

Memoir of the late Captain Joseph Huddart, F. R. S. & C. [With two papers by him from Phil. Trans., 1777 and 1796] / [Joseph Huddart].

Contributors

Huddart, Joseph.

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Novem-
BER 7. 1846

THE GREAT BRITAIN AND NAUTICAL CHARTS.

TO THE EDITOR OF THE SHIPPING AND MERCANTILE GAZETTE.

SIR,—As we have probably heard all the statements and conjectures respecting the loss of the Great Britain, which are likely to throw any light upon her disaster, I think it right that some of the observations that have been made should not pass unnoticed. I consider it but justice to myself and others, that some of the obloquy which has been cast on private charts by the resolutions of the Great Western directors, and by those interested in the sale of the Admiralty surveys, should be fairly answered. I would refer more particularly to the remarks in the *Shipping and Mercantile Gazette* of Oct. 23, and the *Nautical Magazine*.

Up to a recent period the Admiralty had no good charts of the coasts in question, and now make use of my chart of St. George's Channel for the navy. The copyright of this was purchased of the late Captain Huddart by this house for 2,000*l.*, and I will state, that it has afforded materials for nearly every chart that has since been published—Captain Hosken's chart included. The notice of the lighthouse on St. John's Point is shown on this chart (as it is upon all others that I have), and has been so since January, 1844, or four months before the lighthouse itself was illuminated. Concerning the omission of the light in the chart published at Liverpool, I shall not remark, but I think it unjust to argue from that one circumstance that all charts are incorrect, as it is to assume that all Admiralty charts are absolutely perfect. I will not say a word in dispraise of the collection of Admiralty surveys, they are worthy of the nation, and are as complete as care and talent can make them: but they are liable to omissions as gross, and errors as glaring, as that to which the loss of the Great Britain has been attributed.

I will cite one or two instances that occur to me. The Admiralty charts of Harwich would have inevitably laid any ship on shore that followed their direction, until Captain Washington's survey of the harbour was published in 1842. This fine chart was issued with a scale attached, that was nearly one-seventh in error. Another: Captain Blackwood's survey of Endeavour Straits (Australia) was published in March, 1846; in August, the ship *Heroine*, following the track laid down in it, after passing two shoals not mentioned, struck, and was nearly wrecked on a shoal of nine feet, where nine fathoms was marked on the chart. Again, as to description of lights by authority:—The *Nautical Magazine* is conducted well, I acknowledge, but in a corrected description of the lights in the English Channel at twenty-nine places, in July, 1845, there are not fewer than fourteen errors, any one of which is as likely to produce a disaster as great as that of the Great Britain. This list is especially marked to be depended on.

I do not cite these instances invidiously, they may be easily multiplied, but merely to show that absolute perfection is not attainable.

Now it has been complained of that the Admiralty charts are not appreciated by the mercantile marine; that Mr. Bates's endeavours to promulgate them have been thwarted. I can say to this, that every chart seller has the same opportunity of supplying the public with these documents, and at the same rate, and they are sold in large numbers by chart publishers. But the Admiralty charts are not the only documents of authority extant, nor are our naval surveyors the only observers; and if private enterprise be left untrammelled, the wants of the public will be far more efficiently served than by the exercise of any authority, such as that proposed by the Great Western directors, or of any body of men, upon which to throw the responsibility of error.

That there are many very inferior charts sold I am quite ready to admit, but with those of any character, I boldly challenge comparison with the Admiralty charts for amount or correctness of information; and with respect to the alleged cheapness of the Admiralty charts, I at once deny their superior claims on this head. Charts are not the only instruments of navigation, but to have them of the best authority is undoubtedly the duty of every seaman: but if he has not discrimination enough to decide between a good and a bad chart, the assistance they will afford to him is of minor importance. When accidents do occur, if commanders will be but ingenuous enough to publish by what authority they have been led into error, and thus afford the means of refuting, when necessary, any erroneous statements, the evils complained of, that of incomplete charts, will soon be cured.

I am, sir, yours, &c. *A. G. Findlay.*

53, Fleet-street.

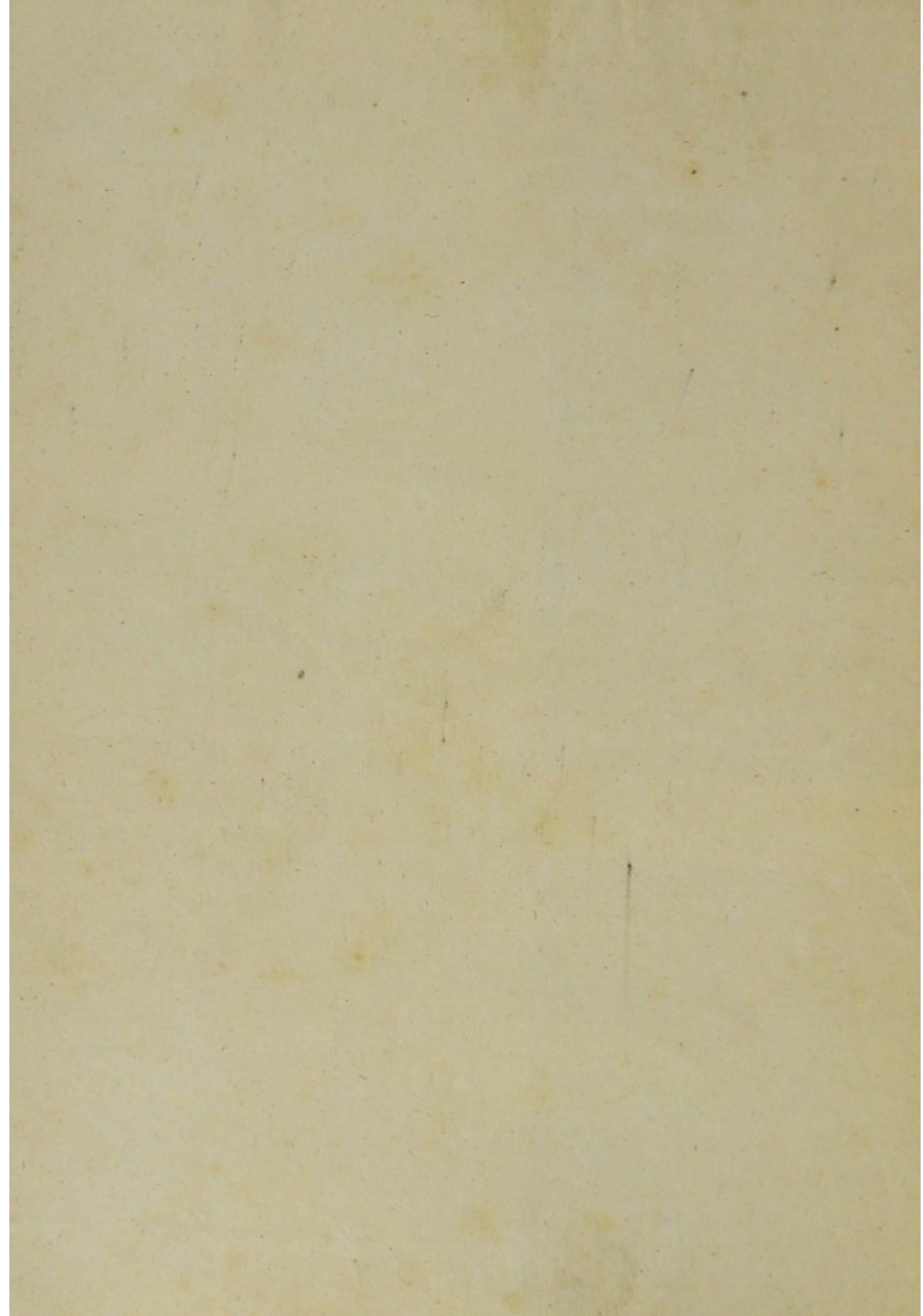
R. H. LAURIE.

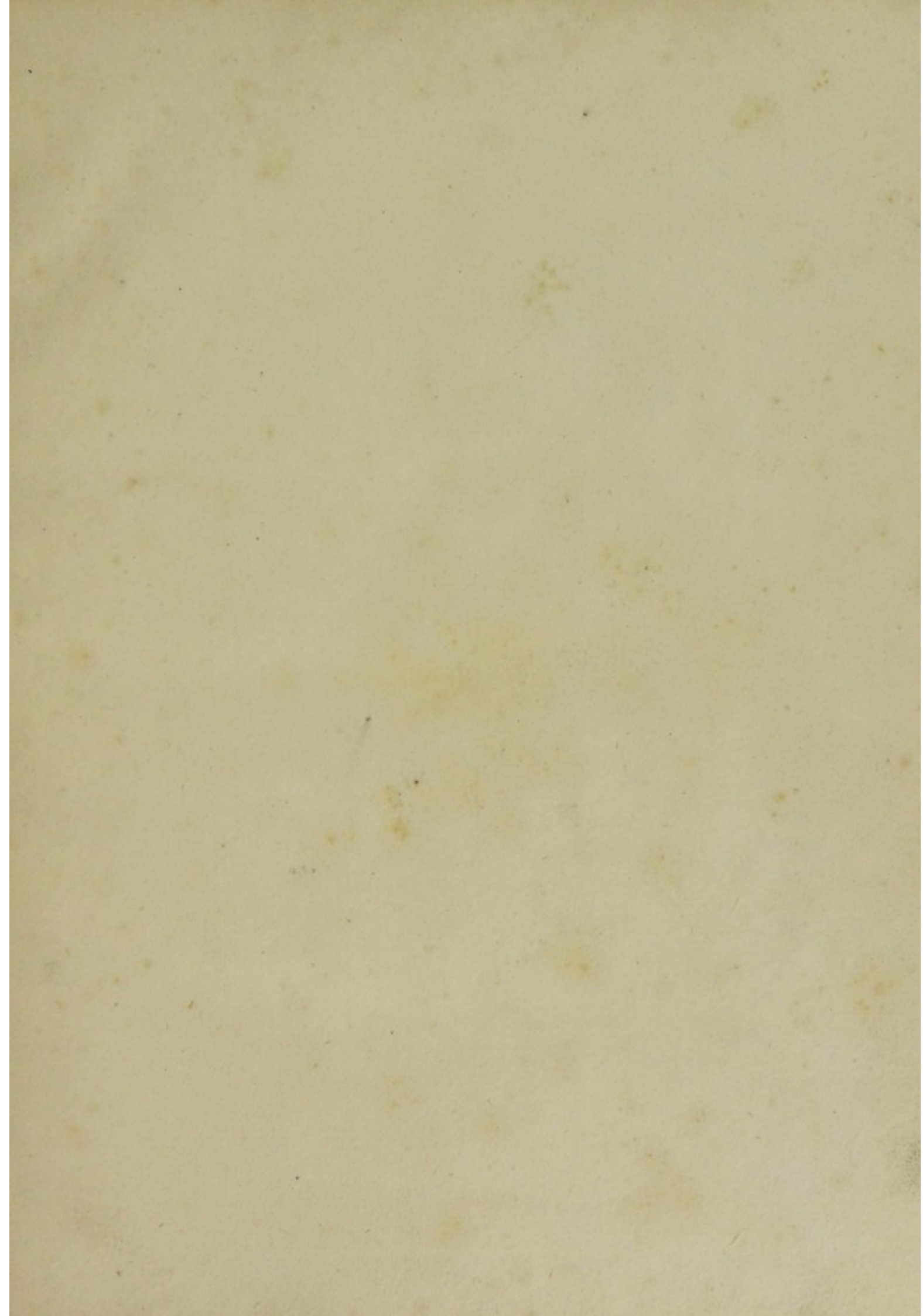
[We publish this letter, considering it desirable that our nautical friends should be correctly informed upon the subject of marine charts: at the same time it is due to remark, that there are slight discrepancies in Mr. Laurie's letter which we hope to see explained.—Ed. S. & M. G.]

St. George's Ch.

See Naut. Mag. Nov. 1842 - p. 781
Ment. by Wm Cotton, F.R.S.

? Inst. of Civil Engineers.







CAPT. JOSEPH HUDDART, F.R.S.

Etat. Sue. 61.

From a Picture by John Hoppner Esq. R.A. in the possession of Charles Hamden Turner Esq.

to - Laurie Esq.
with Sir Joseph Huddart
Capt.

MEMOIR

OF THE LATE

CAPTAIN JOSEPH HUDDART,

F. R. S. &c.



Geo. Cruikshank
del.

LONDON :

PRINTED BY W. PHILLIPS, GEORGE YARD, LOMBARD STREET.

1821.



TO CHARLES HAMPDEN TURNER, Esq.

MY DEAR SIR,

IN dedicating to you the following pages I perform an act peculiarly congenial to my feelings for many reasons ; amongst which, the kind and efficient assistance received from you in their compilation, and the friendship long subsisting between us, might have alone sufficed, had there not existed another and a stronger inducement. I feel that in dedicating to you a record of the life of my Father, the late CAPTAIN HUDDART, I offer a grateful tribute of respect to his memory ; for the esteem and regard for you, cherished by him for many years, knew no abatement to the latest period of his valuable life.

I am, with great truth,

My dear Sir,

Your faithful and obliged friend,

JOSEPH HUDDART.

BRYNKIR, December 1821.

THE CHURCHMAN'S HAND-BOOK

BY

THE REV. J. H. W. L.

In this book is given the substance of the following papers, & others, which have been published in the Churchman's Hand-Book, and which are intended to be of use to the clergy and laity in the preparation of the services of the Church, and in the study of the Scriptures, and in the conduct of the spiritual life.

LONDON: PUBLISHED BY THE REV. J. H. W. L.

1854.

PRINTED BY THE REV. J. H. W. L.

AND SOLD BY THE REV. J. H. W. L.

JOSEPH H. W. L.

THE CHURCHMAN'S HAND-BOOK

Introduction.

THE plaudits of admiring nations attend the Warrior and the Statesman, whose actions illumine the page of enduring History, whilst the silent lapse of time but too often consigns gradually to oblivion the name of the philosopher who strengthened the sinews of the one, and multiplied the powers of the other, by scientific and mechanical improvements and discoveries; and are we not indebted for very many of the useful arts of life to benefactors of whose existence we are ignorant, except as regards its consequences, and but too frequently indifferent?

Filial piety, and unshaken friendship, have united their endeavours to rescue from the ebbing tide of forgetfulness the name of JOSEPH HUDDART, and to combine it with his many useful works for which a nation owes its tribute of thanks.

Never perhaps did a nation boast a higher rank in the lists of empire, or in the annals of science, than Britain at this moment, in all that the intellect of man has contributed to external glory, or to the advancement of the highest branches of practical knowledge. The names of WATT, RENNIE, and HUDDART have been long known to the enlightened of every European country; the friendship which united them added lustre to their individual acquirements, and was at once a pledge of the utility of their undertakings, and a proof of the liberality of their sentiments.

The grave has closed over them all; but, unlike the bulk of mankind, they have left to their country innumerable works of useful science and mechanism, which must prove to posterity lasting records of their skill and industry; and their surviving friends possess the pleasing and consoling reflection that, in them, superior talent, persevering exertion, and private worth were intimately combined. Hence, we cannot but regret, that the want of a due estimation of their own importance should seem to have prevented their

making such notes or leaving such memoranda, as might have afforded the means of ascertaining the progress of their discoveries, and of giving a faithful history of their lives ; which now can only be exhibited, but as the one is exemplified in the beneficial results of their labours, and the other is inscribed on the memories of their contemporaries. The following account of CAPTAIN HUDDART must necessarily therefore be incomplete, although it is hoped and believed to be in no instance incorrect ; and as such, it is presented with all its imperfections to a numerous circle, each individual of which will acknowledge his merit, and deplore his loss as a man, a philosopher, and a Christian.

making such notes as having a good opportunity, as
might have effected the success of retaining the
progress in their knowledge and it being a natural
history of their lives; which may not be easily
filled, but as the one is prescribed in the historical
records of their lives, and the other is a natural
and the progress of their knowledge, it is not
being so much of their knowledge as of their
history, the historical, although it is a natural and
believed to be in the natural history, and as such,
it is not with all the importance of a history,
which each individual of which with a knowledge of
their, and the fact of it, to a natural history,
and a history.

MEMOIR, &c.

CAPTAIN HUDDART was born at **ALLONBY**, (a village in Cumberland much frequented as a bathing place), on the 11th of January, 1740-1, O. S. : he was an only child, and at the usual age was placed under the care of the Reverend Mr. Wilson, at Allonby. This gentleman had acquired a considerable knowledge of Medicine and Astronomy at Glasgow College, and possessed a share of learning superior to most others who are emphatically styled country schoolmasters. The mind of Mr. Huddart, even at this early period, seemed much inclined to the study of Mathematics, a branch of science in which, unfortunately, Mr. Wilson was incapable of giving him any instruction ; this deficiency was, however, in some measure compensated by the cultivation of his early

inclination for the study of Astronomy; an opportunity being afforded him of making astronomical observations with John Wilson (son of the Rev. Mr. Wilson) a youth of great promise and talent, and the present Sir Joseph Senhouse then at the same school, who has since considerably distinguished himself as a man of science.

It has generally been observed that such men as have, by means of their extraordinary talents, arrived at elevated situations and consequence in the world, from humble birth, have emitted some sparks of genius in their infancy, announcing their future eminence. The subject of this memoir is known to have given very signal proofs of precocious talent and persevering application, of which the following anecdotes are illustrative: for the first of them the author is indebted to the recollection of his friend Sir Joseph Senhouse.

Being in a boat, and observing the great labour of the rowers, it forcibly struck his mind that a machine might be invented to propel the boat forward by

operating on the oars, and thereby supersede the necessity of manual labour; he lost no time in endeavouring to make one on this principle, and actually succeeded so far as to construct a little boat which rowed itself by means of some machinery within it, impelled by a spring. This invention was certainly short of perfection; nevertheless, as the production of a school-boy, it evinced a strong mechanical turn which eventually produced most important results.

About the same time a flour-mill was erecting at Allonby, and the attention of our youth was caught by its mechanism: it occurred to him that he could construct similar machinery himself; he accordingly followed the workmen in their progress, and by the time they had completed their task, the youth produced his mill in miniature, the work of his own hands, which proved an accurate imitation and was set going with the original.

Machinery was not the only species of mechanics on which the mind of young Huddart was bent; his attention was even thus early attracted towards Ship-

building also, which to the latest period of his life was his favorite study, although much interrupted by other useful undertakings in which he was engaged, and which more immediately pressed on his attention.

Having met with a "Treatise on Ship-building and Navigation, by Mungo Murray," published in 1754, he was so delighted with the accurate delineation and clear style of that work, that he commenced building the model of a seventy-four gun ship, exactly according to the rules and directions therein laid down, with all the ribs, planks, bolts, rigging, &c. &c. of a real vessel; this model he completed with indefatigable labour and perseverance; it is still in the possession of the family, and is esteemed by every navigator who has seen it, as a surprising instance of juvenile talent and assiduity, particularly when it is considered that he had not at that time seen a ship of war.

These and other more serious occupations did not prevent his amusing himself with the lighter and more fascinating study of music; he was particularly fond of it, and without any instruction whatever, but

merely from application and assiduity, he made considerable progress in this agreeable science ; he could play on the violin, harpsichord, and flute.

Several other anecdotes might be adduced, but as the inventions and amusements of a school-boy cannot be generally interesting, these may suffice.

It was the intention of Mr. Huddart (the father of the gentleman whose life we are now recording) that his son should be educated for the church ; the mind of the youth had however taken a strong bias to other pursuits ; he evinced thus early an anxious desire to embrace a sea-faring life, sharpened probably by frequent opportunities of indulging this taste owing to the vicinity of the sea. In the year 1756 the following circumstance occurred, which confirmed him in his choice.

Great shoals of herrings having come into the Solway Firth, Mr. Huddart and some of his respectable neighbours formed a Company for the purpose of extending the fisheries there, and erecting the necessary buildings for curing fish ; in this concern, the

subject of this memoir was consequently much and actively engaged, particularly in the catching of them; he had thus an opportunity not only of indulging in, and permanently establishing his previous predilection for the sea, but also of acquiring a dawn of that practical knowledge which proved the harbinger of his subsequent celebrity.

In the year 1762 his father died, by which event he succeeded to his father's interest in the fishery; on this occasion he took the command of a small brig for the purpose of conveying to Ireland the fish cured by the Company.

Although his leisure moments were chiefly devoted to the study of Ship-building and Astronomy, yet in his coasting voyages he availed himself of every favorable opportunity to survey the coasts, roadsteads, and harbours; this he found of great utility, when he undertook the important survey of St. George's Channel, a few years afterwards.

- In this year (1762) he married the younger daughter of Mr. Johnston of Cowper, a respectable, though

small landed proprietor; the issue of this marriage was five sons, two of whom died in their infancy; of the surviving three, the eldest and youngest (William and Johnston) adopted their father's profession; they paid the tribute of nature before him; the other, named Joseph, is now the only survivor.

In the year 1763, the shoals of herrings having wholly left the Firth, Mr. Huddart directed his views to other objects, and took the command of a brig belonging to a relation, as a temporary employment, until he had an opportunity of building one for himself at Maryport: this undertaking he accomplished in the course of the year 1768, according to a model of his own, personally contributing with unwearied exertion to its completion, and moulding every timber with his own hands. In this vessel he traded successfully to North America on his own account, making an annual voyage to that country, and filling up the intermediate time in the coal trade to Ireland.

The experience he had acquired in the coasting trade, enabled him to embark with safety in more

extended concerns, and to rely with confidence on his own calculations: the following incident fully exemplifies this observation. Being about to sail on his first voyage to America, his friends were naturally apprehensive that through inexperience he might not reach his destined port in safety; they therefore engaged a person to embark with him, who had frequently made the voyage. Mr. Huddart's observations and reckoning induced him to believe that the first land they made was the very port they were bound to; the experienced person however who accompanied him, insisted that it was not, and that the coast had quite a different appearance; Mr. Huddart knew better, his accuracy enabled him to sail at once into the river; his guide was then, and not till then, reluctantly obliged to acknowledge his mistake.

In the year 1771, being in London on a visit to his paternal uncle, he was introduced by him to Sir Richard Hotham, who had married his uncle's eldest daughter. Sir Richard was a Ship-owner, and husbanded two ships in the Honorable East India Com-

pany's service: Mr. Huddart accompanied him to Dudman's yard, to see a ship he was there building for the Company's service; at the same time, they inspected several other Indiamen. Sir Richard was so much pleased with the judicious remarks Mr. Huddart made on this occasion, as to express a strong desire that he should relinquish his present pursuits, and enter into the Company's service, intimating that he could not fail of meeting with great encouragement and success. Mr. Huddart, however, finding that by the existing regulations of the Company, he could not enter into a higher station than fourth officer, and feeling his situation in his own vessel very comfortable and independent, at that time declined the proposal.

In the year 1773, on his return from one of his voyages to North America, he received a pressing invitation from Sir Richard Hotham to revisit London; this he complied with, and Sir Richard proposed to him that he should enter the Company's service as fourth officer in the *York*, then nearly ready for

launching, bound to St. Helena and Bencoolen; engaging, as an inducement, that he should succeed to the command of that ship, upon the resignation of Captain Hayter, and without purchase. Notwithstanding the apparent advantages of this offer, Mr. Huddart was little inclined to accept it, not seeing any pecuniary benefit likely to accrue immediately from such a change in his situation, as many of the captains and officers were losing money at that time by their private trade. Being, however, urged by some of his particular friends, he acceded to Sir Richard's proposal so far, as to try one voyage, putting a Master into the command of his own vessel until his return, when he could, if he judged it necessary, resume his former occupation; he accordingly entered into the Company's service in October, and sailed from the Downs on Christmas eve 1773.

In the progress of this voyage Mr. Huddart invariably pursued the bent of his genius, occupying his leisure time in scientific pursuits: he made many useful surveys, particularly on the west coast of Sumatra.

The York returned to England in October, 1775, after a very successful voyage for the owners; the markets were, however, so bad that the officers lost by their private trade, and Mr. Huddart on settling his accounts, found that the loss on his investment amounted to £120; this inauspicious commencement induced him to relinquish all thoughts of remaining longer in the service; he therefore continued with the York only until she was cleared, and the stores delivered; he then returned to his family at Allonby, and resumed the command of his own vessel.

The contentions in America having at this period assumed a serious aspect, Mr. Huddart was prevented making his annual voyage to that country; he therefore confined himself to the coal trade from Maryport to Ireland until October 1776, when, at the request of Sir Richard Hotham, he undertook to superintend the curing of provisions at Cork for his ships in the Company's service; when these were ready, he shipped them on board his own vessel, and arrived in London in December.

X At this time Mr. Sayer, an eminent chart-seller in Fleet-street, having heard of the surveys made by Mr. Huddart, obtained his permission to publish those of the Sumatra coast, and at the same time engaged him to complete a survey of St. George's Channel, of which there was then no accurate chart: for this purpose, Mr. Huddart procured a small vessel, having again put a Master into his own for a voyage to Memel, and as soon as the season permitted he proceeded to the Channel. This was an undertaking of no ordinary moment; it required all the perseverance, energy, and indefatigable industry, which a firm confidence in his own talents and qualifications could alone inspire; it was an undertaking in which strong corporeal as well as mental exertions were indispensable; and that the selection of the individual employed on this occasion was judicious, is manifested by the complete accuracy of the work, which, from long experience, has received the sanction and approbation of all navigators in that Channel. The emolument derived from this undertaking was inconsiderable,

the celebrity acquired by it was great, and Mr. Huddart must have felt himself highly gratified in contemplating the beneficial consequences resulting to navigation, from the exertion of his superior talents in this important and invaluable survey. He completed the survey in the summer of 1777. X

The vessel before alluded to as building at Dudman's yard, was lost in her first voyage homeward bound, having struck on some rocks on the coast of Pelowar on the 17th of December 1773, upon which Sir Richard Hotham petitioned the Court of Directors for leave to build another in her place; this he found considerable difficulty in prevailing on the Court to accede to; however, he at length obtained leave, in great measure through the influence and interest of Mr. Dingwal (who had also married a daughter of Mr. Huddart's uncle, and the sister of Lady Hotham) upon the condition that Mr. Huddart should succeed to the command of the new ship without purchase on the first vacancy,—an event very likely soon to occur from the declining health of Captain Barrow

who had commanded the ship which was lost, and was subsequently appointed to the command of the new one, afterwards called the Royal Admiral. In consequence of this arrangement, Mr. Huddart accepted the situation of chief officer in that ship; he went into Cumberland, sold his vessel, settled his other concerns there, and on his return in August took a lodging in Deptford, where the Royal Admiral was then building, in order more minutely to inspect the finishing and fitting out of that ship. Ship building having always been a favorite pursuit with him, his whole time and attention were devoted to this object, and he had the satisfaction of seeing her completed entirely according to his own wishes.

This vessel was chartered for Bombay, and sailed from the Downs on the 27th of April 1778; she put into Portsmouth, where Captain Barrow, whose health had long been declining, died; upon which, as had been previously agreed on, the Court of Directors was petitioned to appoint Mr. Huddart to the command; this was with some difficulty complied with,

as he had only performed one voyage previously to India in the Company's service, the regulations requiring that two at least should be made.

The command thus devolved on Mr. Huddart, but under such peculiar circumstances as prevented him from reaping the usual pecuniary advantages from it; for he was under the necessity of taking charge of Captain Barrow's investment, of the profits on which, together with every other incidental benefit accruing to the commander, he had to render an account to the executors; thus, though saddled with the heavy charge and responsibility of the command, he could only enjoy the profits arising from his own private trade as chief officer; and perhaps it should be observed that, in the management of this trust, he acquitted himself to the entire satisfaction of Captain Barrow's executors. He arrived in the Downs, after a successful voyage, on the 13th January, 1780.

On this voyage he took out his eldest son William as Midshipman, being then seventeen years of age. During the passage outward bound, Captain Huddart

and his son met with an accident which had nearly proved fatal to both. As the ships were nearing the Cape of Good Hope, the Colebrook, one of the convoy, struck against an unknown sunken rock, by which misfortune she was so much damaged that all efforts to keep her above water were unavailing ; she sunk about six hours afterwards, only affording time for the other ship's boats to receive her passengers and crew, who were saved with the exception of about twenty persons. On their arrival at the Cape, Captain Huddart, with his characteristic desire for investigation, attempted to ascertain the true situation of this rock, which was hitherto unknown even to the Dutch ; for this purpose he got a Dutch pilot, and a boat from the Resident, and attended by his own pinnace, proceeded with his son and a few other officers to survey it ; to effect this it was necessary previously to land, in order to get the true situation of the headland and some adjacent rocks, &c. which lay above water : as the surf ran high, they rested on their oars until it appeared safe to land, when

they attempted to pull in ; then, as he himself stated, “ without the least warning, a high breaker towering up, in less than three seconds of time upset the pinnacle ;” being sensible of the danger, he sprung from the boat, which being perceived by his son who was steering it, he jumped out also, and getting upon his father’s back, Captain Huddart in this situation swam with that surf about fifty or sixty yards ; on its return, having fortunately got ground, he was enabled to withstand it, and eventually landed safe ; seven people were covered in the boat, who, by their own exertions, and the assistance he afforded them as soon as he was able, were all fortunately saved. The only loss sustained on this occasion, which might have proved so fatal, was that of their instruments and firelocks.

Captain Huddart did not remain long in England ; he again sailed from the Downs June 3d, 1780, for Bombay ; on his arrival there, owing to the war, the Royal Admiral was put under the orders of Admiral Sir Edward Hughes : whilst acting with the British

fleet, he was engaged in the reduction of Jagginaultporam and Negapatam, two Dutch settlements, and was otherwise actively employed for about two years in the king's service : he did not arrive in the Downs from this voyage till August 25th, 1783.

This voyage, from Captain Huddart's having been detained so long in India in consequence of the war, was as unprofitable to himself as the former one ; and it being now ten years since he first entered the Company's service, he found on examining the state of his affairs, that he had but in a very trivial degree increased his property. A brighter prospect was now however about to dawn, which in some measure recompensed him for a life hitherto attended with various hardships, and trying vicissitudes.

The Directors have the sole appointment of the voyages, beginning with the Chairman, who has the first nomination ; this privilege was attended on this occasion with a fortunate result to Captain Huddart, whose independence of mind was such, that he always revolted at the idea of soliciting favors, or exposing

himself to obligations ; his worthy friend Sir Henry Fletcher, who then filled the Chair, kindly and voluntarily (no application whatever having been made to him) appointed him to one of the Bombay and China voyages, then considered the best ; this may be fairly noticed as a proof of highly disinterested friendship, and it should be recorded in honor of that upright character, that, on Captain Huddart's return, he could not prevail on him to accept a pipe of choice wine selected purposely for him at Madeira, as a small token of acknowledgement for his disinterested and liberal kindness. Captain Huddart sailed from the Downs on the 27th of March 1784, and returned to England in April 1786.

In this voyage he was very successful, and as he himself was known to observe, " this was the first moment that he could say he had benefitted by entering the Company's service, thirteen years before."

During the passage, Captain Huddart was fortunate enough to fall in with the " Basses de India," a ridge of rocks, the true position of which was not until this

period known with sufficient accuracy : finding himself about the latitude where he might expect them, he sent the pinnace a-head to reconnoitre, when, about eight o'clock on a fine clear morning, he was rejoiced to observe the signal for soundings, on which he took the necessary measures for an accurate observation, and he was thus enabled to lay down their true situation with unerring precision, as appears by his survey.

On his arrival in the Downs he received the afflicting intelligence of the death of Mrs. Huddart ; she died on the 12th of February 1786, at Allonby, after a very long and painful illness.

His youngest son, Johnston, then fourteen years of age, accompanied him on this voyage as Midshipman. His eldest son, William, having been with him the two preceding voyages, he naturally wished to promote him, but as he could not with propriety advance him in the Royal Admiral over his own officers, he got him appointed second officer with Captain Frazer in the Mansfield, to Bengal, which vessel re-

turned to England in September 1785. At this time, the York being chartered for an extra voyage to St. Helena and China, Sir Richard Hotham very kindly nominated him to the command, an offer too flattering to a young man only twenty-two years old, to be resisted, although his state of health was such as almost to induce him to decline it; he however did accept it, and proceeded on his voyage; the event but too well justified his apprehensions, and the trust he undertook, bringing with it much fatigue and anxiety, probably hastened the melancholy catastrophe which soon followed; his health gradually growing worse, he died in China on the 30th March 1787, and was buried at Macao.

The following Letter from John Henry Cox, Esq. to Mr. Mills, Purser of the York, exemplifies the high estimation in which this amiable young man was held.

Canton, 4th April, 1787.

Dear Sir,

I have just now received yours of the 31st March last from on board the York in Macao Roads, con-

firming the melancholy intelligence of the death of Captain William Huddart; I do assure you that none of his friends can more sincerely deplore this unfortunate and untimely event than myself, having, during the little time I enjoyed the pleasure of his acquaintance, conceived a very great regard and friendship for him; this, together with the respect I bear to his father, had determined me before the receipt of your letter to pay all possible honor to his memory, and to have a handsome marble tablet placed over his grave, with a short and suitable inscription. I expect to set off for Macao this afternoon, and will immediately upon my arrival give the necessary orders for this purpose: should his friends in England be desirous of having any particular inscription placed over his tomb, they may be assured of their wishes on this head being most punctually attended to. With respect to any expenses that may be incurred in carrying these intentions into execution, I shall insist upon being permitted to bear them myself, accepting with a melancholy satisfaction this opportunity of testifying my

regard and attachment to so amiable and valuable a character as was that of your friend.

I remain, dear Sir,

Your obedient Servant,

JOHN HENRY COX.

The death of this beloved son was a severe affliction to his father; he was a youth of great promise and abilities, and had made considerable progress in science under his paternal instruction. Captain Huddart, communicating this melancholy event to a friend, after enumerating the many excellent qualities of his son, remarked "that it was the first and only time in a life of hardships and vicissitude in which he had repined at the dispensations of Providence, but that he hoped the Almighty in his infinite mercy would forgive him."

On the return of the York to England, it appeared there was a loss on his son's private trade amounting to about £700; from a strong sense of probity, and respect to the memory of a beloved son, he would not

allow the creditors to suffer this loss, and although at that time limited in his fortune, and in no manner whatever bound, or expected to liquidate it, he very honorably and handsomely discharged the whole amount.

We are now arrived at that period when Captain Huddart made his last voyage to India, being the fourth in the Royal Admiral; she was now stationed by the Court of Directors to Madras and China, and sailed from the Downs on the 20th January 1787, and returned to England after another prosperous voyage in July 1788.

Captain Huddart had now been constantly navigating for twenty-five years, reckoning from the time he took the command of a Brig in 1763, and it may be mentioned as a striking proof of his foresight and prudence, under the protection of a kind Providence, that, during the entire of this period, he never met with any serious disaster. The following anecdote illustrative of the principle on which he always acted, has been communicated to the author by a friend.

Having on one occasion received his despatches for Europe from the Governor and Council at Bombay, he set sail, together with several other vessels, a fair wind and fine weather promising a happy voyage: two or three days afterwards, he returned singly to port; the Governor, astonished and dissatisfied, sharply remonstrated with him for not keeping at sea as the others did, and said he would write to the Court of Directors to represent his conduct. The appearance of bad weather which induced Captain Huddart to take this step, was followed by one of the most violent storms ever remembered there, and which strewed the coast with the wrecks of the vessels that had sailed with him: when this tremendous storm had subsided, and Captain Huddart saw he could proceed with safety on his voyage, he called at the Government House to take leave; and accosting the Governor jocularly, said "Governor, I am now ready to sail, and only wait for your letter to the Court of Directors."

On his arrival in England he found Sir Richard

Hotham very desirous of retiring from his shipping interests; he was then in treaty for the sale of the Royal Admiral, but found he could not dispose of it with advantage, unless he could also sell the command. Captain Huddart had then no intention of quitting the Company's service, but as he had on many occasions experienced the kindness of Sir Richard, he consented to withdraw from it, thus to enable him the more easily to accomplish his views; an agreement was accordingly entered into, by which Sir Richard engaged to give Captain Huddart £1000, as a compensation for the command; a sum so very inadequate to its value, as clearly to exemplify Captain Huddart's easiness of disposition, and indifference to the acquirement of wealth; for in computing the value of this ship, £8000 was paid to Sir Richard for the command alone.

Thus Captain Huddart retired from the Company's service, having been engaged in it for the space of fifteen years, ten of which he served as commander in the Royal Admiral.

After Captain Huddart's return from this his last voyage, he obtained for his son Johnston the appointment of third officer on board the *Princess Amelia*. When this vessel returned to England in 1794, Johnston was in a very delicate state of health, being threatened with that dreadful malady a consumption, which proceeded from a neglected cold caught during the voyage; he was advised to try a milder climate, and towards the close of that year went through Germany to Italy, and died at Leghorn on the 29th January following, aged twenty-four years. This was another trying affliction to his father; he was a young man of superior talents, very amiable in his disposition and engaging in his manners; his remains were interred in the burial-ground of the British factory, where a marble monument is erected to his memory.

During the period of Captain Huddart's being engaged in the Company's service, it may be supposed that a person of his genius and active mind would have many opportunities of exercising his talents in the wide field laid open for their employment in the

eastern hemisphere ; of these he never failed to avail himself, having employed every leisure interval in hydrographical and astronomical pursuits.

From the great knowledge he had acquired in Astronomy, he was enabled, by the eclipse of Jupiter's satellites, to ascertain the longitude of Bombay with greater precision than had been done by any former geographer.

He observed an annular and central eclipse of the sun when at China ; he went some distance to accomplish this object, and thus determined with great accuracy the longitude.

Together with several other Surveys, he completed one of the whole Peninsula from Bombay to Coringó, also one of the River Tigris from Canton to the island of Sankeet, for which last in particular, and for his exertions in improving the navigation to and from the East Indies and China, he received the thanks of the Court of Directors in a letter dated the 28th of October, 1786.

The wonderful perseverance and indefatigable in-

dustry of Captain Huddart, the caution he evinced in adopting any conclusion, however desirous he was of arriving at it, until he had thoroughly investigated the principles on which it was founded, were the great causes of rendering his labours substantially useful.

On retiring from an active sea-faring life he purchased a house in that healthy and elevated situation, Highbury Terrace, distant only three miles from London, where he erected an observatory, and furnished it with choice instruments for the purpose of making celestial observations; this agreeably divided his leisure moments with a workshop fitted up with a forge, lathe, &c.; thus gratifying the taste for astronomical and mechanical pursuits so congenial to his mind.

The mechanism of clocks and watches had always, and early attracted his attention. The following anecdote, which should perhaps have been sooner inserted, may now be mentioned as illustrative of this. On his first visit to London, when a boy, walking with his uncle through St. Jame's Park, a day or two after his arrival, a man having the appearance of a

tradesman, touched his hat to him; " You surely cannot know that man," said his uncle; " Yes," replied the youngster, " he belongs to Westminster Abbey, I gave him sixpence yesterday to shew me the works of the great clock."

This branch of mechanism he continued to take great delight in; he frequently cleaned and repaired his own clocks and watches, taking the works to pieces, and putting them together again, as if he had served an apprenticeship to the art; at a late period of his life he made the pendulum of the astronomical clock in his own observatory, for the purpose of obtaining accurate astronomical observations.

In the year 1790 he was employed in the important survey of Hasbro' Gatt.

In 1791 the Trinity Corporation, duly appreciating the importance of the services he had rendered to navigation in general, and at the same time desirous of securing to that Corporation the advantages of his superior talents, elected him an Elder Brother; from this time till his last illness,—a period of twenty-five

years, he was one of the most active members of that useful establishment. During this period, his attention was constantly directed to the improvement and security of the coasting navigation, the erection of lighthouses, &c., and among many others, that of the Longships, in the constructing of which his utmost abilities were called forth: on this occasion the Trinity Corporation unanimously voted him their thanks, as expressed in the following Resolution.

At a General Court of the Corporation of Trinity House, held on Thursday the 8th October, 1795,

Resolved unanimously,

“ That the thanks of this Court be returned to
 “ Captain Joseph Huddart for the important services
 “ he has rendered to this Corporation, and to Navigation in general, by proceeding twice this year
 “ from London to the Land’s End, and there directing the completion, and proper exhibition of the
 “ Light on the rocks called the Longships, and in
 “ devising with the utmost ingenuity, a method of

“ fixing poles or beacons on the Wolf Rock, and
 “ Rundle Stone, by which such beacons are now
 “ erected in the best and most permanent manner,
 “ after all the various modes of placing them, pursued
 “ for a great length of time by Lieutenant Smith and
 “ his agents had proved ineffectual ; And also for the
 “ directions Captain Huddart has formed for ships
 “ sailing by this light, and the poles or beacons, with
 “ a sketch of the same, and the land, which are de-
 “ signed with the greatest accuracy, and executed in
 “ the neatest manner.

“ By Command of the Corporation,

“ DAVID COURT.”

In this year, 1791, Captain Huddart was elected a
 Fellow of the Royal Society. Among other papers
 written by him, and presented to this Society, as may
 be seen in the “ Philosophical Transactions,” were
 the following.

“ An account of Persons who could not distinguish
 colours :” in a letter to the Rev. Joseph Priestley,
 LL.D. F.R.S. See Appendix, A.

“ Observations on Horizontal Refractions which affect the appearance of terrestrial objects, and the dip, or depression of the horizon of the sea.” This communication was read in November, 1796, ordered to be printed, and the thanks of the Society voted to him. See Appendix, B.

When it was determined to commence that great national undertaking the London Docks, Captain Huddart, having established his well earned fame as an Engineer, was solicited to become a Director, the projectors being desirous of procuring the advantage of his talents in their construction: he accepted the office, and took a most active part in the plan and execution of these extensive works. Soon after this, it was resolved to erect Docks for the accommodation of the East India trade. Captain Huddart became a Director of this undertaking also, and contributed materially to the plan and construction of them; the honor of laying the first stone of this important work was delegated to him, in the absence of the Right Honorable William Pitt, who had en-

gaged to do it, but who was from some cause prevented attending.

The period now arrived (1799) when the attention of Captain Huddart was particularly called to an object, the furtherance of which he had long had it in contemplation to attempt.

During the time he was engaged in the East India service, he had frequently observed great imperfections in the manufacture of cordage, especially in cables and the larger ropes, by which many lives and much valuable property were unnecessarily exposed to danger; his attention had, therefore, been early given to the discovery of some principle by which deficiencies so apparent might be remedied; and his inventive genius, aided by his sound mechanical and mathematical attainments, was not long in producing the most valuable improvement in cordage.

Soon after the subject of this memoir quitted the sea, he explained his plan, and described the principle of his improvement in cordage to Mr. Barnes, a rope-maker in Maryport, Cumberland, and there personally

assisted in the first experiments. Mr. Barnes being a gentleman of confined capital, and Maryport a place of small trade, it was not probable that his improvements could there be extensively applied; but, the advantageous employment, in the neighbouring collieries, of some ropes made under Captain Huddart's immediate inspection, satisfied him that the principle on which they were constructed was a real improvement in the manufacture.

His anxiety to forward every object connected with the maritime interest of his country, induced him to offer his invention to the East India Company for its adoption by their rope manufacturers, who declined it on the absurd and illiberal principle of not altering what had been long practised, expressing at the same time a difficulty in attempting a change in the manufacture of an article so particularly in the power of their workmen.

Hence the improvement lay dormant six or seven years, and might have remained so much longer, had it not been suggested to Captain Huddart by some

gentlemen wholly unconnected with the manufacture of cordage, that they were ready to adopt the principle in all its parts, provided he would superintend the erection of the necessary buildings and machinery, and that they would agree to such terms of remuneration as he might require; to which he readily replied that, as the success of such an establishment must be doubtful, he was not desirous of an arrangement by which he, the inventor, must be the only certain gainer; that, unwilling as he was generally to embark in trade, he would nevertheless provide his equal proportion of capital, and bear his chance of success or failure in the proposed undertaking.

In consequence of this, land was immediately purchased, and buildings were erected; machinery was constructed under Captain Huddart's immediate attention, and every wheel, and every shaft were laid down by his order.

This engagement commenced in the latter part of the year 1799, and continued till the hour of his death.

In the early part of the year 1800, the machinery

was ready, and the first cordage manufactured by it, was a cable of large dimension. From the moment the machinery was put in action, there could remain no doubt of its success; and indeed so correct was it, as originally invented by Captain Huddart, that no improvement up to the hour in which this memoir is written, has been suggested in its principle, which is that of making every component part of the rope bear its proportion of strain.

It is not requisite here, neither would it suit the brevity of this memoir, to enter into the various suggestions which at times presented themselves to the fertile mind of Captain Huddart, to give the utmost effect to the principle of his invention; but it may be gratifying to the readers of this memoir to know something of the cause and construction of the latest and largest part of the machinery erected at the manufactory at Limehouse, which, in point of stupendous and beautiful mechanism, aided by the soundest mathematical calculation, stands unrivalled in this or any other country, with the exception of the steam engine,

the invention of Captain Huddart's friend and cotemporary, the celebrated Mr. Watt.

For some years after the establishment of the works, Captain Huddart adopted machinery only so far as to carry the principle into effect by putting each yarn in the strand (or part composing the rope) into its proper place, the strands were afterwards laid into a rope or cable, by workmen in the ordinary way ; now, although the greatest attention was given by the foreman, that this part should be carefully executed, so that the cordage produced was very far superior to any hitherto manufactured, still Captain Huddart saw the inconveniences which might arise, and the ease by which his improvement might be thwarted, by the inattention of workmen ; he therefore constructed machinery by which the strands were laid into ropes, and the ropes closed into cables, thus perfecting his invention, and producing a manufacture equal and complete in all its parts.

This machinery, capable of making cables for the largest ship in the navy, was erected wholly from

drawings made and constructed by Captain Huddart himself, the various parts were wrought on the spot under his own immediate attendance, and so perfectly and completely had he arranged the whole, that, extensive as it is, and combining so many parts as it does, no alteration was necessary; the cordage first made by it was complete, and till this moment no addition to, or deviation from its original construction has been found requisite.

Thus was perfected an invention of the highest possible consequence, and Captain Huddart had the satisfaction of knowing that, in sixteen years experience, no one reasonable instance had occurred of complaint or defectiveness in the cordage manufactured by the machinery of his own constructing.

During the period this object was attaining, Captain Huddart found time to forward another improvement connected with naval affairs, and which was in the important science of naval architecture.

He had long observed the great deficiency of scientific knowledge in the construction of the forms of

ships, and about the year 1797 he built a vessel at Maryport, for the purpose of trying some experiments which he then caused to be made. About the year 1802 he brought this vessel to London, and after making such alterations as furthered the object he had in view, he disposed of her, and commenced an extensive series of observations on the important points of the motion and resistance of bodies in fluids.

These experiments were made with great personal labour, and at much expense; and after a very careful and attentive consideration of the subject, he determined to build another vessel to prove the result of his labours.

This vessel was built at the ship-yard of his friend Sir Robert Wigram; the draft was drawn by himself, every line was laid down, and every part completed under his own immediate inspection; and so accurate had his experiments been, and so correct was his mathematical knowledge, that this vessel most satisfactorily proved the truth of what he had done; she drew precisely the draft of water he calculated, and her in-

creased deepening was in exact conformity with what his calculations led him to expect ; she sailed too, and performed in every way, according to his best hopes, and he was much pleased in the prospect of adding another important improvement to the navy.

Till within a very few months of his death, indeed till the last hour his health would permit, he personally assisted in experiments on this pursuit, and had his life been spared, no doubt can be entertained that he would have produced most valuable results ; indeed, so completely and accurately had he investigated the material points connected with naval architecture, that little more remained than to put what he had done into form, and it was his full intention to have laid down a ship of each class in the navy, the construction of which he had no doubt of improving, having regard to the objects of stowage and defence, so as to increase the rate of sailing one knot an hour.

The papers from which these results would have been drawn are in the possession of his son, but it is

to be feared that, owing to the application by Captain Huddart of his high mathematical knowledge and language in noting the experiments, little can be made of them.

Captain Huddart was always anxious to keep the principles on which his results had been arrived at, from the eyes of foreigners; and although he would willingly have presented all his improvements to the Admiralty, still he always expressed a determination to have so done, with such injunctions as should have prevented his various reasonings from being known; and this he would have insisted on, fully satisfied that the mathematicians of other countries connected with their naval establishments, would readily have availed themselves of the means by which the improvements had been effected, and his great object, viz. that every British Man of War should be superior to its enemy, would have been defeated.

The works in which Captain Huddart was actively engaged as an Engineer were very numerous, but the particulars of them the author of this memoir is not

well acquainted with; it must therefore suffice to enumerate the few following, which he is enabled to do from documents in his possession. It may, at the same time, be observed that Captain Huddart was frequently consulted by Government and by private individuals on various important works; on these occasions, he invariably gave his opinion and advice with the utmost candour and liberality, without any other view than that of promoting the public good.

In December, 1789, Captain Huddart received the thanks of the Trustees of the harbour of Whitehaven for his plan for the improvement of that harbour.

In March, 1791, the thanks of the Directors of the British Society of Fisheries were voted to him for his Survey and Chart of the islands and coast of Scotland.

In September, 1793, he received the thanks of the Mayor and Corporation of Boston, for his Survey of the harbour and river at that place, which were conveyed in a letter from Sir Joseph Banks; and at the same time the Corporation presented him with a

handsome silver cup, as an acknowledgment of the service thus rendered to them.

In November, 1794, Captain Huddart received the thanks of the Commissioners of Customs for his survey of the port of Hull, with a view to the construction of a new Dock there.

In June, 1795, he received the thanks of the Trustees of the harbour at Swansea for the important communications made to them for the improvement of that harbour, and which was carried into effect agreeably to his suggestions.

In March, 1796, after surveying the harbour of St. Agnes, Cornwall, he furnished the Proprietors with a plan for a new jetty. In the same year he surveyed the harbour at Portsmouth.

In 1800, at the request of the Magistrates and Council of Edinburgh, he surveyed the harbour at Leith, and made a report thereon, dated November the 3rd; his suggestions were approved and carried into effect, for which he received their thanks, conveyed to him by the Right Hon. the Lord Provost.

In January, 1803, he received the thanks of the Directors General of Inland Navigation for the "Consideration and Application" he gave to the improvement of the harbour of Dublin.

In May, 1808, Captain Huddart surveyed Holyhead, from which place he sent a report on the proper situation for the erection of a light-house, and in conformity with his suggestions, that useful and important light-house on the South Stack was erected.

In the same year, he went to Ireland at the request of Government, accompanied by Mr. Rennie, to survey and give an opinion respecting the propriety of establishing a harbour at Howth for the accommodation of Packets, and at a subsequent period made a report thereon.

In August of that year, Captain Huddart, Mr. Mylne, and Mr. Rennie, at the request of the Navy Board, gave in an able report on the improvement of His Majesty's Dock-yard at Woolwich, particularly with regard to the accumulation of mud there.

In September, also, of that year, he again went to

Portsmouth, at the desire of Government, on account of the projected improvements of the harbour, and was accompanied by Mr. Mylne.

In August, 1812, Captain Huddart received the thanks of the Lords Commissioners of the Admiralty for the assistance he gave in the survey of His Majesty's Dock-yard at Sheerness.

He determined the boundaries of the Oyster fisheries near Whitstable, which had been a subject of litigation for many years, the change in the magnetic poles having altered the boundaries.

In the year 1809, Captain Huddart purchased the ancient demesne of Brynkir in Caernarvonshire, and in the two following years he added to his former purchase the demesne of Wern, and other estates in the same county; this property he placed entirely under the management and direction of his son. It is a singular circumstance, that he never saw the purchases he had made; he often talked of going into Wales, but the pressure of numerous avocations obliged him to postpone his visit from time to time, till at length

his health beginning to decline, he was under the necessity of relinquishing the intention altogether.

The writer of this memoir, anxious to give as accurate a detail as possible of the late Captain Huddart's surveys, applied for information on the subject to Mr. Laurie, who published many of his works; in consequence of this application, he received a letter from that gentleman, of which the following is an extract.

“ Having mentioned your wishes to our geographer, Mr. Purdy, he has sent the enclosed remarks, and as no one is better qualified to give an opinion of your late father's nautical surveys, I hope they will give you satisfaction.”

The following is the letter alluded to as received from Mr. Purdy, which, from the accuracy, clearness, and ability with which the subject is treated by that distinguished and eminent geographer, the author is induced to copy verbatim, and at the same time to express his grateful acknowledgments for the ready and polite attention paid by him to the application.

London, 16th April, 1818.

Sir,

Mr. Laurie has been pleased to refer to me the expression of your wishes relative to the hydrographic works of your honored parent, the late Captain Huddart, and I sit down most willingly to fulfil them,—not, indeed, with entire satisfaction, because inadequately qualified ; but with an earnest wish to do justice to a subject affecting the reputation of a gentleman whose character I have, for many years, held in the highest respect.

I have read, with great pleasure, the biographic notices of Captain Huddart which have appeared in several periodic publications ; particularly the memoir given in the “ Gentleman’s Magazine,” wherein the large Chart of St. George’s Channel is particularly mentioned, as one of Captain Huddart’s first efforts in the improvement of hydrography. This work, originally dated on board the Royal Admiral, 31st March, 1778, still maintains its well established reputation ; and, perhaps, requires no farther comment. It is

pleasant to find that, as the *original survey*, with requisite additions, it is yet preferred to all the imitations of it that have since been published.

The same remarks apply, with at least equal force, to the Chart of the western coasts and islands of Scotland, which first appeared, and was dedicated to the Society for the encouragement of the Fisheries, between the years 1787 and 1794. This Chart, in three sheets, comprises all the Coasts and Channels between the Mull of Cantire and Cape Wrath, and is therefore to be considered as a continuation of the preceding one of the Irish Sea. It possesses, exclusively, the merit of rectifying the geography of this part of the British Empire in all succeeding works, particularly the large Maps of Scotland, &c. Without its limits, and immediately without them, error has still been found to commence. Mr. Colin Lamont, a respectable mathematician of Greenock, has furnished me with his esteemed testimony in its favour. This gentleman has employed himself occasionally, for many years past, in prosecuting an

extensive survey of the West of Scotland, and he has particularly examined the points settled by Captain Huddart. It is expressed on the face of the Chart that, "the survey was carried on from observations made at Campbelltown, Tobermory, Cana, Ullapool, Laxford, Stornaway, Glash, Namaddy, and Barra, to determine the latitude and longitude by astronomical instruments and chronometers, from which a series of triangles, determined from the true meridian, was carried on, to find the situation of the intermediate places, &c." Upon this Mr. Lamont has said, "As to the consistency of Captain Huddart's results in latitude, and my humble attempts, nothing ever afforded me more genuine satisfaction than the almost incredible coincidence of two observers, at distant periods, total strangers to each other; insomuch that, of the ten or eleven different positions which he settled in Scotland, and which are included in very nearly five hundred that I have observed, none differ equal to the breadth of the lines usually drawn on Maps or Charts."

The survey of the River Tigris, from Canton to the island of Sankeet, is dated London, 10th of October, 1786, and comprises copious directions for the navigation of that river, appearances of land, &c. To these are added the important determination of the position of Canton, viz. Lat. $23^{\circ} 6' 57''$ N. Lon. $113^{\circ} 16' 15''$ E., as shewn in the Tables prefixed to the *Oriental Navigator*, in 1816, and therein given, (from reasonable conviction of its accuracy) in preference to many other and later results, which have appeared to the present time.

This is particularly noticed, because the mouth of the Tigris is the grand point of departure for all vessels bound from Canton to every part of the adjacent seas; and, being finally settled, it serves for the rectification of the whole.

In 1788, Captain Huddart made his sketch of the Straits of Gaspar. It was published as merely a *sketch*, yet its longitudes varied but four minutes from the longitudes since adopted, and it afforded an important rectification of the previously existing Charts, &c. of

this navigation. An improved edition has been lately published.

False Bay, at the Cape of Good Hope, was surveyed by Captain Huddart in 1797. He had previously surveyed Simon's or Seamon's Bay. Of False Bay there is a new edition, with additions.

Captain Huddart also made some surveys of the Road of Bencoolen, and of a part of the Western Coasts of Sumatra, with the detail of which I am not correctly acquainted; and he, at different times, materially improved the "Oriental Navigator," or Directory for the East Indies, the volume to which the Tables of Positions, composed by myself, are now affixed.

The Charts above mentioned are, as I believe, all the larger Charts that the Captain published: but the honorable testimony of Major Rennell has shown that his active mind was occasionally engaged on other important objects.

In the Preface to his Memoir of a Map of Hindoostan, this gentleman writes, "By the aid of a

series of observations of latitude and longitude, taken by Captain Huddart, along the Malabar Coast, or Western Coast of India, the form of the peninsula is now brought very near to the truth." (Pref. page iv.) And again, "As Captain Huddart's series of longitudes commenced at Bombay, in lat. $18^{\circ} 58'$, and were continued to Anjenga, in lat. $8^{\circ} 39'$, and then back again to Bombay, by which the error of his timekeeper was ascertained, and which was only as much as amounted to $2\frac{1}{4}$ minutes of longitude, we have every reason to be satisfied with this series, as far as respects general positions: and, indeed, Geography is greatly indebted to the labours of this gentleman, who has presented us with the longitudes of sixteen places on this coast, and by that means given the true general figure of it, which exhibits, to those who have been in the habit of contemplating it, a very different form from what it ever did before." (Memoir, edition of 1788, page 18.)

To this remark of Major Rennell it may be added that the true longitude of Bombay appears to be 72°

58' E; Captain Huddart made it $72^{\circ} 54'$: so that thus, in all this extent of coast, the approximation was to about four minutes, from the results of our best observers to the present day.

A remarkable instance of Captain Huddart's merit as an observer, occurs in Colonel Mudge's account of the Trigonometrical Survey. The Scilly Islands had previously and generally been placed twenty minutes, and more than twenty minutes, of longitude, to the west of their true meridian. In a note on this subject, Colonel Mudge says, " In the *Requisite Tables*, published by order of the Board of Longitude, the latitude of the Scilly Lights is said to be $49^{\circ} 56' 0''$, and longitude $6^{\circ} 46' 0''$. The latitude, according to the survey, is $49^{\circ} 53' 36'' 8$, and longitude $6^{\circ} 19' 23'' 4$. An error of $2' 23''$ in the latitude, may not perhaps be considered extraordinary; but how, in a maritime country like our own, where chronometers are in such constant use, so great an error as $26' 37''$ ($1^m 46\frac{1}{2}s$ in time) in the longitude, should have remained undetected, excepting by one person, is surprising. J.

Huddart, Esq. visited the Scilly Isles, having with him a watch made by Arnold, and obtained his time at that spot in the island of St. Mary, where the body of Sir Cloudesly Shovel is said to have been thrown ashore, by means of equal altitudes of the Sun's limb; he then found, comparing his time with that shewn by the watch, that $0^h 25^m 18^s$ was the difference between the meridians of Greenwich and this spot in St. Mary's. Now St. Agnes' light-house is about $2'$ of a degree west of the place to which Mr. Huddart alludes; therefore, $25' 18'' + 8'' = 25' 26''$ is the longitude of St. Agnes, through these means; which differs only $4^s 5$ in time, *or a little more than one minute of longitude from that found by the survey.*"

It would be superfluous for me to point out the meritorious acts of Captain Huddart as an Elder Brother of the Trinity House, or I might expatiate considerably on the numerous and important services which he has rendered to the country in that capacity.

It is well known that, so long as his health permitted, he was one of the most active and useful

members of that honorable and beneficial institution ; and that, during this period, more improvement in our light-houses, and other sea-marks, was made than in any preceding, or than probably may be made in any succeeding period of equal length. ALL were improved, and many added, as those for the passage of the Needles, &c.

In 1790, when the new Lights of Hasborough, and that off the Newarp were established, the adjacent sea and shoals were accurately surveyed by Captain Huddart, and a Chart was delivered, on paying light-dues, to the northern Coasters, with complete directions, &c. This Chart gave the longitude of Yarmouth church, a most important position, which has been adopted for all Maps and Charts since published ; for, previously, the longitude of the coast of Norfolk was unknown.

In 1794 the Light-vessel at the Owers was established for the guidance of all vessels bound up and down the English Channel, and especially those bound in to Spithead, &c.; and, in 1795, the still

more useful one off the North Sand Head of the Goodwin. The description and uses of the latter were, I presume, drawn up by Captain Huddart.

In the same year was established the very useful Light-house of the Longships, near the Land's End of England, for the purpose of guiding vessels from the numerous dangers in the vicinity of the Cornish coast. This was aided by a similar description, with directions.

In 1802 a Floating Light was placed near the Sand called the Sunk, in the King's or North Channel of the Thames' mouth; a survey of the adjacent shoals and passages was made by Captain Huddart; copies of which, with directions, were distributed to the Mariners in the Coasting Trade.

The year 1806 saw the new and most useful Light-house on Flamborough Head, on the coast of Yorkshire, the environs of which were, in like manner, surveyed and described by Captain Huddart.

In the West, the Light-house on the South Stack, near Holyhead, was established in 1809.

The works of Captain Huddart, above enumerated, are the principal that I have any knowledge of. They are not numerous in proportion to their consequence, for they have, in every instance, obviated glaring deficiencies, they have filled up chasms of ignorance with useful knowledge; and they have been, invariably, the results of arduous exertion, most *skilfully applied*, in situations and circumstances of peculiar danger and difficulty; for who but he would *voluntarily* have selected the extremity of Africa, or the rugged cliffs of Western Scotland, for the display of those talents which might have been exhibited, in circumstances of comparative safety, with more benefit to himself in point of emolument, though proportionably with less advantage to others. This evidently was not his object; and his motives seem to have been as pure, as unsophisticated, as were his manners. He made no parade of science, but he possessed it, and was particularly distinguished as one of our earliest Lunarians. Thousands have reason to bless his name for that safety which has been derived from his labours; and

the Navigators of all nations, may consider it as synonymous with **BENEFACTOR**.

I have the honor to be,

Sir,

Your humble Servant,

JOHN PURDY.

As Captain Huddart advanced in life, he was not exempt from some of the usual infirmities of old age: they were not such, however, as to prevent his fulfilling several of the numerous duties which now pressed on his attention; he was always particularly zealous in the performance of those which devolved on him as an Elder Brother of the Trinity House Corporation, and as a Director of the London and East India Docks; all the leisure moments he could spare from these engagements, were devoted to the experiments before alluded to, for the improvement of Ship-building, which, to the latest moment his health would permit, he took the greatest possible interest in. The farther he advanced into the vale of years, the more

his reputation and celebrity increased, and the importance attached to his opinion as an Engineer was such, that the applications made to him by Government and private individuals, exceeded what he could have attended to, even though he had still been in the possession of his former strength; he was therefore frequently obliged to decline them, and it no doubt occasioned much regret to a person of his active and benevolent disposition to find himself unable to comply with those demands, knowing the good that must have resulted from his labours; such, however, was the will of Heaven.

We have now come to that period of our narrative when the declining state of Captain Huddart's health obliged him to forego all attention whatever to his public duties; he had persevered with an energy peculiar to himself in his attention to those he considered the most important, but he had now reached the limit beyond which his strength could not carry him. This but too well foreseen and melancholy event occurred in November 1815; when, finding his illness rapidly

augmenting, he made his will, arranged his affairs, and desired that his son, then in Wales, should be apprized of his situation: at this time his appetite had almost left him, his strength was rapidly declining, and it was but too evident to his family and friends, that he could not long survive. Dr. Babington, Sir William Blizard, Mr. Blizard, Sir Everard Home, and Mr. Hole, attended him in the most assiduous and friendly manner, but all their efforts could only prolong his valuable life a few months.

At an early period of his disorder, when it first assumed a serious aspect, he turned his active and comprehensive mind to the study of the anatomy of the human body, with which he soon made himself well acquainted; he kept an exact journal of every symptom of his complaint, and of the medicine he daily took: so long as he entertained any hopes of conquering his disorder, he was indefatigable in seconding the efforts of his medical advisers, but at length his complaint turning to a dropsy, he sunk under it after suffering the operation of tapping twice.

From the commencement of his complaint, he kept an exact registry of his weight, and by weighing every thing he took, together with what he lost, he marked the progressive decay of his system; he ascertained by these means the exact quantity of weight carried off by insensible perspiration and by the breath: these minute calculations astonished his professional attendants, particularly Dr. Babington, who frequently told him that had he originally turned his attention to physic he must have reached the top of the profession.

During his protracted illness his excellent and kind friend Archdeacon Watson visited him frequently, and about three weeks before his death administered the holy Sacrament to him for the last time.

Twelve hours previous to his decease, he lost in a great measure his articulation, of which however he was not himself sensible. He endeavoured, and appeared very anxious to say something to his son, which neither he nor the attendants could understand; and, imagining that he did not speak loud enough, Captain Huddart exerted his voice as much as his

weak state would allow. The by-standers comprehended him so far as to learn that he could hear what was said to him, and that he was surprized he could not be heard by those around him. His son then finding it necessary to apprise him that his articulation was not so distinct as usual, he immediately made signs for paper, pen, and ink, and being raised up in the bed, he took the pen and wrote,—but alas! the few words he attempted could not be deciphered: after this effort he was laid down again, and from that time did not attempt to speak.

His illness had been so lengthened, and his sufferings so severe, that his form was very much reduced, and his strength quite exhausted. He had been, through life, accustomed occasionally to weigh himself; his usual weight, for some years previous to his illness, was about two hundred and twenty pounds: in the month of January, seven months prior to his death, he found himself weighing only one hundred and thirty-four pounds; yet, notwithstanding his great bodily weakness, he retained his faculties: he was

perfectly tranquil and resigned to the will of his Creator, and breathed his last apparently without much pain, at nine o'clock a. m. on the 19th of August 1816. He had expressed a wish to be buried at St. Martin's church, Westminster, where his uncle and family were interred : he desired his funeral might be private, mentioning a few particular friends only whom he wished to be invited on the melancholy occasion, and on the 28th of August his mortal remains were deposited in the vault of that church.

Captain Huddart was tall and muscular in his person, and his countenance was benign, open, and placid : he was a man of pure and untainted morals, and was particularly temperate and abstemious in his habits : although the greater part of his life was spent in the maritime profession, he was never known to have been even once intoxicated ; he was in general an early riser, usually breakfasted at eight o'clock, dined at one, drank tea at five, supped at eight, and retired to bed at ten ; he was kind and benevolent to all around him, indeed his sole object through life

seemed to have been the good of his fellow creatures. One of the greatest gratifications he experienced, as an Elder Brother of the Trinity House Corporation, was the opportunity afforded him of placing on the pension list of that excellent institution, those deserving but destitute objects, old and decrepit Seamen (some of whom he had perhaps known in early life), or their widows and orphans; his loss was justly deplored as a great calamity in his native county, Cumberland, to which his benevolence had been more particularly directed.

Smoking tobacco was recommended to Captain Huddart, when a young man, for a complaint on his chest, and he thus acquired a habit in which he generally indulged; it was his first occupation on rising, occasionally during the day, and again before he retired to rest. When his mind was engaged in serious and deep reflection, his pipe was in more than usual requisition; his dress was disregarded, and he paid no attention either to the quality or the regularity of his meals; occasionally he appeared absorbed in his own thoughts; if, at these times, a question was put

to him, or an observation made by any of his family, he would continue to muse, seemingly not aware that he had been addressed, and frequently, after a lapse of many minutes, would turn to the person who had accosted him, and reply.

His manners were simple and unaffected, and without appearance of conscious superiority. Though his pursuits necessarily brought with them an extended acquaintance, he rarely mixed in general society; there were comparatively few who enjoyed his intimacy; to these he was ever most friendly and communicative, and in his own social family circle, where the temper more freely develops itself, he displayed a perfect equanimity of mind, and cheerfulness of disposition, relating with good humour and satisfaction anecdotes and incidents of his early life.

A handsome monument has been erected to his memory in the Chapel of Ease at Allonby, the place of his nativity. The following inscription, illustrative of his character and talents, and commemorative of the eminent services rendered to his country, has been supplied by the friend to whom this Memoir is dedicated.

Sacred to the Memory of
CAPTAIN JOSEPH HUDDART, F.R.S.

Formerly of the
Honorable East India Company's Service,
And one of the Elder Brethren of the Corporation of the Trinity House, London;

HE WAS BORN AT THIS PLACE
11th January, 1741,
AND DIED AT HIGHBURY TERRACE, NEAR LONDON,
August 19th, 1816.

He has left a memorial of his Fame far more lasting than this Monument,
in those numerous Works of Science by which he has done
Honor to his Country, benefitted Commerce,
and improved Navigation.

"Unto whom much is given, of them shall much be required;"

And of him it may be truly said that the pre-eminent powers of his mind, and his
superior acquirements in Mathematics, Mechanics, and Astronomy,
were unceasingly devoted to the services of humanity,
by pointing out a

More Secure Path in the Trackless Deep,
and by increasing the facilities,
and lessening the dangers of those who

"go down to the sea in Ships, and occupy their business in great waters."

"THESE MEN SEE THE WONDERS IN THE DEEP."

They were strongly impressed on his capacious mind: he saw and acknowledged
in them the wondrous works of God,
and meekly trusting in the merits of his Saviour,
closed a life of unblemished integrity
in the 75th year of his age.

HIS ONLY SURVIVING SON
Erects this Monument in commemoration of those virtues,
which endeared him in all the relations of
private life.

REPORT TO THE SECRETARY OF

THE ARMY AND NAVAL OFFICES

OF THE

NAVY DEPARTMENT

FOR THE YEAR 1898

BY

THE SECRETARY

OF THE NAVY DEPARTMENT

AND

THE

NAVY DEPARTMENT

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APPENDIX. A.

An account of Persons who could not distinguish Colours. By Mr. JOSEPH HUDDART; in a Letter to the Rev. Joseph Priestley, LL.D. F.R.S.

Read February 13th, 1777.

London, January 15th, 1777.

Sir,

WHEN I had the pleasure of waiting on you last winter, I had hopes before now of giving you a more perfect account of the peculiarity of vision which I then mentioned to you, in a person of my acquaintance in the North: however, if I give you now the best I am able, I persuade myself you will pardon the delay.

I promised to procure you a written account from the person himself, but this I was unfortunately disappointed in, by his dying suddenly of a pleurisy a short time after my return to the country.

You will recollect I told you that this person lived at Maryport in Cumberland, near which place, viz. at Allonby, I myself live, and having known him about ten years, have had frequent opportunities of conversing with him. His name was Harris, by trade a shoemaker. I had often heard from others that he could discern the form and magnitude of all objects very distinctly, but could not distinguish colours. This report having excited my curiosity, I conversed with him frequently on the subject. The account he gave was this: That he had reason to believe other persons saw something in objects which he could not see; that their language seemed to mark qualities with confidence and precision, which he could only guess at with hesitation, and frequently with error. His first suspicion of this arose when he was about four years old. Having by accident found in the

street a child's stocking, he carried it to a neighbouring house to enquire for the owner: he observed the people called it a *red* stocking, though he did not understand why they gave it that denomination, as he himself thought it completely described by being called *a stocking*. The circumstance, however, remained in his memory, and together with subsequent observations led him to the knowledge of his defect. As the idea of colours is among the first that enters the mind, it may perhaps seem extraordinary that he did not observe his want of it still earlier. This, however, may in some measure be accounted for from the circumstance of his family being Quakers, among whom a general uniformity of colours is known to prevail.

He observed also that, when young, other children could discern cherries on a tree by some pretended difference of colour, though he could only distinguish them from the leaves by their difference of size and shape. He observed also, that by means of this difference of colour they could see the cherries at a

greater distance than he could, though he could see other objects at as great a distance as they; that is, where the sight was not assisted by the colour. Large objects he could see as well as other persons; and even the smaller ones if they were not enveloped in other things, as in the case of cherries among the leaves.

I believe he could never do more than guess the name of any colour; yet he could distinguish white from black, or black from any light or bright colour. Dove or straw-colour he called white, and different colours he frequently called by the same name: yet he could discern a difference between them when placed together. In general, colours of an equal degree of brightness, however they might otherwise differ, he frequently confounded together. Yet a striped ribbon he could distinguish from a plain one; but he could not tell what the colours were with any tolerable exactness. Dark colours in general he often mistook for black, but never imagined white to be a dark colour, nor a dark to be a white colour.

He was an intelligent man, and very desirous of understanding the nature of light and colours, for which end he had attended a course of lectures in natural philosophy.

He had two brothers in the same circumstances as to sight ; and two other brothers and sisters who, as well as their parents, had nothing of this defect.

One of the first mentioned brothers, who is now living, is master of a trading vessel belonging to Maryport. I met with him at Dublin, in December 1776, and took the opportunity of conversing with him. I wished to try his capacity to distinguish the colours in a prism, but not having one by me, I asked him, Whether he had ever seen a rain-bow ? He replied, He had often, and could distinguish the different colours ; meaning only, that it was composed of different colours, for he could not tell what they were.

I then procured and shewed him a piece of ribbon : he immediately, without any difficulty, pronounced it a striped and not a plain ribbon. He then attempted to name the different stripes : the several stripes of

white he uniformly, and without hesitation, called white: the four black stripes he was deceived in, for three of them he thought brown, though they were exactly of the same shade with the other, which he properly called black. He spoke, however, with diffidence as to all those stripes; and it must be owned, the black was not very distinct: the light green he called yellow; but he was not very positive: he said, "I think this is what you call yellow." The middle stripe, which had a slight tinge of red, he called a sort of blue. But he was most of all deceived by the orange colour; of this he spoke very confidently, saying, "This is the colour of grass; this is green." I also shewed him a great variety of ribbons, the colours of which he sometimes named rightly, and sometimes as differently as possible from the true colours.

I asked him, Whether he imagined it possible for all the various colours he saw, to be mere difference of light and shade; whether he thought there could be various degrees between white and black; and that all colours could be composed of these two mix-

tures only? With some hesitation he replied, No, he did imagine there was some other difference.

I could not conveniently procure from this person an account in writing; but I have given his own words, having set them down in writing immediately. Besides, as this conversation happened only the 10th of last month, it is still fresh in my memory. I have endeavoured to give a faithful account of this matter, and not to render it more wonderful than it really is.

It is proper to add, that the experiment of the striped ribbon was made in the day-time, and in a good light.

I am, Sir, &c.

APPENDIX B.

Observations on Horizontal Refractions which affect the appearance of terrestrial objects, and the Dip, or Depression of the Horizon of the Sea. By JOSEPH HUDDART, Esq. F.R.S.

Read November 24th, 1796.

THE variation and uncertainty of the dip, in different states of the air, taken at the same altitude above the level of the sea, was the occasion of my turning my thoughts to this subject; as it renders the latitude observed incorrect, by giving an erroneous zenith distance of a celestial object.

I have often observed that low lands and the extremity of head-lands or points, forming an acute angle with the horizon of the sea, and viewed from a distance beyond it, appear elevated above it, with an

open space between the land and the sea. The most remarkable instance of this appearance of the land I observed at Macao, for several days previous to a typhoon, in which the *Locko* lost her topmasts in Macao Roads; the points of the islands and low lands appearing the highest, and the spaces between them and the sea the largest, I ever saw. I believe it arises, and is proportional to the evaporation going on from the sea; and in reflecting upon this phenomenon, I am convinced that those appearances must arise from refraction, and that instead of the density of the atmosphere increasing to the surface of the sea, it must decrease from some space above it; and that evaporation is the principal cause which prevents the uniformity of density and refraction being continued, by the general law, down to the surface of the earth: and I am inclined to believe, though I mention it here as a conjecture, that the difference of specific gravity in the particles of the atmosphere may be a principal agent in evaporation; for the corpuscles of air, from their affinity with water, being combined at the sur-

face of the fluid from expansion, form air specifically lighter than the drier atmosphere ; and therefore float, or rise, from that principle, as steam from water ; and in their rising (the surrounding corpuscles from the same cause imbibing a part of the moisture), become continually drier as they ascend, yet continue ascending until they become equally dense with the air.* However, these conjectures I shall leave, and proceed to the following observations upon refractions.

In the year 1793, when at Allonby in Cumberland, I made some remarks on the appearance of the Abbey Head, in Galloway, which in distance from Allonby is about seven leagues ; and from my window, at fifty feet above the level of the sea at that time of tide, I observed the appearance of the land about the Head as represented in Tab. 1. fig. 1. There was a dry

* Mr. Hamilton, in his very curious essay on the ascent of vapours, does not allow of this principle, even as an assistant ; though by a remark (page 15) he takes notice of those appearances in the horizon of the sea, and says they arise from a strong or unusual degree of refraction ; the contrary of which I hope to illustrate in the course of this paper.

sand, $x y$, called Robin Rigg, between me and the Head, at the distance from my house of between three and four miles, over which I saw the horizon of the sea, $H O$; the sand at this time was about three or four feet above the level of the sea. The hummock d is a part of the head-land, but appeared insulated or detached from the rest, and considerably elevated above the sea, with an open space between. I then came down about twenty-five feet, when I had the dry sand of Robin Rigg, $x y$, in the apparent horizon, and lost all that floating appearance seen from above, and the Abbey Head appeared every where distinct to the surface of the sand; this being in the afternoon, the wet or moisture on the sand would in a great measure be dried up. I have reason, therefore, to conclude that evaporation is the cause of a less refraction near the surface of the sea; and when so much so as to make an object appear elevated wholly above the horizon, (as at d in fig. 1.) there will from every point of this object issue two pencils of rays of light, which enter the eye of the observer; and that below

the dotted line A B (parallel to the horizon of the sea H O), the objects on the land will appear inverted.

To explain this phenomenon, I shall propose the following theory, and compare it with the observations which I have made. Suppose H O, fig. 2, to represent the horizontal surface of the sea, and the parallel lines above it, the laminæ or strata of corpuscles, which next the fluid are most expanded, or the rarest; and every lamina upwards increasing in density till it arrive at a maximum (and which I shall in future call the maximum of density) at the line D C, above which it again decreases in density, ad infinitum.

Though this in reality may be the case, I do not wish to extend the meaning of the word density further, than to be taken for the refractive power of the atmosphere; that is, a ray of light entering obliquely a denser lamina to be refracted towards a perpendicular to its surface; and in entering a rarer lamina, the contrary; which laminæ being taken at infinitely small distances, the ray of light will form a curve, agreeable to the laws of dioptrics.

In order to establish this principle in horizontal refractions, I traced over various parts of this shore at different times, when those appearances seemed favorable, with a good telescope, and found objects sufficient to confirm it; though it be difficult at that distance of the land to get terrestrial objects well defined so near the horizon, as will afterwards appear.

One day observing the land elevated, and seeing a small vessel at about eight miles distance, I from my window directed my telescope to her, and thought her a fitter object than any other I had seen for the purpose of explaining the phenomena of these refractions. The telescope was forty feet above the level of the sea, the boat's mast about thirty-five feet, she being about twenty to thirty tons burthen. The barometer at 29.7 inches, and Fahrenheit's thermometer at 54° .

The appearance of the vessel, as magnified in the telescope, was as represented in fig. 3, and from the mast head to the boom was well defined. I pretty distinctly saw the head and shoulders of the man at

the helm ; but the hull of the vessel was contracted, confused, and ill defined : the inverted image began to be well defined at the boom (for I could not clearly perceive the man at the helm inverted,) and from the boom to the horizon of the sea the sails were well defined, and I could see a small opening above the horizon of the sea, in the angle made by the gaff and mast ; and had the mast been shorter by ten feet (to the height of y), the whole would have been elevated above the horizon of the sea, and from y to d an open space. This drawing was taken from a sketch I took at the time, and represents the proportion of the inverted to the erect object, as near as I could take it by the eye, the former being about two-thirds of the latter in height, and the same breadth respectively ; though at one time during my observation, which I continued for about an hour, I thought the inverted nearly as tall as the erect object. The day was fine and clear, with a very light air of wind, and I found very little tremor or oscillation in viewing her through the telescope.

I have laid down fig. 4. for the explanation of the above phenomenon, in which A represents the window I viewed B the vessel from ; H O, the curved surface of the sea ; C D, parallel to H O, the height of the maximum of density of the atmosphere ; the lines marked with the small letters *a a*, *b b*, *c c*, *d d*, the pencils of rays under their various refractions from the vessel to the eye, or object glass of the telescope.

The pencil of rays *a a*, from a point near the head of the mainsail, is wholly refracted in a curve convex upwards, being every where above the maximum of density ; and the pencil of rays *d d*, which issues from the same point in the sail, and passes near the horizon of the sea at *x*, is convex upwards from the sail to W, where it passes the line of maximum of density, which is the point of inflection ; there it becomes convex downwards, passing near the horizon at *x* to *y*, where it is again inflected, and becomes convex upwards from thence to the eye. The pencil of rays *b b*, from the end of the boom, passing nearly parallel to the horizon, and near the maximum of density, suffers

very little deviation from a right line in the first part ; but in ascending (from the curvature of the sea) will be convex upwards to the eye. The pencil of rays $c c$, from the same point in the boom, may have the small part to c convex upwards, from c to z it will be convex downwards, and from z to the eye convex upwards.

From this investigation it appears, that two pencils of rays cannot pass from the same point, and enter the eye, from the law of refraction, except one pencil pass through a medium which the other has not entered ; and therefore the maximum of density was below the boom, and could not exceed ten feet of height above the surface of the sea at the time these observations were made.

Respecting the hull of the vessel being confused, and ill defined in the telescope, as by fig. 3, it arises from the blending of the rays, from the different parts of the object, refracted through the two mediums ; some parts of the hull appearing erect, and some inverted. Suppose the dotted line $i i$, fig. 4, an inde-

finite pencil of rays, passing from between the inverted and erect parts of the object, or the upper part of the hull of the vessel, to the eye, (for the lower part of the hull could not be observed): the objects cannot appear inverted, except the angles at the eye $a A c$ and $a A d$, exceed the angle $a A i$; for the intermediate space could only be contracted by the secondary pencils of rays. The lengths of the inverted, compared with the erect image of the sail, is as the sines of the angles at the eye $a A i$ to $i A d$; and the angle at the eye $a A d$, made by the two pencils of rays from the same point near the head of the sail, must be double the angle $a A i$, when the inverted image is as tall as the erect. In this case, the sines of the angles $a A b$, $a A c$, $a A d$, fig. 4, are proportional to the altitudes $a b$, $a c$, $a d$, in the magnified view of the vessel, fig. 3.

Under this consideration no inverted image of the sail will be formed, until the angle at the eye, made by the two refracted pencils of rays $a a$ and $d d$, exceed the angle made by $a a$, and $b b$, the apparent

height of the sail of the vessel ; for were those angles equal, the inverted sail would only be contracted into the parallel of altitude of the boom b , and render the appearance confused, as in the hull of the vessel.

Respecting the existence of two pencils of rays entering the eye from every point of an object not more elevated than a , or less than i , fig. 3, in this state of the atmosphere, I cannot bring a stronger proof than that of the strength of a light when the rays pass near the horizon of the sea, proved by the following observations.

Going down Channel about five years ago in the Trinity yacht, with several of the elder brethren, to inspect the light-houses, &c. I was told by some of the gentlemen, who had been on a former survey, that the lower light of Portland was not so strong as the upper light, at near distances, but that at greater distances it was much stronger. I suspected that this difference arose from the lower light being at or near the horizon of the sea, and mentioned it at the time ; but afterwards had a good opportunity of making the

observation. We passed the Bill of Portland in the evening, steering towards the Start, a fresh breeze from the northward and clear night; when we had run about five leagues from the lights, during which time the upper light was universally allowed to be the stronger, several gentlemen keeping watch to make observations thereon, the lower light, drawing near the horizon, suddenly shone with double lustre. Mr. Strachan, whose sight is weak, had for some time before lost sight of both lights, but could then clearly perceive the lower light. I then went aloft, (as well as others,) but before I got half mast up, the lower light was weaker than the upper one; on coming down upon deck, I found it again as strong as before. We proceeded on, and soon lost the lower light from the deck; and upon drawing the upper light near the horizon, it like the former shone exceeding bright. I again went aloft, when it diminished in brightness; but from the mast-head I could then see the lower light near the horizon as strong as before. This is in consequence of the double quantity of light entering

the eye by the two pencils of rays from every point. To illustrate which, we compare the vessel, fig. 4, to a light-house built upon the shore, and A the place of the observer; and having brought down the light so low as to view it in the direction *a a*, another light would appear in the horizon at *x* from the pencil *d d*; and had the vessel been still enough to have observed it at this time with a good glass, I doubt not but the two images might have been distinctly seen: as the light dropped, (by increasing the distance) the two images would appear continually to approach each other, till blended with double light in one, and disappear at the altitude *i*, above the apparent horizon of the sea. But, as explained before, if the strength of evaporation did not separate by refraction the pencils *a a* and *d d* to a greater angle than double the angle that the lamps and reflectors appear under, the two images would be blended, and the strong appearance of light would be of shorter duration. The distance run from the lights, during the time each of the lights shone bright, would have been useful, but this

did not occur at the time, nor have I had the like opportunity since. However, I recommend to the mariner to station people at different heights in looking out for a light, in order to get sight of it near the horizon, when it is always the strongest.

Respecting the appearance of the Abbey Head before mentioned, fig. 1, the dotted line A B represents the limit, or the lowest points of the land that can be seen over the sea; for, as above stated, all the objects appearing below this line, are the land above it inverted; and where the land is low, as at *d* and *m*, it must appear elevated above the horizon of the sea.

In fig. 5. let H O represent the curve of the ocean, and *d* the extreme top of the mount visible at A by the help of refraction; the dotted pencil of rays *c c* passing from *d* to the eye in some part a little below the maximum of density, where inversion begins; therefore no land lower than this can be seen; for any pencil from a point in the land lower than this, must in the refraction have a contrary flexure in the curve, and therefore pass above the observer. Let

A D be a tangent to the curve at A, then the object d will appear to be elevated by refraction to D; also let A v be a tangent to the pencil A x at A, then the angle D A x will appear to be an open space, or between D and the horizon of the sea. Suppose a star should appear very near and over the mount d , as at *, two pencils would issue from every point of it, and form a star below as well as above the hummock d . There are always confused or ill defined images of the objects at the height of the dotted line, fig. 1, above the level of the sea, as before mentioned; and instead of the points of d ending sharp in that line, they appear blunted, and the Abbey Head is frequently insulated at the neck m .

I have viewed, from an elevated situation, a point or head land at a distance beyond the horizon of the sea, forming, as in fig. 6, a straight line A B, making an acute angle B A O with the horizon of the sea. Seeing the extreme point blunted and elevated, I descended; and though in descending the horizon cut the land higher, as at H O, H O, yet the point

had always the same appearance as *a, a, a*, fig. 6, though the land is known to continue in the direction of the straight line *A B* to beneath the horizon, or nearly so, as viewed from the height above.

If then from a low situation we view this head land through a telescope, the inclination of the surface *A B* to the horizon being known to be a straight line, it will appear as in fig. 7, the dotted line (at the height of the point where a perpendicular *x y* would touch the extreme of the land) being at the limit or lowest point of erect vision. And if a tangent to the curved appearance of the land *a b*, is drawn parallel to the inclined surface of the land *A B*, fig. 6, touching it at *C*, the point *C* will shew the height of the maximum of density, where the pencil of the rays of light, from thence to the eye, approach nearest the sea; for pencils of rays from this land, taken at small distances from *C*, will form parallel curves, nearly through the refracting mediums, and *C* will be the point of greatest refraction; for above *C*, as at *B*, the refraction somewhat decreasing, will appear below the line *a b*, or

the parallel to the surface of the land, and the refractions decrease below the point C; for had they increased uniformly down to the surface of the sea, it would render the apparent angle of the point of land \approx more acute than the angle C α O, contrary to all observations.

Thus I have endeavoured to explain the phenomena of the distorted appearance of the land near the horizon of the sea, when the evaporation is great; and when at the least, I never found the land quite free from it when I used a telescope; and from thence infer, that we cannot have any expectation to find a true correction for the effect of terrestrial refraction, by taking any certain part of the contained arc; for the points \approx C B, fig. 7, will have various refractions, though they are at nearly the same distance from the observer. And if the observations are made wholly over land, if the ground rises to within a small distance of the rays of light in their passage from the object to the eye, as well as at the situation of the object and observer, the refractions will be subject to

be influenced by the evaporations of rains, dews, &c., which is sufficiently proved by the observations of Colonel Williams, Captain Mudge, and Mr. Dalby, Phil. Trans. 1795, p. 583.

The appearances mentioned by Colonel Williams, Captain Mudge, and Mr. Dalby, (Phil. Trans. 1795, p. 586, 587,) cannot be demonstrated upon general principles, as they arise from evaporation producing partial refractions. In those general principles, it is supposed that the same lamina of density is every where at an equal distance from the surface of the sea, at least as far as the eye can reach a terrestrial object; but in the partial refractions, the lamina of the expanded or rarefied medium may be of various figures according to circumstances, which will refract according to the incidence of the rays, and affect the appearance of the land accordingly, which I have often seen to a surprising degree. But my principal view is to shew the uncertainty of the dip of the sea, and that the effect of evaporation tends to depress the apparent horizon at x , when the eye is not above the

maximum of density; and from hence the difficulty of laying down any correct formula for these refractions, whilst the law of evaporation is so little understood, which indeed seems a task not easy to surmount. The effect indicated by the barometer and thermometer is insufficient: and should the hygrometer be improved to fix a standard for moisture in the atmosphere, and shew the variations near the surface of the ocean, which certainly must be taken into the account, (evaporation going on quicker in a dry than a moist atmosphere,) the theory might still be incomplete for correcting the tables of the dip. I shall therefore conclude this paper, by shewing a method I used in practice, in order to obviate this error, in low latitudes.

When I was desirous to attain more accurately the latitude of any head-land, &c. in sight, I frequently observed the angular distances of the Sun's nearest limb from the horizons, upon the meridian both north and south, beginning a few minutes before noon, and taking alternately the observations each way, from the poop, or some convenient part of the ship, where the

Sun and the horizon both north and south were not intercepted; and having found the greatest and least distances from the respective horizons, which was at the Sun's passing the meridian, and corrected both for refraction, by subtracting from the least, and adding to the greatest altitude, the quantity given by the table; and also having corrected for the error of the instrument, and the Sun's semi-diameter; the sum of these two angular distances, reduced as above, -180° , is equal to double the dip, as by the following

EXAMPLE.

The Sun's declination $4^\circ 32' 30''$ north, and its semi-diameter $15' 58''$ took the following observation:

The meridian distance of the

Sun's nearest limb from the	South	North
horizon of the sea	$78^\circ 36' 30'' =$	$101^\circ 1' 20''$
Refraction per table	$- 0 11 =$	$+ 0 11$
Distances corr. for refraction $=$	$78 36 19 =$	$101 1 31$
Error of the Sextant	$+ 1 32$	$+ 1 32$
Sun's semi-diameter	$+ 15 58$	$+ 15 58$
Carried over . . .	$78 53 49$	$101 19 1$

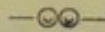
	South	North
Brought over	78° 53' 49"	101° 19' 1"
$\frac{1}{2}$ diff. or the dip found	6 25	78 58 49
Altitude reduced	<u>78 47 24</u>	<u>180 12 50</u>
Zenith distance	<u>11 12 36</u>	<u>180°</u>
		diff. . . . 12 50
The Sun's declination N.	<u>4 32 30</u>	$\frac{1}{2}$ = 6 25
Latitude of the ship N.	<u>15 45 06</u>	Dip.

I regret that I cannot in this paper insert the dip which I have found in my observations; for I only retained the latitude of the ship determined thereby, as is usual at sea; I generally rejected the error of the instrument, the dip, and semi-diameter, as they affect both observations with the same signs, and reduced the observation by the following method:

	South	North
Sun's dist. as before	78° 36' 30"	101° 1' 20"
Refraction	— 0 11	+ 0 11
Dis. cor. for refraction	78 36 19	101 1 31
		+ 78 36 19
Sum of S. diam. dip, & refraction = $\frac{1}{2}$ diff.	+ 11 5	Sum 179 37 50
	<u>78 47 24</u>	<u>180</u>
		Diff. 22 10
		$\frac{1}{2}$ 11 5
	90	101 12 36
		<u>90</u>
The $\frac{1}{2}$ dist. as before =	11 12 36	$\frac{1}{2}$ D. = 11 12 36

It may be observed, that neither the dip, semi-diameter, or index error, can affect the zenith distance of the Sun's centre ; and the refraction being small near the zenith, the result must be true if the angles are accurately taken ; and it is only necessary to observe, that when the sum of the distances is less than 180° , the half difference must be added to the distances, as by the last reduction. There is a difficulty in making this observation when the Sun passes the meridian very near the zenith, as the change in azimuth from east to west is too quick to allow sufficient time ; nor can it be obtained by the sextant when the Sun passes the meridian more than 30 degrees from the zenith ; for I never could adjust the back observation of the Hadley's quadrant with sufficient accuracy to be depended upon.

Postscript.



Perhaps it ought to have been more particularly stated in the body of this memoir, that between the late CAPTAIN HUDDART and many of the highly scientific men who were his contemporaries, there existed feelings of strong attachment; and that when either he was jointly engaged with them, or opportunities occurred in which kindness could be expressed towards him, the best attention was always offered. Among others, whose professions led them to act with CAPTAIN HUDDART, was the late MR. RENNIE, with whom he was engaged in many of his most important reports and public works; and it is in the knowledge of the writer, that MR. RENNIE was at all times happy to have the advice and sanction of CAPTAIN HUDDART, previous to engaging in any work of consequence. To have been thus consulted by one so sound in science and

so useful in its application as the late MR. RENNIE, will be considered a valuable testimonial of his knowledge and abilities ; and CAPTAIN HUDDART was anxious, while his powers remained, to further the undertakings of his friend.

With the late MR. WATT of Soho, eminent as a philosopher, and the greatest contributor to the advancement of practical science that this country or even Europe has ever known, CAPTAIN HUDDART had the happiness of being well acquainted ; and although their individual pursuits had not in the earlier periods of their lives led them to much personal intercourse, so great was MR. WATT's estimation of him, and so anxious was he to evince it, that at a very advanced period of life, and without solicitation on the part of CAPTAIN HUDDART, he presented himself in London, purposely to attend as an evidence in support of a patent which had been infringed, and which was at the time under litigation. This anecdote, trifling as it might appear under any other circumstance, serves only to sanction the opinion which the recorder of

CAPTAIN HUDDART'S life entertains of his abilities. The friendship and active co-operation of such men as the late Mr. WATT and Mr. RENNIE, cannot fail to shed a lustre over his memory.

It ought too, to have been known, that in his own particular sphere, and in the East India Company's service, where he passed so large a portion of his life, he was equally beloved and respected, for he was ever kind and ready to afford such assistance as was in his power: and in relation to his anxiety to forward the science of Navigation, it reflects credit on his memory, that after a fire which destroyed the first edition of that most excellent and accurate work, "Tables for Navigation and Nautical Astronomy, by Mendoza de Rios," Captain Huddart materially contributed to the printing of a second. As a member of the Trinity House, his talents and acquirements were always at the service of the Corporation; and in the many and extensive surveys undertaken by him for this most honourable and useful Board, he displayed a knowledge of the practical application of science, which few other men

have attained ; and so plain, but so correct were the instructions given by him for the various Lights and Beacons erected under his immediate attention, that mariners of slight acquirement cannot fail to understand them ; and so anxious was he to forward one of the particular branches entrusted to the care of the Trinity House, that of Light-houses, that in several instances he attended their erection ; not suffering that to be done by others which could be accomplished by himself, when great responsibility or public utility demanded his personal superintendence.



W. Phillips, Printer, London.

Fig. 1.

Abbey Head

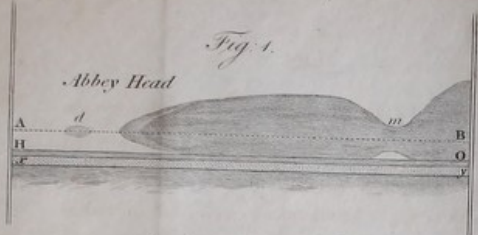


Fig. 2.

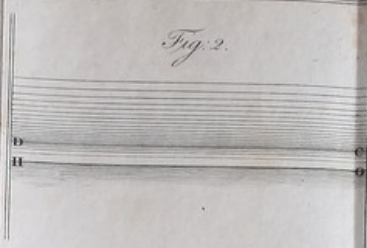


Fig. 3.

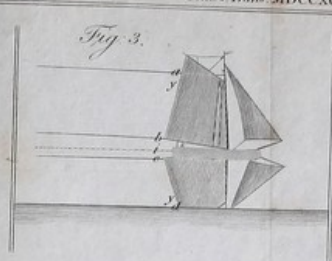


Fig. 4.

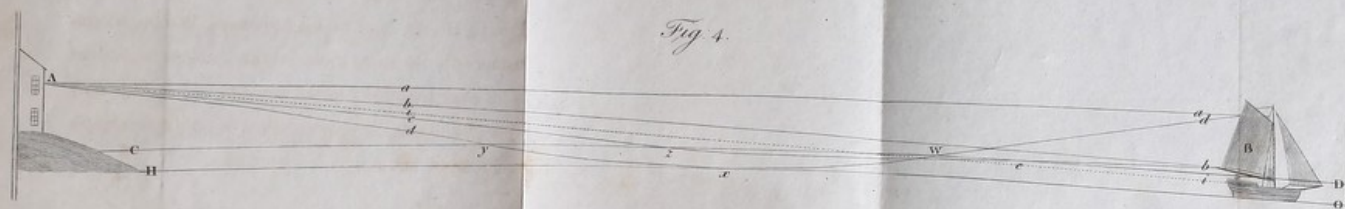


Fig. 5.

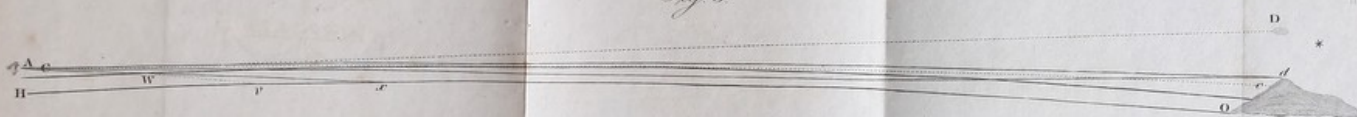


Fig. 6.

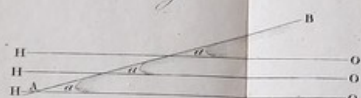


Fig. 7.

