leſſen the frequency of that complaint, even in thoſe climates that have been once the moſt afflicted with it.

It hath alſo been aſſerted, that men living on ſhore will be affected with the ſcurvy, though they have never been confined to ſalted meats; but of this I have known no inſtance, except in thoſe who breathed a marſhy air, or what was otherwiſe putrid, and who wanted exerciſe, fruits, and the common herbs: under ſuch circumſtances, it muſt be owned that the humours

* LINNÆUS, in ſeveral parts of his work, confirms what is here ſaid of ſalted meats, as one of the chief cauſes of the ſcurvy. See Amœnitat. Acad. vol. v. p. 6. & ſeq. p. 42.

will

will corrupt in the ſame manner, though not in the ſame degree, with thoſe of ſeamen. Thus, in the late war, when Siſinghurſt Caſtle in Kent was filled with French priſoners, the ſcurvy broke out among them, notwithſtanding they had never been ſerved with ſalted victuals in England, but had daily had an allowance of freſh meat, and of bread in proportion, though without greens or other vegetables. The country ſurgeon who attended them, and from whom I received this information, having formerly been employed in the navy, was the better able to judge of the diſorder, and to cure it. Beſides the deficiency of herbs, he obſerved that the wards were foul and crowded, the houſe damp (from a moat that ſurrounded it), and that the bounds allotted for taking the air were ſo ſmall, and in wet weather ſo ſloughy, that the men ſeldom cared to go out. He added, that a repreſentation having been made, he had been empowered to furnifh the prifoners with roots and greens for boiling in their foup, and to quarter the fick in a neighbouring village, in a dry fituation, with liberty to go out for air and exercife; and that by thefe means they had all quickly recovered. It is probable, that the fcurvy fooner appeared among thefe ftrangers, from their having been taken at fea, and being, from their diet, more difpofed to the difeafe. My informer farther acquainted me, that, in the lower and wetter parts of that county, where fome of his practice lay, he had now and then met with flighter cafes of the fcurvy among the common people; fuch, he faid, as lived the whole winter on falted bacon, without fermented liquors, greens, or fruit, a few apples excepted; but he remarked, that, in the winters following a plentiful growth of apples, thefe peafants were manifeftly lefs liable to the complaint.

I HAVE dwelt the longer on this part of my ſubject, as I look upon the knowledge of the nature and cauſe of the ſcurvy to be an eſſential ſtep towards improving the means of prevention and cure. And I am perſuaded, after mature reflection, and the opportunities I have had of converſing with thoſe, who to much ſagacity had joined no ſmall experience in nautical practice, that, upon an examination of the ſeveral articles, which have either been of old approved, or have of late been introduced into the navy, it will be found, that, though theſe means may vary in form, and in their mode of operating; yet that they all ſome way contribute towards preventing or correcting *putrefaction*, whether of the air in the cloſer parts of a ſhip, of the meats, of the water, of the clothes and bedding, or of the body itſelf. And, if in this inquiry (which may be made by the way, whilſt we take a review of the principal articles of proviſion, and

and other methods ufed by Captain COOK to guard againft the fcurvy), I fay, if in this inquiry it fhall appear, that the notion of a feptic or putrid origin, is not without foundation, it will be no fmall encouragement to proceed on that principle, in order farther to improve this important branch of medicine.

CAPTAIN COOK begins his lift of his prefervative ftores with *malt:* 'Of this,' he fays, 'was made *fweet wort*, and given not 'only to thofe men who had manifeft 'fymptoms of the fcurvy, but to fuch alfo 'as were judged to be moft liable to it.' Dr. MACBRIDE, who firft fuggefted this preparation, was led (as he obferves) to the difcovery by fome experiments that had been laid before this Society, by which it appeared that the air produced by alimentary fermentation was endowed with a power of correcting putrefaction *. The fact he confirmed by numerous trials; and, finding this fluid to be the *fixed air*, he justly concluded, that whatever substance, proper for food, abounded with it, and which could be conveniently carried to sea, would make one of the surest remedies against the scurvy; which he then considered as a *putrid disease*, and, as such, to be prevented or cured by that powerful kind of antiseptic †. Beer, for instance, had always been esteemed one of the best antiscorbutics; but, as that derived all its *fixed air* from the malt of which it was made, he inferred that malt itself was preferable in long voyages, as it took up less room than the brewed liquor, and would keep longer sound. Experience hath since verified this

* Append. to my *Observations on the Diseases of the Army*.

* MACBRIDE's Exper. Ess. *passim*.

ingenious

ngenious theory; and the malt hath now gained ſo much credit in the navy, that there only wanted ſo long, ſo healthful, and ſo celebrated a voyage as this, to rank it among the moſt indiſpenſable articles of proviſion. For though Captain COOK remarks, that ' a proper attention to other ' things muſt be joined, and that he is not ' altogether of opinion that the wort will ' be able to cure the ſcurvy, in an advanced ' ſtate, at ſea; yet he is perſuaded that it ' is ſufficient to prevent that diſtemper ' from making any great progreſs, for a ' conſiderable time;' and therefore he doth not heſitate to pronounce it ' one of the ' beſt antiſcorbutic medicines yet found ' out*.'

THIS

* Having been favoured with a ſight of the medical journal of Mr. PATTEN, ſurgeon to the Reſolution, I read the following paſſage in it, not a little ſtrengthening the above teſtimony: ' I have found the *wort* ' of the utmoſt ſervice, in all ſcorbutic caſes, during

' the

This salutary *gas* (or *fixed air*) is contained, more or less, in all fermentable liquors, and begins to oppose putrefaction, as soon as the working or intestine motion commences.

In wine, it abounds; and perhaps no vegetable substance is more replete with it than the juice of the grape. If we join the grateful taste of wine, we must rank it the first in the list of antiscorbutic liquors. Cyder is likewise excellent, with other vinous productions from fruit; as also the

'the voyage. As many took it by way of prevention, few cases occurred where it had a fair trial; but these, however, I flatter myself, will be sufficient to convince every impartial person, that it is the best remedy hitherto found out for the cure of the sea-scurvy: and I am well convinced, from what I have seen the *wort* perform, and from its mode of operation, that, if aided by *portable soup*, *sour krout*, *sugar*, *sago*, and *courants*, the scurvy, that maritime pestilence, will seldom or never make its alarming appearance among a ship's crew, on the longest voyages; proper care with regard to cleanliness and provisions being observed.'

various

various kinds of beer. It hath been a conſtant obſervation, that, in long cruiſes or diſtant voyages, the ſcurvy is never ſeen whilſt the ſmall-beer holds out at a full allowance; but that, when it is all expended, the diſtemper ſoon prevails. It were therefore to be wiſhed, that this moſt wholeſome beverage could be renewed at ſea; but our ſhips afford not ſufficient convenience. The Ruſſians, however, make a ſhift to prepare on board, as well as at land, ſomething of a middle quality between wort and ſmall-beer, in the following manner: They take ground malt and rye-meal, in a certain proportion, which they knead into ſmall loaves, and bake in the oven. Theſe they occaſionally infuſe in a proper quantity of warm water, which begins ſo ſoon to ferment, that, in the ſpace of twenty-four hours, their brewage is completed, in the production of a ſmall, briſk, and acidulous liquor, they call *quas*, palatable to themſelves, and not diſagreeable to the taſte of ſtrangers. The late Dr. MOUNSEY, fellow of this Society, who had lived long in Ruſſia, and had been *Archiater* under two ſucceſſive ſovereigns, acquainted me, that the *quas* was the common and ſalutary drink both of the fleets and armies of that empire, and that it was particularly good againſt the ſcurvy. He added, that, happening to be at Moſcow when he peruſed my *Obſervations on the Jail and Hoſpital Fever*, then lately publiſhed *, he had been induced to compare what he read in that treatiſe with what he ſhould ſee in the ſeveral priſons of that large city. But, to his ſurpriſe, after viſiting them all, and finding them full of malefactors (for the late Empreſs at that time ſuffered none who were convicted of capi-

* That treatiſe was firſt publiſhed by itſelf, and afterwards incorporated with the *Obſervations on the Diſeaſes of the Army*.

tal

tal crimes to be put to death), he could diſcover no fever among them, nor learn that any acute diſtemper, peculiar to jails, had ever been known there. He obſerved, that ſome of theſe places of confinement had a yard, into which the priſoners were allowed to come for the air; but that there were others without that advantage, yet not ſickly. So that he could aſſign no other reaſon for the healthful condition of theſe men than the kind of diet they uſed, which was the ſame with that of the common people of the country; who, not being able to purchaſe fleſh-meat, live moſtly on rye-bread (the moſt aceſcent of any bread), and drink *quas*. He concluded with ſaying, that, upon his return to St. Peterſburg, he had made the ſame enquiry there, and with the ſame reſult.

Thus far Dr. Mounsey; from whoſe account it would ſeem, that the rye-meal

aſſiſted

aſſiſted both in quickening the fermentation and adding more fixed air, ſince the malt alone could not ſo readily produce ſo tart and briſk a liquor. And there is little doubt, but that, whenever the other grains can be brought to a proper degree of fermentation, they will, more or leſs, in the ſame way, become uſeful. That oats will, I am ſatisfied, from what I have been told by one of the intelligent friends of Captain Cook. This gentleman being on a cruize in a large ſhip *, in the beginning of the late war, and the ſcurvy breaking out among his crew, he bethought himſelf of a kind of food he had ſeen uſed in ſome parts of the country, as the moſt proper on that occaſion. Some oat-meal is put into a wooden veſſel, hot water is poured upon it, and the infuſion continues until the liquor begins to taſte ſouriſh, that is, till a fermentation comes on, which, in a place

* The Eſſex, a ſeventy gun ſhip.

moderately warm, may be in the ſpace of two days. The water is then poured off from the grounds, and boiled down to the conſiſtence of a jelly *. This he ordered to be made and dealt out in meſſes, being firſt ſweetened with ſugar, and ſeaſoned with ſome prize French wine, which, though turned ſour, yet improved the taſte, and made this aliment not leſs palatable than medicinal.

He aſſured me, that, upon this diet chiefly, and by abſtaining from ſalted meats, his *ſcorbutic* ſick had quite recovered on board; and not in that voyage only, but, by the ſame means, in his ſubſequent cruizes during the war, without his being obliged to ſend one of them on ſhore becauſe they could not get well at ſea. Yet oat-meal unfermented, like barley unmalted, hath no ſenſible effect in curing the

* This rural food, in the North, is called *ſooins*.

ſcurvy;

ſcurvy; as if the *fixed air*, which is incorporated with theſe grains, could mix with the chyle which they produce, enter the lacteals with it, and make part of the nouriſhment of the body, without manifeſting any elaſtic or antiſeptic quality, when not looſened by a previous fermentation.

Before the power of the *fixed air*, in ſubduing putrefaction, was known, the efficacy of fruits, greens, and fermented liquors, was commonly aſcribed to the acid in their compoſition; and we have ſtill reaſon to believe that the acid concurs in producing that effect. If it be alleged that mineral acids, which contain little or no *fixed air*, have been uſed in the ſcurvy with little ſucceſs; I would anſwer, that I doubt that, in thoſe trials, they have never been ſufficiently diluted; for it is eaſy to conceive, that, in the ſmall quantity of water the elixir of vitriol, for inſtance, is commonly

monly given, that auftere acid can fcarcely get beyond the firft paffages; confidering the delicate fenfibility of the mouths of the lacteals, which muft force them to contract, and exclude fo pungent a liquor. It were therefore a proper experiment to be made, in a deficiency of malt, or when that grain fhall happen to be fpoiled by keeping*, to ufe diftilled water, acidulated with the fpirit of fea-falt, in the proportion of only ten drops to a quart; or with the weak fpirit of vitriol, thirteen drops to the fame meafure†; and to give to thofe that are threatened with the fcurvy at leaft three quarts of

* Captain Cook told me, that the malt held out fufficiently good for the two firft years; but that in the third, having loft much of its tafte, he doubted whether it retained any of its virtues. Mr. Patten, however, obferved, that, though the malt at that time was fenfibly decayed, yet neverthelefs he had ftill found it ufeful, when he employed a larger proportion of it to make the infufion.

† In thefe proportions I found the water tafte juft acidulous and pleafant.

this liquor daily, to be conſumed as they ſhall think proper.

But if the *fixed air* and acids are ſuch preſervatives againſt the ſcurvy, why ſhould Captain Cook make ſo little account of the *rob* of lemons and of oranges (for ſo they have called the extracts or inſpiſſated juices of thoſe fruits) in treating that diſtemper? This, I found, was the reaſon: Theſe preparations being only ſent out upon trial, the ſurgeon of the ſhip was told, at a conjecture, how much he might give for a doſe, but without ſtrictly limiting it. The experiment was made with the quantity ſpecified, but with ſo little advantage, that, judging it not adviſeable to loſe more time, he ſet about the cure with the wort alone, of the efficacy of which he was certain; whilſt he reſerved theſe *robs* for other purpoſes; more particularly for colds, when, to a large draught of warm water, with

with ſome ſpirits and ſugar, he added a ſpoonful of one of them, and with this compoſition made a grateful ſudorific that anſwered his intention. No wonder, then, if Captain Cook, not knowing how much to order of theſe concentrated juices for the ſcurvy, but ſeeing them fail as they were given at this time, ſhould entertain no great opinion of their antiſcorbutic virtue. It may be alſo proper to take notice, that, as they had been reduced to a ſmall proportion of their bulk by evaporation upon fire, it is probable they were much weakened by that proceſs, and that, with their aqueous parts, they had loſt not a little of their aërial, on which ſo much of their antiſeptic power depended. If, therefore, a farther trial of theſe excellent fruits were to be made, it would ſeem more adviſeable to ſend to ſea the purified juices entire in caſks; agreeably to a propoſal which I find hath been preſented to the Admiralty, ſome years ago, by an ingenious and experienced ſurgeon of the navy. For, in truth, the teſtimonies in favour of the ſalutary qualities of theſe acids are ſo numerous, and ſo ſtrong, that I ſhould look upon ſome failures, even in caſes where their want of ſucceſs cannot ſo well be accounted for as in this voyage, as not a ſufficient reaſon for ſtriking them out of the liſt of the moſt powerful preſervatives againſt the conſuming malady of ſailors.

It may be obſerved, that Captain Cook ſays not more in praiſe of vinegar than of the *robs*; yet I would not thence infer that he made no account of that acid; but only that, as he happened in this voyage to be ſparingly provided with it, and yet did well, he could not conſider a large ſtore of vinegar to be ſo material an article of proviſion as was commonly imagined. And, though he ſupplied its place in the meſſes

of

of the men with the acid of the *four krout*, and trufted chiefly to fire for purifying his decks, yet it is to be hoped that future navigators will not therefore omit it. Vinegar will ferve at leaft for a wholefome variety in the feafoning of falted meats, and may be fometimes fuccefsfully ufed as a medicine, efpecially in the afperfions of the berths of the fick. It is obfervable, that, though the fmell be little grateful to a perfon in health, yet it is often agreeable to thofe who are fick, at leaft to fuch as are confined to a foul and crowded ward. There the phyfician himfelf will fmell to vinegar, as much for pleafure, as for guarding againft infection.

Now the wort and the acid juices were only difpenfed as medicines; but the next article was of more extenfive ufe. This was the *four krout* (four cabbage), a food of univerfal requeft in Germany. The

N acidity

acidity is acquired by its ſpontaneous fermentation, and it was that very taſte which made it the more acceptable to all who ate it. To its farther commendation we may add, that it held out good to the laſt of the voyage.

It may ſeem ſtrange, that though cabbage hath had ſo high encomiums beſtowed upon it by the ancients (witneſs what Cato the elder and Pliny the naturaliſt ſay on the ſubject), and hath had the ſanction of the experience of nations for ages, it ſhould yet be diſapproved of by ſome of the diſtinguiſhed medical writers of our times. One finds it yield a rank ſmell in decoction, which he confounds with that of putrefaction. Another analyzes it, and diſcovers ſo much groſs air in the compoſition, as to render it indigeſtible; yet this flatulence, ſo much decried, muſt now be acknowledged to be the *fixed air*, which makes

makes the cabbage ſo wholeſome when fermented. Nay it hath been traduced by one of the moſt celebrated phyſicians of our age, as partaking of a poiſonous nature: nor much better founded was that notion of the ſame learned profeſſor, that, cabbage being an alcaleſcent plant, and therefore diſpoſing to putrefaction, it could never be uſed in the ſcurvy, excepting when the diſeaſe proceeded from an acid. But the experiments, which I formerly laid before the Society, evinced this vegetable, with the reſt of the ſuppoſed alcaleſcents, to be really aceſcent; and proved that the ſcurvy is never owing to acidity, but, much otherwiſe, to a ſpecies of putrefaction; that very cauſe, of which the ill-grounded claſs of alcaleſcents was ſuppoſed to be a promoter *.

* See this remark more at large, in my *Obſervations on the Diſeaſes of the Army*, App. Pap. 7.

AMONG other of the late improvements of the naval ſtores, we have heard much of the *portable ſoup*, and accordingly we find that Captain COOK hath not a little availed himſelf of it in his voyage. This concentrated broth, being freed from all fat, and having by long boiling evaporated the moſt putreſcent parts of the meat, is reduced to the conſiſtence of a glue, which in effect it is, and will, like other glues, in a dry place, keep ſound for years together. It hath been ſaid, that broths turn ſour on keeping, though made without any vegetable *. Now, whether any real acid can be thus formed or not, I incline at leaſt to believe, that the gelatinous parts of animal ſubſtances, ſuch as compoſe theſe cakes, are not of a nature much diſpoſed to putrefy. But, however that may be, ſince

* 'La ſeule matiere qui s'agriſſe dans le ſang eſt la 'matiere gelatineuſe, &c.' SENAC, Structure du Cœur, l. iii. ch. iv. § 5.

Captain

Captain Cook obſerves, that this ſoup was the means of making his people eat a greater quantity of greens than they would have done otherwiſe, ſo far we muſt allow it to have been virtually antiſeptic.

So much for thoſe articles that have of late been ſupplied to all the King's ſhips on long voyages, and in which, therefore, our worthy brother claims no other merit than the prudent diſpenſation of them; but what follows, being regulations either wholly new, or improved hints from ſome of his experienced friends, we may juſtly appropriate them to himſelf.

First, then, he put his people at three watches, inſtead of two, which laſt is the general practice at ſea; that is, he divided the whole crew into three companies, and, by ordering each company upon the watch by turns, four hours at a time, every man had

had eight hours free, for four of duty: whereas, at watch and watch, the half of the men being on duty at once, with returns of it every four hours, they can have but broken ſleep, and, when expoſed to wet, they have not time to get dry before they lie down. When the ſervice requires them, ſuch hardſhips muſt be endured; but when there is no preſſing call, ought not a mariner to be refreſhed with as much uninterrupted reſt as a common labourer?

I AM well informed, that an officer diſtinguiſhes himſelf in nothing more than in preſerving his men from wet, and the other injuries of the weather. Theſe were moſt eſſential points with this humane Commander. In the torrid zone, he ſhaded his people from the ſcorching ſun by an awning over his deck; and, in his courſe under the antarctic circle, he had a coat provided for each man, of a ſubſtantial woollen

len ſtuff, with the addition of a hood for covering their heads. This garb (which the ſailors called their *Magellan jacket)* they occaſionally wore, and found it moſt comfortable for working in rain and ſnow, and among the broken ice in the high latitudes of the South.

Let us proceed to another article, one of the moſt material, the care to guard againſt putrefaction, by keeping clean the perſons, the clothes, the bedding, and berths of the ſailors. The Captain acquainted me, that regularly, one morning in the week, he paſſed his ſhip's company in review, and ſaw that every man had changed his linen, and was in other points as clean and neat as circumſtances would permit. It is well known how much *cleanlineſs* is conducive to health, but it is not ſo obvious how much it alſo tends to regularity and other virtues. That diligent officer was perſuaded, that ſuch men as he could induce to be more cleanly than they were diſpoſed to be of themſelves, became at the ſame time more ſober, more orderly, and more attentive to their duty. It muſt be acknowledged that a ſeaman has but indifferent means to keep himſelf clean, had he the greateſt inclination to do it; for I have not heard that commanders of ſhips have yet availed themſelves of the *ſtill* for providing freſh water for waſhing; and it is well known that ſea-water doth not mix with ſoap, and that linen wet with brine never thoroughly dries. But for Captain COOK, the frequent opportunities he had of taking in water among the iſlands of the South-Sea, enabled him in that tract to diſpenſe to his ſhip's company ſome freſh water for every uſe; and when he navigated in the high latitudes of the

ſouthern

ſouthern oceans, he ſtill more abundantly provided them with it, as you will find by the ſequel of this diſcourſe.

Of the hammocks and bedding I need ſay little, as all officers are now ſenſible, how much it concerns the health of their people to have this part of a ſhip's furniture kept dry and well aired; as by the breath and perſpiration of ſo many men, every thing below, even in the ſpace of twenty-four hours, is apt to contract an offenſive moiſture. But Captain Cook was not ſatisfied with ordering upon deck the hammocks and bedding every day that was fair (the common practice), but took care that every bundle ſhould be unlaſhed, and ſo ſpread out, that every part of it might be expoſed to the air,

His next concern was to ſee to the purity of the ſhip itſelf, without which at-

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tention all the reſt would have profited little. I ſhall not however detain you with his orders about waſhing and ſcraping the decks, as I do not underſtand that in this kind of cleanſing he excelled others; but ſince our author has laid ſo great a ſtreſs upon *fire*, as a purifier, I ſhall endeavour to explain his way of uſing it, more fully than he has done in his Paper. Some wood, and that not ſparingly, being put into a proper ſtove or grate, was lighted, and carried ſucceſſively to every part below deck. Wherever fire is, the air neareſt to it being heated becomes ſpecifically lighter, and by being lighter riſes, and paſſes through the hatchways into the atmoſphere. The vacant ſpace is filled with the cold air around, and that being heated in its turn, in like manner aſcends, and is replaced by other air as before. Thus, by continuing the fire for ſome time, in any of the lower apartments, the foul

air

air is in a good meaſure driven out, and the freſh admitted. This is not all: I apprehend that the acid ſteams of the wood, in burning, act here as an antiſeptic, and correct the corrupted air that remains.

An officer of diſtinguiſhed rank, another of Captain Cook's experienced friends, mentioned to me a common and juſt obſervation in the fleet, which was, that all the old twenty-gun ſhips were remarkably leſs ſickly than thoſe of the ſame ſize of a modern conſtruction. This, he ſaid, was a circumſtance he could not otherwiſe account for, than by the former having their *galley* * in the fore-part of the *orlop* †, the chimney vented ſo ill, that it was ſure to fill every part with ſmoke whenever the wind was a-ſtern. This was a nuiſance for the time, but, as he thought, abun-

* Their fire-place or kitchen.

† The deck immediately above the hold.

dantly

dantly compenſated by the extraordinary good health of the ſeveral crews. Poſſibly theſe fire-places were alſo beneficial, by drying and ventilating the lower decks, more when they were below, than they can do now that they are placed under the forecaſtle upon the upper deck.

BUT the moſt obvious uſe of the portable fires was their drying up the moiſture, and eſpecially in thoſe places where there was the leaſt circulation of air. This humidity, compoſed of the breath and perſpirable matter of a multitude of men, and often of animals (kept for a live-ſtock), and of the ſteams of the bilge water from the well, where the corruption is the greateſt; this putrid moiſture, I ſay, being one of the main cauſes of the ſcurvy, was therefore more particularly attended to, in order to its removal. The fires were the powerful inſtrument for that purpoſe; and whilſt they

they burned, ſome men were employed in rubbing hard, with canvaſs or oakhum, every part of the inſide of the ſhip that was damp and acceſſible. But the advantage of fire appears no where ſo manifeſt as in cleanſing the well; for this being in the loweſt part of the hold, the whole leakage runs into it, whether of the ſhip itſelf, or of the caſks of ſpoilt meats or corrupted water. The mephitic vapours from this ſink alone have often been the cauſe of inſtantaneous death to thoſe who have unwarily approached to clean it; and not to one only, but to ſeveral ſucceſſively, when they have gone down to ſuccour their unfortunate companions. Yet this very place hath not only been rendered ſafe but ſweet, by means of an iron pot filled with fire and let down to burn in it.

When, from the circumſtances of the weather, this ſalutary operation could not take

take place, the ſhip was fumigated with gun-powder, as deſcribed in Captain Cook's Paper; though that ſmoke could have little or no effect in drying, but only in remedying the corruption of the air, by means of the acid ſpirits from the ſulphur and nitre, aided perhaps by ſome ſpecies of an aërial fluid, then diſengaged from the fuel, to counteract putrefaction. But as theſe purifications by gun-powder, as well as by burning tar and other reſinous ſubſtances, are ſufficiently known, I ſhall not inſiſt longer on them here.

Among the ſeveral means of ſweetening or renewing the air, we ſhould expect to hear of Dr. Hales's ventilator. I muſt confeſs it was my expectation, and therefore, perſuaded as I was of the excellence of the invention, it was not without much regret that I ſaw ſo good an opportunity loſt, of giving the ſame favourable impreſ-
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ſion of it to the Public. If a degree of ſucceſs, exceeding our moſt ſanguine hopes, is not ſufficient for juſtifying the omiſſion of a meaſure, deemed one of the moſt eſſential for attaining an end, I would plead in favour of our worthy brother, that by a humiliating fatality, ſo often accompanying the moſt uſeful diſcoveries, the credit of this ventilator is yet far from being eſtabliſhed in the navy. What wonder then, if Captain COOK, being ſo much otherwiſe taken up, ſhould not have had time to examine it, and therefore avoided the encumbering his ſhip with an apparatus he had poſſibly never ſeen uſed, and of which he had at beſt received but a doubtful character? Nor was he altogether unprovided with a machine for ventilation. He had the *wind-ſails*, though he hath not mentioned them in his Paper; and he told me that he had found them at times very ſerviceable, and particularly between the

Tropics.

Tropics. They have the merit of taking up little room, they require no labour in working, and the contrivance is ſo ſimple that they can fail in no hands. But their powers are ſmall in compariſon with thoſe of Dr. HALES's ventilator: they cannot be put up in hard gales of wind, and are of no efficacy in dead calms, when a refreſhment of the air is moſt wanted. Should there be any objection to the having them both?

SUCH were the meaſures taken by our ſagacious Navigator for procuring a purity of air. It remains only to ſee in what manner he ſupplied pure water; another article of ſo great moment, that the thirſty voyager, upon his ſalt and putrid diet, with a ſhort allowance of that element, and that in a corrupted ſtate, muſt account a plentiful proviſion of freſh water to be indeed *the beſt of things*.

Captain Cook was not without an apparatus for diſtilling ſea-water, and though he could not obtain nearly ſo much as was expected from the invention, yet he ſometimes availed himſelf of it; but for the moſt of his voyage he was otherwiſe provided. Within the ſouthern tropic, in the Pacific Ocean, he found ſo many iſlands, and thoſe ſo well ſtored with ſprings, that, as I have hinted before, he ſeldom was without a ſufficiency of water for every uſeful purpoſe. Yet, not ſatisfied with plenty, he would have the pureſt; and therefore, whenever an opportunity offered, he emptied what he had taken in only a few days before, and filled his caſks anew. But was he not above four months in his paſſage from the Cape of Good Hope to New Zealand, in the frozen zone of the South, without once ſeeing land? and did he not actually complete his courſes in the other high latitudes, without the

 benefit

benefit of a ſingle fountain? Here was indeed *a wonder of the deep!* I may call it the *romance of his voyage!* Thoſe very ſhoals, fields, and floating mountains of ice, among which he ſteered his perilous courſe, and which preſented ſuch terrifying proſpects of deſtruction; thoſe, I ſay, were the very means of his ſupport, by ſupplying him abundantly with what he moſt wanted. It had been ſaid that thoſe vaſt maſſes of ice, called *iſlands* or *mountains*, melted into freſh water; though CRANTZ, the relator of that paradox, did not imagine they originated from the ſea, but that they were firſt formed in the great rivers of the North, and, being carried down into the ocean, were afterwards increaſed to that amazing height by the ſnow that fell upon them *. But that all frozen ſea-water would thaw into freſh,

* Hiſt. of Greenland, b. i. ch. ii. § 11, 12.

had

had either never been aſſerted, or had met with little credit. This is certain, that Captain COOK expected no ſuch tranſmutation, and therefore was agreeably ſurpriſed to find he had one difficulty leſs to encounter, that of preſerving the health of his men ſo long on ſalt and putrid proviſions, with a ſcanty allowance of corrupted water, or what he could procure by diſtiliation. The melted ice of the ſea was not only freſh, but ſoft; and ſo wholeſome, as to ſhew the fallacy of human reaſon unſupported by experiments. An ancient, of great authority, had aſſigned, from theory, bad qualities to melted ſnow; and, from that period to the preſent times, this prejudice, extending to ice, had not been quite removed.

IN this circumnavigation, amidſt ſleets and falls of ſnow, fogs, and much moiſt weather, the Reſolution enjoyed nearly the ſame ſtate of health ſhe had done in the temperate and torrid zones. It appears only from the journal of the ſurgeon, that, towards the end of the ſeveral courſes, ſome of the crew began to complain of the ſcurvy; but the diſeaſe made little progreſs, excepting in one who had become early an invalid from another cauſe. The other diſorders were likewiſe neither numerous nor fatal, ſuch as colds in various forms, ſlight diarrhœas, and intermittents that readily yielded to the Bark. There were alſo ſome continued fevers, but which, by timely care, never roſe to an alarming height. Much commendation is therefore due to the attention and abilities of Mr. PATTEN, the ſurgeon of the Reſolution, for having ſo well ſeconded his captain in the diſcharge of his duty. For it muſt be allowed, that, in deſpite of the beſt regulations and the beſt proviſions, there will always be, among a numerous crew, during a long voyage,

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ſome caſualties more or leſs productive of ſickneſs; and, unleſs there be an intelligent medical aſſiſtant on board, many, under the wiſeſt commander, will periſh, that otherwiſe might have been ſaved.

THESE, GENTLEMEN, are the reflections I had to lay before you on this intereſting ſubject; and, if I have encroached on your time, you will recollect that much of my diſcourſe hath been employed in explaining ſome things but juſt mentioned by Captain COOK, and in adding other materials, which I had procured partly in converſation with himſelf, and partly, after his departure, with thoſe intelligent friends he alludes to in his Paper. This was my plan; which, as I have now executed, you will pleaſe to return your thanks to thoſe gentlemen, who, on your account, ſo cheerfully communicated to me their obſervations.

As to your acknowledgments to Captain Cook, and your high opinion of his deserts, you will beſt teſtify them by the honourable diſtinction ſuggeſted by your Council, in preſenting him with this Medal: for I need not gather your ſuffrages, ſince the attention, with which you have favoured me, hath abundantly expreſſed your approbation. My ſatisfaction, therefore, had been complete, had he himſelf been preſent to receive the honours you now confer upon him. But you are appriſed that our brave and indefatigable Brother is at this inſtant far removed from us, anticipating, I may ſay, your wonted requeſt on theſe occaſions, by continuing his labours for the advancement of Natural Knowledge, and for the honour of this Society; as you may be aſſured, that the object of his new enterprize is not leſs great, perhaps ſtill greater, than either of the former.

ALLOW me then, GENTLEMEN, to deliver this Medal, with his unperiſhing name engraven upon it, into the hands of one who will be happy to receive that truſt, and to know that this reſpectable Body never more cordially nor more meritoriouſly beſtowed that faithful ſymbol of their eſteem and affection. For if Rome decreed the *Civic Crown* to him who ſaved the life of a ſingle citizen, what wreaths are due to that Man, who, having himſelf ſaved many, perpetuates in your Tranſactions the means by which Britain may now, on the moſt diſtant voyages, preſerve numbers of her intrepid ſons, her *Mariners*; who, braving every danger, have ſo liberally contributed to the fame, to the opulence, and to the maritime empire, of their country*!

* Here followed Captain COOK's Paper, which was preſented to the Society, and is inſerted in part ii. vol. lxvi. of the Philoſophical Tranſactions; but, as

the

the ſubſtance of that publication is now contained in the laſt pages of Captain Cook's Voyage, it was judged unneceſſary to repeat it here. The only material circumſtance of Captain Cook's communication to the Society, omitted in his Journal, is the following extract of a letter which he wrote to the Preſident, juſt before his late embarkation, dated Plymouth Sound, July 7, 1776; and is as follows:

'I entirely agree with you, that the dearneſs of the 'rob of lemons and of oranges will hinder them from 'being furniſhed in large quantities; but I do not 'think this ſo neceſſary; for, though they may aſſiſt 'other things, I have no great opinion of them alone. 'Nor have I a higher opinion of vinegar: my people 'had it very ſparingly during the late voyage, and, 'towards the latter part, none at all; and yet we 'experienced no ill effects from the want of it. The 'cuſtom of waſhing the inſide of the ſhip with vine-'gar, I ſeldom obſerved; thinking that fire and 'ſmoke anſwered the purpoſe much better.'

A

DISCOURSE

ON THE

INVENTION AND IMPROVEMENTS

OF THE

REFLECTING TELESCOPE;

DELIVERED AT THE

Anniverſary Meeting of the ROYAL SOCIETY,

November 30, 1777.

By Sir JOHN PRINGLE, Bart. PRESIDENT.

PUBLISHED AT THEIR REQUEST.

A

DISCOURSE

ON THE

INVENTION AND IMPROVEMENTS

OF THE

REFLECTING TELESCOPE.

GENTLEMEN,

IT was with equal truth and modefty obferved by our moft worthy Brother, the Reverend Dr. BRADLEY, in his celebrated Paper concerning the apparent motion of the fixed ftars, and the caufes of that deception, 'that the great exactnefs with which inftruments are now conftructed hath enabled

'bled the aſtronomers of the preſent age to
'diſcover ſeveral changes in the poſition of
'the heavenly bodies, which, by reaſon of
'their ſmallneſs, had eſcaped the notice of
'their predeceſſors *.' And indeed it was upon this liberal principle, the embracing of every aſſiſtance which could be advantageous to their inſtitution, that this Society, from their foundation to this day, have cheriſhed the mechanical arts; nay, have often aſſociated thoſe artiſts that had invented or perfected inſtruments eminently conducive to the advancement of Natural Knowledge.

It is a merit of this kind, I would ſay a ſignal mechanical improvement, which your Council have thought proper at this time to diſtinguiſh; and they have accordingly empowered me to announce to you, on this day of your annual ſolemnity, that

* Phil. Tranſ. vol. xlv.

they

they have adjudged the Prize Medal, founded on the benefaction of Sir GODFREY COPLEY, Baronet, to Mr. JOHN MUDGE of Plymouth, Fellow of this Society, on account of his valuable Paper, 'containing directions for making the best 'composition for the metals of reflecting 'telescopes, together with a description of 'the process for grinding, polishing, and 'giving the great speculum the true parabolic form*.' Nor do they doubt (conscious as they are of their zeal for the honour of the Society, and of their attention to their duty) of obtaining your wonted approbation, when they shall have laid before you the reasons which moved them to put this mark of distinction upon that communication, amidst a number of others very deserving of praise†.

* Phil. Transf. vol. lxvii. part i.

† The encouragement of *experimental* improvements, it may be observed, was the main object of the institution of Sir GODFREY COPLEY's Medal.

BUT,

BUT, before I enter upon theſe conſi-derations, allow me briefly to recal to your memory ſome particulars concerning the invention of reflecting teleſcopes, the ſub-ſequent improvements of theſe inſtruments, and the ſtate in which Mr. MUDGE found them, when he firſt ſet about working them to a greater perfection, than was attainable either by the methods which the artificers thought proper to divulge, or the directions that had been given by learned writers on that ſubject. Thus you will have under your view ſufficient materials to judge of the merits of his performance, and of the equity of your Council in decreeing theſe honours to him.

'It muſt be acknowledged,' ſays Dr. SMITH in his Complete Syſtem of Optics, 'that Mr. JAMES GREGORY of Aberdeen 'was the firſt inventor of the reflecting 'teleſcope; but his conſtruction is quite

'different

'different from Sir ISAAC NEWTON'S,
'and not nearly ſo advantageous*.'

BUT, with much deference to ſo reſpectable an author, and with all regard to the fame of GREGORY, let us not forget to do juſtice to MERSENNUS, by acknowledging him to be the man who is entitled to the credit of having entertained the *firſt* thought of a reflector. A teleſcope with *ſpecula* he certainly propoſed to the celebrated DESCARTES, many years before GREGORY'S invention; though indeed in a manner ſo very unſatisfactory, that DESCARTES, who had given particular attention to the improvement of the teleſcope, was ſo far from approving the propoſal, that he endeavoured to convince MERSENNUS of its fallacy†. Dr. SMITH, it

* Remarks upon Art. xxiv.

† Lettres de DESCARTES, tom. ii. printed at Paris in 1657, lett. 29. and 32. See this point diſcuſſed by two

it appears, had never perufed the two letters of DESCARTES to MERSENNUS which briefly touch on that fubject.

AGAIN, as to his affertion, 'that GREGORY's conftruction was not nearly fo 'advantageous as NEWTON's,' it may be accounted for from his having fet it down early in the compofition of his work, and forgetting to qualify it afterwards, when, before the publication, he had received pretty fure information to the contrary. Or perhaps he was influenced by the example of Dr. BRADLEY, who had been a moft fuccefsful obferver, and yet had always preferred the *Newtonian* telefcope to the other. But if long experience is allowed to be the final arbiter in fuch matters, we muft adjudge the fuperiority to the latter, as that is now, and has been for feveral years paft, the only inftrument of the kind in requeft.

two learned and candid authors, M. LE ROI in the Encyclopedie, under the article *Telefcope*; and M. MONTUCLA in Hift. des Mathem. tom. ii. p. 643.

GREGORY,

GREGORY, a young man of an uncommon genius, was led to the invention, in ſeeking to correct two imperfections of the common teleſcope; the firſt was, its too great length, which made it leſs manageable; the ſecond, the incorrectneſs of the image. Mathematicians had demonſtrated, that a pencil of rays could not be collected in a ſingle point by a ſpherical lens; and alſo, that the image tranſmitted by ſuch a lens would be in ſome degree incurvated. Theſe inconveniences, he believed, would be obviated, by ſubſtituting for the object glaſs a metallic ſpeculum, of a parabolic figure, to receive the image, and to reflect it towards a ſmall ſpeculum of the ſame metal: this again was to return the image to an eye glaſs placed behind the great ſpeculum, which, for that purpoſe, was to be perforated in its centre. This conſtruction he publiſhed in 1663, in his *Optica Promota*, a work which in every reſpect doth honour to the author. But as GREGORY, as he himſelf declares, was endowed with no mechanical dexterity, nor could find any workman capable of realizing his invention; after ſome fruitleſs attempts in that way, he was obliged to give up the purſuit: and, probably, had not ſome new diſcoveries been made in light and colours, a reflecting teleſcope would never more have been thought of, conſidering the difficulty of the execution, and the ſmall advantages that could accrue from it, deducible from the principles of optics that were then known.

BUT NEWTON, whoſe happy genius for experimental knowledge was equal to that for geometry, and who to theſe talents, in a ſupreme degree, joined patience and mechanical abilities; NEWTON, I ſay, thus accompliſhed, happily interpoſed, and ſaved this noble invention from well-nigh periſhing in its infant ſtate. He likewiſe, at an early period of life, had applied himſelf to the improvement of the teleſcope; but, imagining that GREGORY's *ſpecula* were neither very neceſſary, nor likely to be executed, he began with proſecuting the views of DESCARTES, who aimed at making a more perfect image of an object, by grinding lenſes, not to the figure of a ſphere, but to that of one of the conic ſections. Now, whilſt he was thus employed, three years after GREGORY's publication, he happened to take to the examination of the colours formed by a priſm; and having, by the means of that ſimple inſtrument, made the ever memorable diſcovery of the *different refrangibility of the rays of light*; he then perceived that the errors of teleſcopes, ariſing from that cauſe alone, were ſome hundred times greater than ſuch as were occaſioned by the ſpherical figure of lenſes. This circumſtance forced, as it were, NEWTON to fall into GREGORY'S track, and to turn his thoughts to reflectors. 'The different refrangibility of the 'rays of light,' ſays he, in a letter to Mr. OLDENBURG, Secretary to this Society, dated in February 1672, 'made me take '*reflections* into conſideration, and finding 'them regular, ſo that the angle of reflec'tion of all ſorts of rays was equal to the 'angle of incidence, I underſtood that, by 'their mediation, optic inſtruments might 'be brought to any degree of perfection 'imaginable, provided a reflecting ſub'ſtance could be found, which would po'liſh as finely as glaſs, and reflect as much 'light as glaſs tranſmits, and the art of 'communicating to it a parabolic figure be 'alſo obtained.——Amidſt theſe thoughts, 'I was forced from Cambridge by the 'intervening plague; and it was more than 'two years before I proceeded farther *.'

* Phil. Tranſ. n. 80.

It appears, then, that, if Newton was not the firſt inventor of the reflecting teleſcope, he was the main and effectual inventor. By the force of his admirable genius, he fell upon this new property of light, and thereby found that all lenſes, of whatever figure, would be affected more or leſs with ſuch priſmatic aberrations of the rays, as would be an inſuperable obſtacle to the perfection of a dioptric teleſcope. Here was (if I may uſe the ſimilitude) a diſorder inherent in the conſtitution of this inſtrument, which Newton, like a wiſe phyſician, penetrated into, and, by underſtanding the nature of the diſeaſe, was led to the remedy; one indeed that had been deviſed before, but for a different and a ſlighter ailment, and withal of ſuch difficult compoſition, that the contriver of it himſelf had not been able to prepare it.

It was towards the end of 1668, or in the beginning of the following year, when

Newton, being thus obliged to have recourse to reflectors, and not relying on any artificer for making his *specula*, set about the work himself, and, early in the year 1672, completed two small reflecting telescopes. In these he ground the great speculum into a spherical concave; not but that he approved of the parabolic form proposed by Gregory, though he found himself unable to accomplish it. In a letter that accompanied one of these instruments, which he presented to the Society, he writes, 'that though he then despaired of 'performing that work (to wit, the parabolic figure of the great speculum) by 'geometrical rules, yet he doubted not but 'that the thing might in some measure be 'accomplished by mechanical devices*.'

Not less did the difficulty appear to find a metallic substance that would be of a

* Phil. Trans. n. 81.

proper

proper hardneſs, have the feweſt pores, and receive the ſmootheſt poliſh: a difficulty, in truth, which he deemed almoſt inſurmountable, when he conſidered that every irregularity in a reflecting ſurface would make the rays of light ſtray five or ſix times more out of their due courſe, than the like irregularities in a refracting one. In another letter, written ſoon after, he tells the Secretary, ' that he was very ' ſenſible that metal reflects leſs light than ' glaſs tranſmits;—but as he had found ' ſome metalline ſubſtances to be more ' ſtrongly reflective than others, to poliſh ' better, and to be freer from tarniſhing ' than others, ſo he hoped that there might ' in time be found out ſome ſubſtances ' much freer from theſe inconveniences ' than any yet known *.' Meanwhile here was, as I ſaid, another ſtop; and the more diſcouraging, as it was not, like the former,

* Phil. Tranſ. n. 82.

to be removed by ‘ mechanical devices,’ nor even by any chemical principle that had been diſcovered. That want could only be ſupplied by making repeated trials; nay, I may ſay, as it were, fortuitouſly. NEWTON therefore laboured till he found a compoſition that anſwered in ſome degree, and left it to thoſe who ſhould come after him to find a better. The induſtry of Mr. MUDGE has been aiding to that of Sir ISAAC NEWTON; and the happy aſſiſtant of that great man has been ſo candid as to acknowledge, that chance did ſave him much trouble, by furniſhing him with a metallic mixture, which he had reaſon to believe was fitter for the purpoſe than any that had been uſed before, either publiſhed or concealed from the public.

NEWTON having, with his teleſcope, communicated to the Society a full and ſatisfactory account of its conſtruction and performance,

performance, he received from your illuſtrious predeceſſors ſuch thanks as were due to ſo curious and valuable a preſent. And HUYGENS, one of the greateſt geniuſes of the age, and himſelf a diſtinguiſhed improver of the refractor, no ſooner was informed by Mr. OLDENBURG of the diſcovery, than he wrote in anſwer, ‘ that it ‘ was an admirable teleſcope; and that Mr. ‘ NEWTON had well conſidered the advan- ‘ tage which a concave ſpeculum had above ‘ convex glaſſes in collecting the parallel ‘ rays, which, according to his own calcu- ‘ lation, was very great. Hence that Mr. ‘ NEWTON could give a far greater aper- ‘ ture to that ſpeculum than to an object ‘ glaſs of the ſame diſtance of focus, and ‘ conſequently much more magnify in his ‘ way than by an ordinary teleſcope. Be- ‘ ſides, that by the reflector he avoided an ‘ inconvenience inſeparable from object ‘ glaſſes, which was the obliquity of both

‘ their

'their ſurfaces, which vitiated the refraction
'of the rays that paſs towards the ſides of the
'glaſs, and did more hurt than men were
'aware of. Again, that by the mere re-
'flection of the metalline ſpeculum there
'were not ſo many rays loſt as in glaſſes,
'which reflected a conſiderable quantity by
'each of their ſurfaces, and beſides inter-
'cepted many of them by the obſcurity of
'their matter.——That the main buſineſs
'would be, to find a matter for this ſpecu-
'lum, that would bear as good and even a
'poliſh as glaſs. Laſtly, he believed that
'Mr. NEWTON had not been without
'conſidering the advantage which a para-
'bolic ſpeculum would have above a ſphe-
'rical one in this conſtruction; but had
'deſpaired, as he himſelf had done, of
'working other ſurfaces than ſpherical
'ones with due exactneſs*.' HUYGENS
was not ſatisfied with thus expreſſing to

* Phil. Tranſ. n. 81.

the

the Society his high approbation of the late invention, but drew up a favourable account of the new telefcope, which he caufed to be publifhed in the *Journal des Sçavans*, of the year 1672, and by that channel it was foon known over Europe.

BUT how excellent foever the contrivance was, how well foever fupported and announced to the public, yet, whether it was that the artifts were deterred by the difficulty and labour of the work, or that the difcoveries even of a NEWTON were not to be exempted from the general fatality attending great and ufeful inventions, *the making a flow and vexatious progrefs to the authors*; the fact is, that, excepting an unfuccefsful attempt which the Society made by employing an artificer to imitate the *Newtonian* conftruction, but upon a larger fcale, and a difguifed *Gregorian* telefcope, fet up by CASSEGRAIN abroad as a rival

rival to NEWTON's, and that in theory only (for it never was put in execution by the author*), no reflector was heard of for nearly half a century after. But, when that period was elapfed, a reflecting telefcope was at laft produced to the world of the *Newtonian* conftruction, which the venerable author, ere yet he had finifhed his much diftinguifhed courfe, had the fatisfaction to find executed in fuch a manner, as left no room to fear that the invention would longer continue in obfcurity.

THIS memorable event was owing to the genius, dexterity, and application of a gentleman of this Society, Mr. HADLEY, the inventor of the reflecting quadrant, another moft valuable inftrument. The two telefcopes which NEWTON had made were but fix inches long, were held in the

* Compare MONTUCLA, Hift. de Mathem. tom. ii, p. 647.

hand

hand for viewing objects, and in power were compared to a six feet refractor; whereas HADLEY's was above five feet long, was provided with a well-contrived apparatus for managing it, and equalled in performance the famous aërial telescope of HUYGENS, of 123 feet in length. Excepting as to the manner of making the *specula*, we have, in the Transactions of 1723, a complete description, with a figure, of this telescope, together with that of the machine for moving it; but, by a strange omission, NEWTON's name is not once mentioned in that Paper, so that any person, not acquainted with the history of the invention, and reading that account only, might be apt to conclude that HADLEY had been the sole contriver of it. But other Papers in the same volume, besides the Minutes of the Society, clearly shew that this worthy Member meant nothing less than

than to arrogate to himſelf any merit in this performance that properly belonged to NEWTON.

IT is known that the ſame celebrated artiſt, after finiſhing two teleſcopes of the *Newtonian* conſtruction, accompliſhed a third in the *Gregorian* way; but, I ſhould judge, leſs ſucceſsfully, by Dr. SMITH's declaring ſo ſtrongly in favour of the other. Mr. HADLEY was not leſs communicative than he was ingenious, being ever ready to impart his lights to others: in particular we are informed, 'that he ſpared no pains 'to inſtruct Mr. MOLYNEUX and the Re- 'verend Dr. BRADLEY; and that when 'thoſe gentlemen had made a ſufficient 'proficiency in the art, being deſirous that 'theſe teleſcopes ſhould become more pub- 'lic, they liberally communicated to ſome 'of the principal inſtrument-makers of this 'city the knowledge they had acquired 'from

'from him*.' Now ſuch ſcholars, as it is eaſy to imagine, ſoon advanced beyond their maſters, and completed reflectors by other and better methods than what had been taught them.

CERTAIN it is, at leaſt, that Mr. JAMES SHORT, as early as the year 1734, had ſignalized himſelf at Edinburgh by his work of this kind. The excellent MAC-LAURIN, my dear departed friend, wrote that year to Dr. JURIN, 'that Mr. SHORT, 'who had begun with making glaſs *ſpecula*, 'was then applying himſelf to improve the 'metallic; and that, by taking care of the 'figure, he was enabled to give them 'larger apertures than others had done; 'and that, upon the whole, they ſurpaſſed 'in perfection all that he had ſeen of 'other workmen.' He added, 'that Mr. 'SHORT's teleſcopes were all of the *Grego-*

* SMITH's Syſt. of Opt. b. iii. ch. 2.

'*rian*

'*rian* conſtruction; and that he had much 'improved that excellent invention*.' This character of excellence Mr. SHORT maintained to the laſt, and with the more facility, as he had been well grounded both in the geometrical and philoſophical principles of optics, and upon the whole was a moſt intelligent perſon in whatever related to his profeſſion. It was ſuppoſed he had fallen upon a method of giving the parabolic figure to his great ſpeculum; a point of perfection that GREGORY and NEWTON had wiſhed for, but deſpaired of attaining; and that HADLEY had never, as far as we know, attempted, either in his *Newtonian* or *Gregorian* teleſcope. Mr. SHORT, I am well informed, ſaid he had acquired that faculty, but never would tell by what peculiar means he effected it; ſo that the ſecret of working that configuration, what-

* SMITH's Syſt. of Opt. b. iii. ch. 2. Rem. on art. 489.

ever

ever it was, as far as it then appeared, died with that ingenious artift.

It is Mr. Mudge, therefore, who hath truly realized the expectation of Sir Isaac Newton, who, above an hundred years ago, prefaged that the public would one day poffefs a parabolic fpeculum, 'not accomplifhed by mathematical rules, but by 'mechanical devices.'

This was a *defideratum*, but it was not the only want fupplied by our worthy brother: he has taught us likewife a better compofition of metals for the *fpecula*, how to grind them better, and how to give them a finer polifh; and this laft part (namely the polifh), he remarks, was the moft difficult and effential of the whole operation. In a word, I am of opinion, there is no optician in this great city (which hath been fo long and fo juftly renowned for ingenious and dexterous makers of every kind of mathematical inftruments), fo partial to his own abilities as not to acknowledge, that however fome parts of the mechanical procefs now difclofed might have been known before by individuals of the profeffion, yet that Mr. MUDGE hath opened to them all fome new and important lights, and upon the whole hath greatly improved the art of making reflecting telefcopes.

To enter into the detail of the 'devices' (to ufe NEWTON's expreffion), by which Mr. MUDGE hath arrived at the true parabolic figure, as well as at the other perfections of this inftrument, would encroach too much on your time; and, I may add, would not be altogether fuitable to the prefent occafion. I have laid before you the fum of what he hath performed, and declared to you the opinion of your Council, that without his interpofition the nicety of the art was in danger of being loſt ; or, at beſt, of being kept in the hands of thoſe who were not likely to make it public. The character which Mr. MUDGE bears for integrity, would leave us no room to doubt of his being himſelf perſuaded, that he hath in every point brought the great ſpeculum of reflecting teleſcopes to that degree of perfection which he profeſſes: but as authors and improvers, like parents and preceptors, can rarely diveſt themſelves of too partial a fondneſs for what is their own, or amended by them, it will be ſatiſfactory for you to know, that ſome of our brethren, the moſt intelligent in theſe matters, have frequently diſcourſed with Mr. MUDGE upon this ſubject ; have ſeen him at work upon the *ſpecula* ; nay, have examined two reflecting teleſcopes (the one of 18 inches, the other of 22) completed by him ; and that they are confident he hath by no means exaggerated either what he hath recovered to the body of arts, or what he hath added to it.

NEED I now ſet forth the merit of aſcertaining and advancing the conſtruction of the reflecting teleſcope, to an audience ſo well apprized of its value? To you, who know that of all inventions there are none ſo juſtly entitled to our admiration as thoſe which have been fallen upon for enlarging the powers of viſion; and that the diſcovery of optical inſtruments may be eſteemed among the moſt noble, as well as among the moſt uſeful gifts, which the Supreme Artiſt hath conferred on Man? For all admirable as the eye came out of the hands of Him who made it, yet no organ of the animal frame hath He permitted ſo much to be aſſiſted by human contrivance, not only for the uſes and comfort of common life, but for the advancement of natural ſcience; whether by giving form and proportion to the minute parts of bodies (as it were to the atoms of Nature) imperceptible before; or by contracting ſpace, and, as by magic art, bringing to view the grander objects of the univerſe, the immenſe diſtances of which had either diſguiſed their aſpect, or rendered them quite inviſible!

IF PLINY, in regard to HIPPARCHUS, could extravagantly ſay, '*Auſus rem Deo* '*improbam annumerare poſteris ſtellas!*' what would that pompous hiſtorian of Nature have ſaid, had it been foretold him, that in the latter days a man would ariſe, who ſhould enable poſterity to enumerate more new ſtars than HIPPARCHUS had counted of the old; nay, who ſhould in a manner verify the vulgar notion of their being innumerable! who ſhould aſſign four Moons to Jupiter, and in our Moon (ſuppoſed by many to have a ſmooth and poliſhed ſurface) point out higher mountains than any here below! who ſhould, in the Sun, the fountain of light, diſcover dark ſpots as broad as two quarters of the earth, and by theſe ſpots aſcertain his motion round his axis! who, by the varying *phaſes* of the planets, ſhould compoſe the ſhorteſt and plaineſt demonſtration of the truth of that ſyſtem, till then the greateſt of paradoxes, which ſuppoſed that the earth and planets revolved about that luminary*! Yet theſe were but a part of the annunciations to the world of a ſingle perſon, of GALILEO of unperiſhing memory! To him his contemporary, and rival in fame Lord BACON, aſcribed the invention of the *perſpicilla* (for ſo they called at firſt the teleſcopes), and in a figurative ſtrain thus expreſſed himſelf concerning them: 'With 'theſe (*perſpicilla*), which GALILEO by 'a memorable effort of genius hath diſco-'vered, we are enabled, as with ſome

* GALILEI Sidereus Nuncius, ſparſim.

'ſmall

'small failing veffels, to open and keep up
'a nearer commerce with the ftars*.'

Nor did this celeftial commerce ceafe with the acquifitions of Galileo, but hath been extending ever fince the time that that great man firft turned his glaffes to the heavens. The famous Kepler, on the firft notice, embraced the difcovery, and, in 1611, the year following the *Sidereus Nuncius* of Galileo, publifhed a treatife of dioptrics, geometrically explaining the performance of the *perfpicilla*, and propofing fome proper improvements of them. Then came Snellius, Descartes, and other celebrated geometricians abroad, who applied themfelves to optics, and fuccefsfully cultivated that fruitful branch of fcience. But whilft, at that period, in different parts of Europe, men of the firft

* Quæ (perfpicilla) memorabili conatu adinvenit Galileus, &c. Nov. Organ. l. ii. aphor. 39.

rank in mathematical ſtudies ſeemed to vie with each other in promoting not only the theory of viſion, but the mechanical practice of the inſtruments appertaining to it, and particularly the teleſcope; how did it happen, that, in this country, in the laſt century, which had ſo auſpiciouſly begun with the lights derived from Lord BACON and Dr. HARVEY, we ſhould afterwards find few traces of any attempt in that way earlier than the eſtabliſhment of this Society? Of this pauſe in the courſe of your philoſophical diſcoveries, the diſtracted ſtate of theſe kingdoms, under a long civil war, was indubitably the occaſion. For no ſooner had we ſheathed the bloody ſword, and diſplayed the peaceful olive, than arts and ſciences again ſprang forth, and with ſo much vigour, that the advancement made, in theſe lands, ſince that epoch, in optics alone, may be conſidered as one of the nobleſt

nobleſt exertions of the human genius. Not to contend for a general ſuperiority in the publications here on that ſubject, ſince the time that GREGORY entered firſt into that grand career, to ſilence all competition, I need but mention the *Theory of Light and Colours*; a piece ſo excellent for invention, for judgment in conducting experiments, and for drawing the proper concluſions from them, that, had it been NEWTON's ſingle work, it would not only have done laſting honour to himſelf, but to the country that gave him birth. And as to the inſtruments, which of them, let me aſk, hath not been either found out, or ſignally improved, among you? Or what nation is there that hath embraced the arts, and doth not value itſelf on poſſeſſing every piece of this kind of Britiſh workmanſhip? The reflecting teleſcope I may call wholly yours, both as to the original

contrivance,

contrivance, and every ſtep of its advancement: nay, from its revival by Mr. HADLEY to this day, a ſpace of nearly threeſcore years, we have heard of no artiſt, out of this iſland, who hath been able tolerably to copy, much leſs to add to, this ſplendid invention.

WHAT acknowledgements, then, GENTLEMEN, do we not owe to our worthy Brother, who, for above twenty years paſt, in the uncertain intervals of a toilſome and anxious profeſſion, hath unbent his mind, not in the periſhing recreations of the world, but in inveſtigating, with unremitting diligence, what had been done but concealed by others, and in making many ſucceſsful experiments towards perfecting this inimitable inſtrument! A liberal account of theſe leiſure hours he hath laid before you in his inſtructive Paper: a communication, I am perſuaded, that will not only preſerve, but ſignalize his name in your records, among the very intelligent and ingenuous promoters of the great ends of your inſtitution.

A

DISCOURSE

ON THE

THEORY OF GUNNERY;

DELIVERED AT THE

Anniverſary Meeting of the ROYAL SOCIETY,

November 30, 1778.

By Sir JOHN PRINGLE, Baronet.

PUBLISHED BY THEIR ORDER.

A

DISCOURSE

ON THE

THEORY OF GUNNERY.

GENTLEMEN,

AMONG the ſeveral experiments communicated to the Society, during the courſe of the preceding year, none ſeeming ſo much to engage your attention, as thoſe contained in the Paper, intitled, *The Force of fired Gun-powder, and the initial Velocity of Cannon-balls, determined by* *by Experiments:* with much pleaſure therefore I acquaint you, that, on account of the pre-eminence of that communication, your Council have judged the author, Mr. Charles Hutton, worthy of the honour of the annual Medal, inſtituted on the bequeſt of Sir Godfrey Copley, Baronet, for raiſing a laudable emulation among men of genius, in making experimental enquiries. But, as on former occaſions, ſo now, your Council, waving their privilege of determining the choice, have acted only as a ſelect number deputed by you, to prepare matters for your final deciſion. I come, then, on their part, briefly to lay before you the ſtate of the *Theory of Gunnery*, from its riſe to the time when its true foundation was laid, in order to evince how conducive thoſe experiments may be to the improvement of an art of public concern, as well as to the advancement of Natural Knowledge, the great object of your

your inftitution. And if, upon a review of the fubject, you fhall entertain no lefs favourable an opinion of Mr. HUTTON's performance, than what your Council have done, it is their earneft requeft that you would enhance the value of this Prize, by authorizing your Prefident to prefent it to our ingenious Brother in your name.

ARTILLERY (in the large acceptation of the term) took place long before the invention of gun-powder. We trace the art to the remoteft antiquity, fince the Sacred Records acquaint us, that one of the kings of Judah, eight hundred years before the Chriftian æra, erected on the towers and bulwarks of Jerufalem engines of war, the contrivance of ingenious men, for fhooting arrows and great ftones for the defence of that city*. Such machines were afterwards known to the Greeks and Ro-

* 2 Chron. xxvi. 15.

mans by the names of *baliſta*, *catapulta*, and others, which had amazing powers, and were not leſs terrible in their effects than the cannon and mortars of the moderns. It appears that the *baliſta* was contrived to ſhower volleys of darts and arrows of a very large ſize upon the enemy; whilſt the *catapulta*, or *onagra* (as it was otherwiſe called), was fitted not only for that purpoſe, but for diſcharging ſtones of an enormous weight; I might ſay *rocks*, ſince ſome of them are reported to have weighed ſeveral hundred pounds. Batteries compoſed of numerous pieces of that kind of artillery, nothing could withſtand. Yet, if we are rightly informed, their ſole principle of motion conſiſted in the ſpring of a ſtrongly-twiſted cordage, made of animal ſubſtances ſingularly tough and elaſtic. Theſe warlike inſtruments continued, not only during the time of the Roman empire, but to the twelfth and thirteenth centuries, as we find from hiſtory; nor indeed is it probable that they were totally laid aſide, till gun-powder and the modern ordnance, attaining a good degree of perfection, ſuperſeded their uſe. The very intelligent commentator of POLYBIUS* is of opinion, that the military art rather loſt than gained by the exchange of the *catapulta* for the mortar: but, however that point may be determined in ſpeculation, it is not likely that the ancient *tormenta militaria* will ever be revived; but that all nations will keep to the art of gunnery, and ſtudy how to improve it; that is, they will adhere to a ſyſtem of artillery, wherein the moving power depends on the expanſive force of gun-powder, or of ſome other ſubſtance of a ſimilar nature.

UPON the firſt application of this principle to the purpoſes of war, nothing per-

* M. FOLARD.

haps was lefs thought of than to affift fo empirical a practice by fcientific rules; for, however aiding in thefe matters the ancient mechanicians might have been, who, like ARCHIMEDES, had invented or perfected fome of the *baliftic* machines, no praife feemed now due to the mathematicians for either the difcovery or improvement of the new artillery. In fact, we find the practice of the art had fubfifted about 200 years, before any geometer confidered it as one that admitted a theory, or at leaft fuch a theory as was grounded on geometry.

IT feems but juft to trace and commemorate the inventors of the ingenious arts which furnifh matter for difcourfes on thefe occafions; and not only the main inventors, but even thofe who firft turned their thoughts upon the fubject: for, though fuch men may not have produced any thing perfect, yet they may have fuggefted geſted ideas to others of a leſs inventive, but of a more executive genius, and who, unprovided with theſe hints, would never have made any notable diſcovery. I muſt therefore obſerve, that the Italians were the firſt who emerged out of thoſe thick clouds of ignorance and barbariſm which had ſo long overſpread this quarter of the world. They profited by the unhappy fate of Conſtantinople; for, by liberally receiving the learned emigrants on that diſtreſsful occaſion, they were largely repaid by their arts and ſciences, and ſtill more abundantly by their language, whereby they were enabled to read and to tranſlate thoſe ancient manuſcripts, which the Greeks had ſaved out of the wreck of their country. The art of printing, which was eſtabliſhed ſoon after, was the means of quickly diſſeminating thoſe treaſures of knowledge, and concurred with the fall of the eaſtern empire, to form an epoch for the advancement of

 learning,

learning, unparalleled in the annals of letters.

THE end of the fifteenth century, and the whole of the ſixteenth, were chiefly employed by the Italians in the ſtudy and in the tranſlation of the old Greek authors. The geometry of the ancient Greeks, as well as the arithmetic in numbers and ſpecies of the Arabians, was cultivated; but both remained, as it were, ſciences by themſelves, unaſſiſting to, or at beſt but weak and reluctant auxiliaries to, the philoſophy of the ſchools: and indeed how could the abſtracted doctrines of numbers and quantities be ſtrained to co-operate with a ſyſtem, in which neither the laws of motion, nor any but the ſuperficial, and often deluſive properties of matter, were to be met with? The genius of the Greeks, all acute and brilliant as it was, had never been properly directed to the interpretation

of

of Nature, and was indeed unfit (as Lord Bacon pronounced) for a ſtudy that made ſo ſlow and painful a progreſs, by re-iterated and varied experiments and ob-ſervations. It was no wonder, then, if the *Mixed Mathematics*, as they are called, deſcended to the moderns in a ſtate no wiſe correſponding to the elegance and certainty of thoſe parts of the ſcience which were elementary and pure; and that thoſe mix-ed parts ſhould have been found defective and erroneous, in proportion (if I may ſo expreſs myſelf) to the phyſical conſidera-tions that were to be taken into the en-quiry. The imperfection of the ancients, with regard to natural philoſophy, was not perceived at that time: nay, at the period we are treating of, the learned were firmly perſuaded of the contrary, and that all that was wanting to be known concerning the laws of Nature, and the properties of mat-ter, was to be taken, either directly or by deduction, from the physics of ARISTOTLE. It was not till the seventeenth century was somewhat advanced, that men of science began to listen to Lord BACON and GALILEO, the great founders of the experimental and the true philosophy.

MEAN while, in the beginning of the sixteenth century, unqualified as the Italians then were for entering upon physico-mathematical enquiries*, they nevertheless made the attempt, and in particular took the theory of projectiles into consideration. Some imagined that a body impelled with violence, such as a ball discharged from a cannon, moved in a right line till the force was spent, and that then it fell in another

* The chief exception that occurs to this general remark, is the rapid progress which in that age COPERNICUS made in astronomy; who was not indeed an Italian, but was supposed to have profited by his early travels into Italy, which he enlightened afterwards by his admirable discoveries.

right line perpendicularly to the earth. Upon this principle, abſurd as it was, we find one of the earlieſt authors grounding his whole theory of gunnery*; whilſt others, diſſenting from his hypotheſis, admitted only the ſtraight line, in which the ball moved for ſome time after coming out of the piece, and that other ſtraight line in which it fell to the ground; but aſſerted that theſe two were connected by a curve line, and that this curve was the ſegment of a circle. NICOLAS TARTAGLIA of Breſcia, a mathematician of the firſt rank in thoſe days, and ſtill celebrated for his improvements in algebra, hath been ſuppoſed to be the author of this doctrine, no leſs erroneous than the former, and for which two of his books have been quoted †.

* See MONTUCLA, Hiſt. des Mathem. vol. i. p. 623.

† Thoſe were *La Nuova Scientia*, and *Queſiti ed Inventioni diverſe*.

Theſe I have never ſeen; but, from another of his works, profeſſedly written on this ſubject, and tranſlated into Engliſh under the title of *Colloquies concerning the Art of Shooting in great and ſmall Pieces of Artillery**, I find him, contrary to the opinion of his contemporaries, maintaining that no part of the track of a cannon-ball is in a right line, though the curvature in the firſt part of its flight be ſo ſmall, that it needeth not to be attended to. But TARTAGLIA is far from ſuppoſing, that the line in queſtion hath any relation to a *parabola*, or to any regular curve. It would ſeem, then, that if this mathematician had at firſt been ſo far miſtaken, as to fancy that ſome part of the courſe of a projectile was in a ſtraight line, he had afterwards changed his opinion, and was perhaps ſingular in what he finally embraced.

* Publiſhed at London, A. 1588.

FROM

From numerous inſtances one would imagine, that, in thoſe days, ſo far were men of ſcience from making experiments themſelves, that they even ſhut their eyes againſt what chance would have preſented to their ſight. For, whoever had minded the roving ſhot of an arrow, the flight of a ſtone from a ſling, or had attended to a ſtream of water iſſuing from the ſpout of a ciſtern, might have been convinced, that the path of every projectile was in a continued curve, whatever little he otherwiſe knew concerning the properties of that one.

But had the obſervation of the philoſophers gone ſo far, they had ſtill been at a diſtance from the truth. They might have perceived a likeneſs between the track of thoſe bodies in motion and a parabola, and concluded, from analogy, that all projectiles delineated that curve in the air; but they

they could never have realized their conjectures by mathematical demonſtration, without previouſly knowing the law of *acceleration* in falling bodies: a diſcovery reſerved for the next century, and for GALILEO*, one of the greateſt ornaments of it.

IT was he who firſt inveſtigated the effects of *gravity* on falling bodies, and upon that foundation demonſtrated, that all projectiles would move in a parabola in a non-reſiſting medium. And, as he made little account of the reſiſtance of the air, the properties of which were then imperfectly known, he proved that a ball ſhot horizontally would, in its flight, deſcribe half a parabola; and, when the piece had an elevation above the horizon, the ball would deſcribe

* He was born in the year 1564; but few if any of his works were publiſhed till after the year 1600, and his Dialogues on Motion not before 1638.

ſcribe a whole parabola, ſuppoſing it to fall on the plane of the battery. By the ſame method of reaſoning he ſhewed, that whatever the ranges of the projected body, or the elevations of the piece, were, the ball would ſtill trace that curve line, of a greater or leſſer amplitude, by the time it deſcended to the level of the place from whence it came.

THUS far went GALILEO, confining his projections to the horizontal plane of the battery: but TORRICELLI, his diſciple, ſoon after carried the theory farther, by tracing the ſhot to its fall, whether that place was above or below the plane; and ſtill found, by geometrical deductions, that it flew in a parabola of a larger or a ſmaller amplitude, according to the angle of elevation of the piece, and the ſtrength of the powder.

VARIOUS

VARIOUS and numerous had been the diſputes in Italy about the laws of motion in general, and eſpecially about thoſe of projectiles, from the time the mathematicians had begun the enquiry, till the publication of the Dialogues of GALILEO on that ſubject (a ſpace of upwards of a hundred years); but, from that period, ſo evident did his demonſtrations appear, that all conteſt ceaſed, and every man of ſcience was convinced, that all projectiles moved in the track which he had diſcovered. For, as to the reſiſtance of the air, which he had not paſſed unnoticed (as GALILEO himſelf had been the firſt, at leaſt of the moderns, who ſtarted the notion of the weight of the air and the preſſure of the atmoſphere), yet ſo thin and ſo yielding did they eſteem that fluid to be, that they were aſſured it could occaſion no ſenſible, at leaſt no material, deviation from that curve. As they had the principle from GALILEO,

GALILEO, ſo they believed themſelves warranted by that reſpectable author, not to fear, from that cauſe, any objection which he himſelf had ſuggeſted, but had removed. ‘ Among theſe projectiles,’ ſays he, ‘ which we make uſe of, if they are of ‘ a heavy matter and a round form ; nay, ‘ if they are of a lighter matter, and have ‘ a cylindrical form, ſuch as arrows ſhot ‘ from bows, their track or path will not ‘ ſenſibly decline from the curve of a para- ‘ bola *.’

HERE then was the theory of gunnery laid, in appearance, on the moſt ſolid foundation. And thus far the Italians having proceeded, they ſeemed to have taken leave, and to have committed the ſubject to other nations, whoſe greater power, or greater ambition, was more likely to make them avail themſelves of the perfection of

* See his fourth Dialogue on Motion.

a milia military art, than their inftructors. We had reafon, therefore, to expect, that a neighbouring ftate, intent upon the advancement of the arts and fciences in general, would not fail to give particular attention to thofe that fhould appear moft fubfervient to its grandeur. Accordingly we find, that our fifter Society of that kingdom had not been many years eftablifhed, when an ingenious Member of that illuftrious Body, not queftioning the foundnefs of the *Galilean* principle in regard to projectiles, in the year 1677 propofed to the academy, as a problem for the improvement of artillery, how to direct a piece (fuppofe a mortar) fo as to make the fhot fall where one had a mind; or, in the common expreffion, *to hit a mark*, the ftrength of the powder being given*. This thought met with general approbation, and fo far

* See Hift. de l'Academ. Roy. des Sciences, A. 1707.

were

were the academy from raiſing any difficulty about the obſtruction which the air might occaſion to a body moving with ſo much velocity in it, that we do not find the making experiments on that head was conſidered by them as an eſſential ſtep to the ſolution; but that their principal geometers ſtraightway ſet about ſolving the problem as it had been announced to them, ſome following one method, ſome another, and all upon the ſuppoſition of a projectile moving in the line of a parabola. But M. Blondel, who had been the propoſer, and who more particularly had ſtudied the queſtion, compoſed a large volume on the ſubject, which he publiſhed a few years after*, under the title of *L'Art de Jetter les Bombes*; a performance much celebrated at the time, and that continued in no ſmall requeſt long after, as containing, beſides

* In the year 1683. See Hiſt de l'Acad. R. des Sci. A. 1707.

his own, the labours of ſeveral other Members of that Society of the moſt diſtinguiſhed merit. So many and ſuch hands concurring in framing this work, it was no wonder that the learned throughout Europe were confirmed by it in the *Galilean* theory; and the more, as M. BLONDEL had obviated the only objection they ſuppoſed could be made to it, the *reſiſtance of the air*, which he had taken care expreſsly to mention, and ſo to combat as to perſuade the reader, that the retardation ariſing from that cauſe was ſo inconſiderable as to be of no account in the practice.

THIS illuſion about the ſmall or non-reſiſtance of the air to bodies rapidly moving in it, was ſo prevalent at the end of the laſt century, and in the beginning of the preſent, that, in the hiſtory of the Royal Academy for the year 1707, we find their worthy and moſt accompliſhed

Secretary,

Secretary, after taking notice of the joint labours of fo many able mathematicians concerned in BLONDEL's publication, venturing to fay, ' it did not appear that any ' thing was then wanting for the practice ' of the art (of Gunnery), except perhaps ' perfecting the inftruments for pointing a ' cannon or mortar . . . . . . but that geo- ' metry had done its part, fo to fpeak, with ' regard to practice, &c*.'

BUT far be it from our intention to relate the imperfections of others, in order to raife ourfelves by the comparifon. Candour requires of us not only to acknowledge that, in this country, as to the point in queftion, we did not furpafs our neighbours; but ingenuoufly to own that, on the contrary, we were perhaps more liable to exception. For, fome years before

* Hift. de l'Acad. R. des Sc. A. 1707, under the article *Mechanique*.

BLONDEL's work appeared *, a treatiſe was publiſhed by one of our own artilleriſts, ANDERSON (a perſon of eminence in his profeſſion), intitled *The genuine Uſe and Effects of the Gun*, in which the author ſtrenuouſly ſupports the *Galilean* theory; nor do we learn that he was ever contradicted among us, although he undertook to anſwer all thoſe who ſhould make objections to it. Nay, when he had an opportunity afterwards of making experiments on the ranges of bombs, and by theſe trials was aſſured that their flight was not in a parabola; yet ſo far was he from aſcribing the deviation from that figure to the reſiſtance of the air, that he had recourſe to an hypotheſis, repugnant to all the laws of motion, to ſalve appearances, and to reconcile thoſe experiments with his former doctrine †.

* Viz. in 1674.

† See his treatiſe *To Hit a Mark*, publiſhed in 1690.

AND did not Dr. HALLEY, ſo long the ornament of this Society, communicate, in in the year 1686, a Paper, which he calls *A Diſcourſe concerning Gravity*, in which, treating of the motion of projectiles, he ſays, that being aware of the deflection from the parabolic curve that might be occaſioned by the reſiſtance of the air, he had made ſome experiments, even with cannon-balls, to eſtimate the force of that reſiſtance; yet conclude, 'that in large 'ſhot of metal, whoſe weight many thou-'ſand times ſurpaſſed that of air, and 'whoſe force is very great, in proportion 'to the ſurface wherewith they preſs there-'upon, this oppoſition was not diſcern-'ible.' And again, 'though in ſmall and 'light ſhot, the oppoſition of the air ought 'and muſt be accounted for; yet in ſhoot-'ing great and weighty bombs, there need 'be very little allowance made; and ſo 'theſe rules (thoſe, to wit, grounded on 'the principle of GALILEO) may be put 'in practice to all intents and purposes, as 'if this impediment (the resistance of the 'air) were absolutely removed*.' Such conclusions, which we now find to be erroneous, were the less to be expected from so eminent a person, as they argued too much haste to finish a theory, that was to be made subservient to present use.

IT might indeed have been expected, that men of science, applying themselves to this study, would have been sooner awakened to the consideration of the great opposition of the air, by the *Principia* of NEWTON, published a little after this Paper of HALLEY's†. For in that excellent work the illustrious author had demonstrated, that the curve described by a projectile, in a strongly resisting medium, dif-

* Philos. Trans. No. 179, p. 20.

† In the year 1687.

fered

fered much from a parabola, and that the reſiſtance of the air was great enough to make the difference between the curve of projection of heavy bodies and a parabola far from being inſenſible, and therefore too conſiderable to be neglected.

Have we not then leſs to plead for not attending to the *Principia* of Newton in this article*, than the mathematicians of other nations, who, as M. de Fontenelle obſerves†, partly from the difficulty of undertaking that conciſe and profound work, and partly from a miſapprehenſion of its tendency (which they fancied was to revive the exploded doctrine of *occult qualities*), were late in becoming acquainted with it? But it is not ſo eaſy to account for their inattention to Huygens, a known and even then a much eſteemed author,

* Newton, Princip. Mathem. lib. ii. ſect. 7.

† Eloge de Newton.

and who indeed was ſecond to NEWTON alone in ſcience and in genius. For he, in the year 1690, had publiſhed a treatiſe on *Gravity*, written in a popular manner, wherein he gave an account of ſome experiments he had made at Paris, and in the academy, by which, as well as by mathematical inveſtigations, he was convinced of the truth of NEWTON's concluſions, in regard to the great oppoſition of the air to bodies moving ſwiftly in it; and, by conſequence, believed that the track of all projectiles was very different from the line of a parabola *.

BUT, excepting NEWTON and HUYGENS, the learned ſeemed univerſally to acquieſce in the juſtneſs and ſufficiency of the principles of gunnery invented by GALILEO, enlarged by TORRICELLI, con-

* Diſcours de la Cauſe de la Peſanteur. Leide, 1690.

firmed

firmed and reduced to fyftem by ANDERSON, BLONDEL, HALLEY, and others; and fo far were the theorifts, in that branch of fcience, from fufpecting any defect or fallacy in thefe principles, that they feemed rather to reproach the practical artillerifts, for not profiting more by the inftructions which they had fo liberally imparted to them. Nor do we find that an apology was made for the empirical exercife of the art, by any author of note in that line, earlier than the fixteenth year of this century, when M. DE RESSONS, a French officer of artillery, diftinguifhed by the number of fieges at which he had ferved, by his high military rank, and by his abilities in his profeffion; when he, I fay, thus qualified to bear teftimony, prefented a *Memoire* to the Royal Academy (of which he was a Member), importing, that 'although it was agreed that theory joined 'to practice did conftitute the perfection

' of

'of every art, yet experience had taught 'him, that theory was of very little ſer-'vice in the uſe of mortars: that the work 'of M. BLONDEL had juſtly enough de-'ſcribed the ſeveral parabolic lines, accord-'ing to the different degrees of the eleva-'tion of the piece; but that practice had 'convinced him there was no theory in 'the effects of gun-powder: for that, hav-'ing endeavoured, with the greateſt preci-'ſion, to point a mortar agreeably to thoſe 'calculations, he had never been able 'to eſtabliſh any ſolid foundation upon 'them*.'

THUS, after the theory of gunnery had exerciſed the genius of the learned for nearly two hundred years, and for almoſt fourſcore of that time had reſted on fundamentals which had never been conteſted, it was pronounced at once to be almoſt en-

* Mem. de l'Acad. R. des Sc. A. 1716.

tirely

tirely uſeleſs, and that by one of the moſt competent judges. Now, whether it were owing to the deference due to the authority of that experienced artilleriſt, or to ſome other cauſe, I ſhall not determine, but obſerve, that it appears not from the hiſtory of the Academy, that the ſentiments of M. DE RESSONS were at this time controverted, or any reaſon offered afterwards for the failure of the theory of projectiles, when applied to uſe. Nor can I paſs unnoticed the pauſe that enſued before any farther attempts were made to improve the theory of the art, either upon the old principles or upon new ones, excepting by ſuch authors as ſeemed ignorant of this tranſaction, and who of courſe were not ſufficiently appriſed of the inefficacy of the properties of the parabola, for directing practice: or by thoſe who were employed in ſpeculatively inveſtigating the nature of the curve traced by a ball in the air; a

curve

curve which began at laſt to be conſidered as one deviating much from the line of a parabola: or, finally, by ſuch as, having taken notice that NEWTON's ideas had not been duly attended to, endeavoured to avail themſelves of them, and of ſome experiments that had been made by others, for proving the great oppoſition of the air to bodies of ſwift motion; but without aſcertaining the degree of that reſiſtance, or enriching the art by any practical rules *.

SUCH was the unhinged ſtate of this part of the mixed mathematics, when, within our memory, Mr. BENJAMIN ROBINS took cognizance of it: nor could the ſubject have fallen into abler hands, endowed as he was by Nature with a ſuperior genius and unwearied application. Mr.

* DAN. BERNOULLI, Comment. Acad. Petropol. T. 2. & 3.

ROBINS

ROBINS was deeply verſed in geometry and the doctrine of numbers; but he knew the limits as well as the powers of both, and how inſufficient they were for eſtabliſhing any theory where matter was concerned, without preparing the way, by finding out the phyſical properties of that *matter*, by many and varied experiments and attentive obſervation. Thoſe who had hitherto treated of the foundation of gunnery, by being too forward in the application of their mathematics, had in a manner hurt the credit of that admirable ſcience. They ought to have ſeen the neceſſity of minutely examining every circumſtance which could affect the courſe of a projectile, beſides that of gravity. Mr. ROBINS perceived the error of his predeceſſors in that enquiry, and corrected it. Perſuaded as he was, from Sir ISAAC NEWTON's *Principia*, of the great reſiſtance of the air to bodies moving in it, and alſo of the uncertainty of the force of gun-powder, and of the variations in the flight of ſhot, occaſioned by the unavoidable varieties in the make of it, and in the make of the pieces of artillery which diſcharged it; apprifed, I ſay, of ſo many cauſes of aberration, he juſtly concluded, that the foundation here was at leaſt as much an affair of phyſics as of geometry, and that if the art of throwing bombs had not been advanced by theory, it was not becauſe the art admitted of none, but becauſe the theory which had hitherto been deviſed had been both defective and erroneous. He ſuſpected that moſt of the writers on gunnery had been deceived, in ſuppoſing the reſiſtance of the air to be inconſiderable, and thence aſſerting the track of all ſhot to be nearly in the curve of a parabola, by which means it came to paſs that all their determinations about the flight of projectiles of violent motion, had declined conſiderably from the truth.

truth. But in order to clear this point from every doubt, he found it neceſſary to aſcertain the force of gun-powder, and by that ſtep to eſtimate the velocity of the ſhot impelled by its exploſion. That being done, he proceeded to meaſure the quickneſs of a muſket-bullet, ſhot out of a given barrel, with a given quantity of powder; and to confirm the truth of his concluſions, he contrived a machine, by which the velocity of a bullet might be diminiſhed in any given *ratio*, by being made to ſtrike on a large body of a weight juſtly proportioned to it; whereby the ſwifteſt motions, which otherwiſe would eſcape our examination, were to be exactly determined by thoſe ſlower motions that had a given relation to them. The machine was a large wooden pendulum, which ſwung freely, but in ſo ſlow a manner, that its vibrations could eaſily be counted, whatever was the celerity of the bullet diſcharged againſt it.

The

The thought was ſimple, ingenious, and inconteſtably his own.

He next enquired into the reſiſtance made by the air to projectiles of rapid motion, and which he diſcovered to be much greater than had been ſuppoſed by any writer on the ſubject; and indeed ſo great, that it was manifeſt the curve deſcribed by any ſhot was very different from a parabola, and conſequently that all the applications of the properties of that conic ſection to gunnery were ſo erroneous as to be totally uſeleſs. For, by means of this pendulum, placed at different diſtances from the mouth of the piece, he clearly demonſtrated how much a bullet, flying with a given velocity, would gradually loſe of that motion by the oppoſition of the air: therein furniſhing to the learned a ſignal and inſtructive inſtance of the fallacy of the moſt ſpecious theories, that

do

do not proceed hand in hand with experiments.

I SHOULD too much exceed the juſt bounds of a diſcourſe of this kind, were I to enter more minutely into the ſyſtem founded by Mr. ROBINS, confirmed and improved, as I find, by the labours of ſeveral of the learned, in foreign parts, of great celebrity*. I ſhall only add, that his performance well deſerves the title he gives it of *The New Principles of Gunnery*, ſince the author may more properly be ſaid to have invented a new ſcience than to have added to an old one. And I believe I may venture to ſay, that no phyſico-mathematical diſquiſition hath done more honour to this country, or to the age, than the writ-

* It is much to the honour of Mr. ROBINS, that his writings on this ſubject have been tranſlated into foreign languages by men that were the beſt judges of their merit. I need only name M. M. EULER and LE ROY.

ings of Mr. ROBINS on this ſubject, which have been publiſhed, partly by this Society, partly by himſelf, and partly ſince his death (in the collection of his whole mathematical tracts) by his learned friend.

BUT though our worthy Brother will ever be celebrated for having been the inventor of the true principles of gunnery, yet it would be too flattering to his memory, to ſay he had carried the theory of this art to perfection. He himſelf was far from entertaining ſo high an opinion of his labours: nay, he expreſsly declared, that he left ſome material points to be enquired into at more leiſure (which other occupations, and his immature death, deprived him of); and he much regretted that he wanted conveniency and opportunities for making experiments on balls of a greater weight, than what he had uſed for aſcertaining the initial velocity of them.

MUCH

Much therefore are we indebted to Mr. Hutton, who, treading in the footſteps of the deceaſed, hath reſumed and proſecuted this laſt *deſideratum*, and hath ſhewn himſelf not unequal to ſo difficult an enterprize.

Mr. Robins, for determining the initial velocity of ſhot, ariſing from different quantities of powder, made uſe of balls of about an ounce weight; whereas Mr. Hutton, for the ſame purpoſe, hath employed thoſe of different weights, from one pound to nearly three; or, in other words, Mr. Robins made trial with muſket ſhot only, Mr. Hutton with cannon-balls from 20 to about 50 times heavier. This was a conſiderable ſtep gained in a diſquiſition on that part of the ſcience, in which the reſiſtance of the air, and other circumſtances, were not concerned; and where neither analogy alone, nor mathematical deductions alone, nor the two combined, were sufficient for eftablifhing principles applicable to the motion of cannon-balls, without making a new feries of experiments: and with what labour and judgment thefe have been performed, you underftood by the account which Mr. HUTTON gave of them in his Paper.

BUT fhould it now be enquired, what advantages may be derived from Mr. HUTTON's experiments, for the advancement of the art of gunnery, and of philofophy in general? I would reply, that, as to the former, it may be fufficient to obferve, that though the improvements be only fuch as can be deduced from the force of fired gun-powder; yet they are in a higher, more certain, and in a more general manner, than what refulted from the labours of Mr. ROBINS; who indeed led the way, but who made, as it were in miniature, thofe experiments which Mr. HUTTON hath executed at large, and which Mr. ROBINS himſelf wiſhed to have made, as well as others who have conſidered the ſubject ſince his time. Now theſe experiments, though made by Mr. HUTTON with cannon-balls of a ſmall ſize, may nevertheleſs form juſt concluſions when applied to cannon-ſhot of the largeſt ſize. And ſuch concluſions inform us of the real force of powder, when fired, either in a cannon or a mortar, impelling a ball or bomb of a given weight; that is, they diſcover with what velocity a given quantity of powder drives thoſe projectiles in a ſecond, or in any other aſſigned portion of time. They alſo ſhew the law of variation in the velocity, ariſing from different quantities of powder, with the ſame weight of metal, and likewiſe that law which takes place upon uſing balls of different weights. Farther, they point out the advantage obtained by diminiſhing the windage in cannon, and teach us how we may increaſe the weight of the ſhot in the ſame piece, by making it of a cylindrical form, inſtead of a ſpherical: by this device, a ſmaller ſhip may be enabled to do the execution of a larger one. And experiments of the ſame kind will alſo determine the juſt length of cannon for ſhooting fartheſt with the ſame charge of powder.

LASTLY, it is from theſe experiments, or from others that may be made after the like manner, we are inſtructed how to anſwer every queſtion relative to military projectiles, excepting ſuch as depend on the reſiſtance of the air to bodies moving ſwiftly in it. This indeed is a conſideration which leaves room for greater improvement in the art, and for conferring freſh honours on thoſe, who, like Mr. HUTTON, ſhall have opportunities and abilities for continuing and perfecting this very curious and useful enquiry.

As to the advantages accruing to philosophy from the labours both of Mr. ROBINS and Mr. HUTTON, speak they not for themselves? The sciences of motion and pneumatics are promoted by them; and of what avail their perfection would be for the farther interpretation of Nature, you need not be informed. In fine, we have here before us, in these experiments, the surest test of our advancement in true knowledge, which is, the improvement of a liberal art, and the enlargement of the powers of Man over the works of creation.

SOME, however, may think, that the objects of this Society are the arts of peace alone, not those of war; and that, considering how numerous and how keen the

instruments

inftruments of death already are, it would better become us to difcourage than to countenance their farther improvement. Thefe naturally will be the firft thoughts of the beft difpofed minds. But when, upon a clofer examination, we find that, fince the invention of arms of the quickeft execution, neither battles nor fieges have been more frequent nor more deftructive, indeed apparently otherwife; may we not thence infer, that fuch means as have been employed to fharpen the fword, have tended more to diminifh than to increafe the number of its victims, by fhortening contefts, and making them more decifive. I fhall not however infift on maintaining fo great a paradox; but only furmife, that whatever State would adopt the Utopian maxims, and profcribe the ftudy of arms, would foon, I fear, become a prey to thofe who beft know how to ufe them. For yet, alas, far feem we to be

removed

removed from thoſe promiſed times, *when nation ſhall not lift up ſword againſt nation, neither ſhall they learn war any more!*

MR. HUTTON,

YOU have heard, SIR, the account I have given of the riſe and progreſs of the *Theory of Gunnery*, and of your improvement of it; a recital, which by no means would have done either you or the ſubject juſtice, had it been addreſſed to any other audience than to the preſent. But, as my intention was only briefly to recal to the memory of theſe gentlemen what they knew of this ſubject, antecedently to your Paper, and to remind them of the reſult of your experiments, I flatter myſelf I have ſaid what was ſufficient on the occaſion: being now authoriſed by them to deliver into your hand this Medal, as the perpetual memorial of their approbation. And let me add, SIR, that they make you this preſent with the more cordial affection, as by your other ingenious and valuable communications they are aſſured, not only of your talents, but of your zeal, for promoting the intereſts and honour of their inſtitution.

FINIS.

ERRATUM.

In the title of the Difcourfe, On the Means of Preferving the Health of Mariners, for 1775, read 1776.

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