22 B.

A VOYAGE TOWARDS THE NORTH POLE.

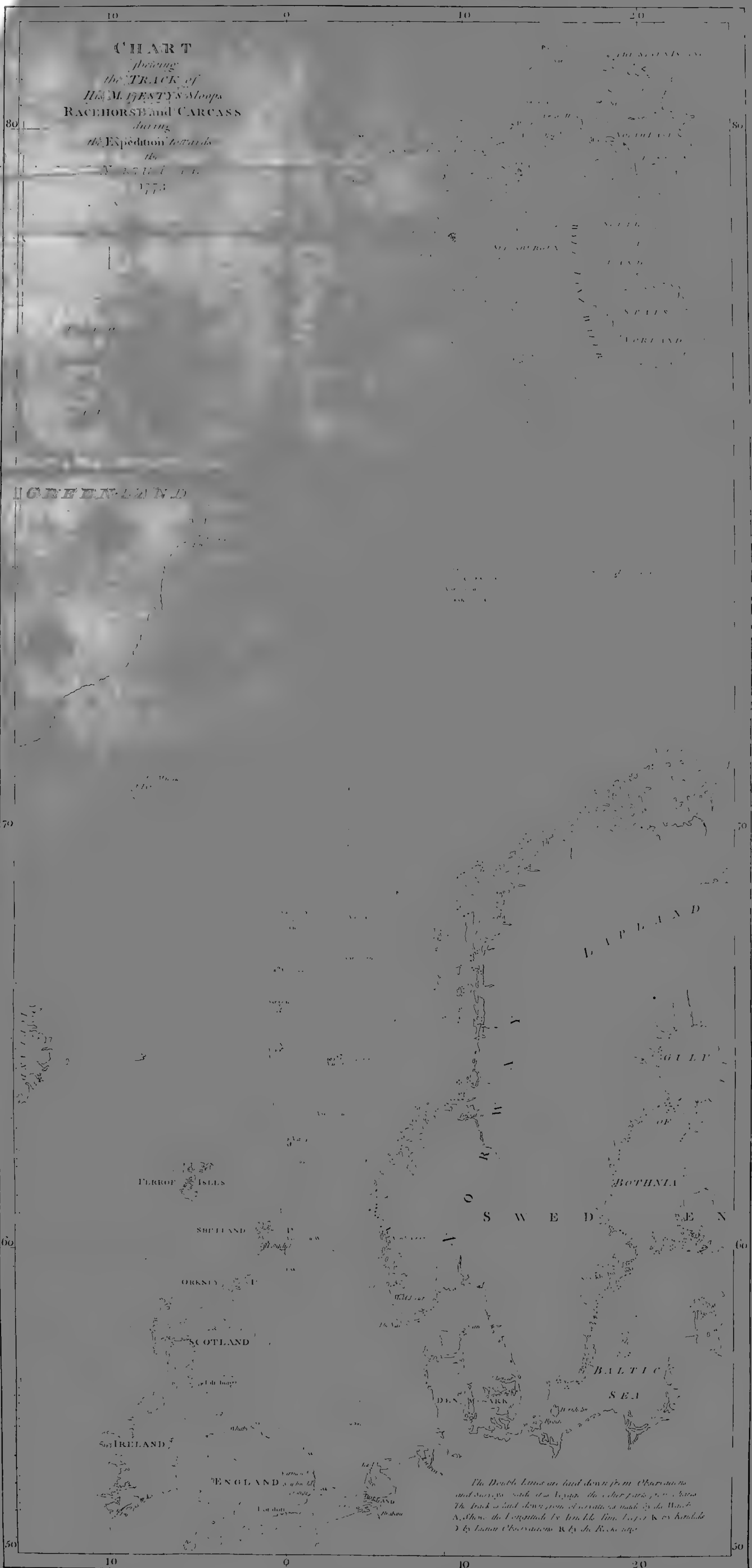
CHART
shewing
the TRACK of
His MAJESTY'S Sloops
RACEHORSE and CARCASS
during
the Expedition towards
the
NORTH POLE
1773
GREENLAND
LAPLAND
GULF
OF
BOTHNIA
SWEDEN
NORWAY
BALTIC
SEA
DENMARK
FERROE ISLES
SHETLAND
ORKNEY
SCOTLAND
IRELAND
ENGLAND
London

A
VOYAGE
TOWARDS
THE NORTH POLE
UNDERTAKEN
BY HIS MAJESTY'S COMMAND
1773

BY CONSTANTINE JOHN PHIPPS

LONDON;
PRINTED BY W. BOWYER, AND J. NICHOLS,
FOR J. NOURSE, BOOKSELLER TO HIS MAJESTY,
IN THE STRAND.
MDCCLXXIV.

TO

THE KING.

SIRE,

AS a Sea Officer addressing Your MAJESTY on a professional subject, I might justly be accused of singular ingratitude did I not avail myself

myſelf of this opportunity of reminding the World, that the Voyage to explore how far Navigation was practicable towards the North Pole, was undertaken at a Period peculiarly diſtinguiſhed by Your MAJESTY's gracious Attention to Your Navy.

In a Time of profound Peace Your MAJESTY, by a liberal Addition to the Half Pay of the Captains, relieved the Neceſſities of many, and gratified the Ambition of all, at once demonſtrating Your MAJESTY's regard to their Welfare, and Remembrance of their Services.

The Armament which followed in a few Months, and Your MAJESTY's Review of that Armament which by the Diſpatch of its Equipment

Equipment had prevented a War, afforded to Your Navy the moſt flattering and diſtinguiſhed Mark of Royal Favour, and to Your Majeſty an additional Proof of that Alacrity for Your Service which had ſo recently received both its Reward and Encouragement from Your MAJESTY's Protection.

Permit me, SIRE, to add, that Your MAJESTY's gracious Approbation of my Endeavours, and the Permiſſion I have been honoured with, of inſcribing the following Account of them to Your MAJESTY, are ſtrong Proofs of that Indulgence with which Your MAJESTY receives every Attempt to promote Your Service.—An Indulgence which, at the ſame Time that it cannot fail of animating the Zeal of others more worthy of

Your

Your MAJESTY's Notice, has added to the moſt devoted Attachment the warmeſt Gratitude of,

SIRE,

Your MAJESTY's moſt dutiful

Subject and Servant,

CONSTANTINE JOHN PHIPPS.

INTRODUCTION.

THE idea of a paſſage to the Eaſt Indies by the North Pole was ſuggeſted as early as the year 1527, by Robert Thorne, merchant, of Briſtol, as appears from two papers preſerved by Hackluit; the one addreſſed to king Henry VIII; the other to Dr. Ley, the king's ambaſſador to Charles V. In that addreſſed to the king he ſays, "I know it to be my bounden duty to manifeſt this "ſecret to your Grace, which hitherto, I ſuppoſe, has "been hid." This ſecret appears to be the honour and advantage which would be derived from the diſcovery of a paſſage by the North Pole. He repreſents in the ſtrongeſt terms the glory which the kings of Spain and Portugal had obtained by their diſcoveries Eaſt and Weſt, and exhorts the king to emulate their fame by undertaking diſcoveries towards the North. He ſtates in a very maſterly ſtyle the reputation that muſt attend the attempt, and the great benefits, ſhould it be crowned with ſucceſs, likely to accrue to the ſubjects of this country, from their advantageous ſituation; which, he obſerves, ſeems to make the exploring this, the only hitherto undiſcovered part, the King's peculiar duty.

To remove any objection to the undertaking which might be drawn from the ſuppoſed danger, he inſiſts upon "the great advantages of conſtant day-light in ſeas, "that, men ſay, without great danger, difficulty, and peril, "yea, rather, it is impoſſible to paſs; for they being paſt "this little way which they named ſo dangerous (which "may be two or three leagues before they come to the "Pole, and as much more after they paſs the Pole), it is "clear from thenceforth the ſeas and lands are as temperate as in theſe parts."

In the paper addreſſed to Dr. Ley he enters more minutely into the advantages and practicability of the undertaking. Amongſt many other arguments to prove the value of the diſcovery, he urges, that by ſailing northward and paſſing the Pole, the navigation from England to the Spice Iſlands would be ſhorter, by more than two thouſand leagues, than either from Spain by the Straits of Magellan, or Portugal by the Cape of Good Hope; and to ſhew the likelihood of ſucceſs in the enterprize he ſays, it is as probable that the coſmographers ſhould be miſtaken in the opinion they entertain of the polar

polar regions being impaſſable from extreme cold, as, it has been found, they were, in ſuppoſing the countries under the Line to be uninhabitable from exceſſive heat. With all the ſpirit of a man convinced of the glory to be gained, and the probability of ſucceſs in the undertaking, he adds,—" God knoweth, that though by it I ſhould " have no great intereſt, yet I have had, and ſtill have, no " little mind of this buſineſs: ſo that if I had faculty to " my will, it ſhould be the firſt thing that I would un- " derſtand, even to attempt, *if our ſeas Northward be* " *navigable to the Pole or no.*" Notwithſtanding the many good arguments, with which he ſupported his propoſition, and the offer of his own ſervices, it does not appear that he prevailed ſo far as to procure an attempt to be made.

Borne, in his *Regiment of the Sea*, written about the year 1577, mentions this as one of the five ways to Cathay, and dwells chiefly on the mildneſs of climate which he imagines muſt be found near the Pole, from the conſtant preſence of the ſun during the ſummer. Theſe arguments, however, were ſoon after controverted by Blundeville, in his Treatiſe on Univerſal Maps.

In 1578, George Beſt, a gentleman who had been with Sir Martin Frobiſher in all his voyages for the diſcovery of the North Weſt paſſage, wrote a very ingenious diſcourſe, to prove all parts of the world habitable.

No voyage, however, appears to have been undertaken to explore the circumpolar ſeas, till the year 1607, when "Henry Hudſon was ſet forth, at the charge of certain "worſhipful merchants of London, to diſcover a paſſage "by the North Pole to Japan and China." He ſailed from Graveſend on the firſt of May, in a ſhip called the Hopewell, having with him ten men and a boy. I have taken great pains to find his original journal, as well as thoſe of ſome others of the adventurers who followed him; but without ſucceſs: the only account I have ſeen is an imperfect abridgement in Purchas, by which it is not poſſible to lay down his track; from which, however, I have drawn the following particulars:—He fell in with the land to the Weſtward in latitude 73°, on the twenty-firſt of June, which he named Hold-with-Hope. The twenty-ſeventh, he fell in with Spitſbergen, and met with much ice; he got to eighty degrees twenty-three minutes, which was the Northernmoſt latitude he obſerved in. Giving an account of the concluſion of his diſcoveries, he ſays, "On the ſixteenth of "Auguſt I ſaw land, by reaſon of the clearneſs of the "weather, *ſtretching far into eighty-two degrees*, and, by "the bowing and ſhewing of the ſky, much farther; "which when I firſt ſaw, I hoped to have had a free ſea "between the land and the ice, and meant to have com-"paſſed this land by the North; but now finding it was "impoſſible, by means of the abundance of ice com-"paſſing us about by the North, and joining to the

"land;

" land; and ſeeing God did bleſs us with a wind, we re-" turned, bearing up the helm." He afterwards adds: " And this I can aſſure at this preſent, that between " ſeventy-eight degrees and an half, and eighty-two de-" grees, by this way there is no paſſage."—In conſequence of this opinion, he was the next year employed on the North Eaſt diſcovery.

In March 1609, old ſtyle, " A voyage was ſet forth by the " right worſhipful Sir Thomas Smith, and the reſt of the " Muſcovy Company, to Cherry Iſland, and for a further " diſcovery to be made towards the North Pole, for the like-" lihood of a trade or a paſſage that way, in the ſhip called " the Amity, of burthen ſeventy tuns, in which Jonas " Poole was maſter, having fourteen men and one boy."—He weighed from Blackwall, March the firſt, old ſtyle; and after great ſeverity of weather, and much difficulty from the ice, he made the South part of Spitſbergen on the 16th of May. He ſailed along and ſounded the coaſt, giving names to ſeveral places, and making many very accurate obſervations. On the 26th, being near Fair Foreland, he ſent his mate on ſhore;—and ſpeaking of the account he gave at his return, ſays, " Moreover, I was " certified that all the ponds and lakes were unfrozen, they " being freſh water; which putteth me in hope of a mild " ſummer here, after ſo ſharp a beginning as I have had; " and my opinion is ſuch, and I aſſure myſelf it is ſo, that " a paſſage may be as ſoon attained this way by the Pole,

" as

"as any unknown way whatſoever, by reaſon the ſun doth "give a great heat in this climate, and the ice (I mean "that freezeth here) is nothing ſo huge as I have ſeen in "ſeventy-three degrees."

Theſe hopes, however, he was ſoon obliged to relinquiſh for that year, having twice attempted in vain to get beyond 79° 50′. On the 21ſt of June, he ſtood to the Southward, to get a loading of fiſh, and arrived in London the laſt of Auguſt. He was employed the following year (1611) in a ſmall bark called the Elizabeth, of 50 tuns. The inſtructions for this voyage, which may be found at length in Purchas, are excellently drawn up: They direct him, after having attended the fiſhery for ſome time, to attempt diſcoveries to the North Pole as long as the ſeaſon will permit; with a diſcretionary clauſe, to act in unforeſeen caſes as ſhall appear to him moſt for the advancement of the diſcovery, and intereſt of his employers. This however proved an unfortunate voyage: for having ſtaid in Croſs Road till the 16th of June, on account of the bad weather, and great quantity of ice, he ſailed from thence on that day, and ſteered W b N fourteen leagues, where he found a bank of ice: he returned to Croſs Road; from whence when he ſailed, he found the ice to lie cloſe to the land about the latitude of 80°, and that it was impoſſible to paſs that way; and the ſtrong tides making it dangerous to deal with the ice, he determined to ſtand along it to the Southward, to try if he could find the ſea more open that way, and ſo

2 get

get to the Weftward, and proceed on his voyage. He found the ice to lie neareft S W and S W b S and ran along it about an hundred and twenty leagues. He had no ground near the ice at 160, 180, or 200 fathoms: perceiving the ice ftill to trend to the fouthward, he determined to return to Spitsbergen for the fifhery, where he loft his fhip.

In the year 1614, another voyage was undertaken, in which Baffin and Fotherby were employed. With much difficulty, and after repeated attempts in vain with the fhip, they got with their boats to the firm ice, which joined to Red-Beach; they walked over the ice to that place, in hopes of finding whale-fins, &c. in which they were difappointed. Fotherby adds, in his account: "Thus, "as we could not find what we defired to fee, fo did we "behold that which we wifhed had not been there to be "feen; which was great abundance of ice, that lay clofe "to the fhore, and alfo off at fea as far as we could "difcern." On the eleventh of Auguft they failed from Fair-Haven, to try if the ice would let them pafs to the Northward, or Northeaftward; they fteered from Cape Barren, or Vogel Sang, N E b E eight leagues, where they met with the ice, which lay E b S and W b N. The fifteenth of Auguft they faw ice frozen in the fea of above the thicknefs of an half-crown.

Fotherby was again fitted out the next year in a pinnace of twenty tons, called the Richard, with ten men. In this voyage he was prevented by the ice from getting farther than in his laſt. He refers to a chart, in which he had traced the ſhip's courſe on every traverſe, to ſhew how far the ſtate of that ſea was diſcovered between eighty and ſeventy-one degrees of latitude, and for twenty-ſix degrees of longitude from Hackluit's headland. He concludes the account of his voyage in the following manner:

" Now, if any demand my opinion concerning hope " of a paſſage to be found in thoſe ſeas, I anſwer; that it " is true, that I both hoped and much deſired to have " paſſed further than I did, but was hindered with ice; " wherein although I have not attained my deſire, yet " foraſmuch as it appears not yet to the contrary, but " that there is a ſpacious ſea betwixt Groinland and king " James his new land [Spitsbergen] although much peſter- " ed with ice; I will not ſeem to diſwade this worſhip- " ful company from the yearly adventuring of 150 or 200 " pounds at the moſt, till ſome further diſcovery be made " of the ſaid ſeas and lands adjacent." It appears that the Ruſſia company, either ſatisfied with his endeavours and deſpairing of further ſucceſs, or tired of the expence of the undertaking, never employed any more ſhips on this diſcovery.

All

All theſe voyages having been fitted out by private adventurers, for the double purpoſe of diſcovery and preſent advantage; it was natural to ſuppoſe, that the attention of the navigators had been diverted from purſuing the more remote and leſs profitable object of the two, with all the attention that could have been wiſhed. I am happy, however, in an opportunity of doing juſtice to the memory of theſe men; which, without having traced their ſteps, and experienced their difficulties, it would have been impoſſible to have done. They appear to have encountered dangers, which at that period muſt have been particularly alarming from their novelty, with the greateſt fortitude and perſeverance; as well as to have ſhewn a degree of diligence and ſkill, not only in the ordinary and practical, but more ſcientific parts of their profeſſion, which might have done honour to modern ſeamen, with all their advantages of later improvements. This, when compared with the accounts given of the ſtate of navigation, even within theſe forty years, by the moſt eminent foreign authors, affords the moſt flattering and ſatisfactory proof of the very early exiſtence of that decided ſuperiority in naval affairs, which has carried the power of this country to the height it has now attained.

This great point of geography, perhaps the moſt important in its conſequences to a commercial nation and maritime power, but the only one which had never yet been the object of royal attention, was ſuffered to remain without further inveſtigation, from the year 1615 till 1773, when the Earl of Sandwich, in conſequence of an application which had been made to him by the Royal Society, laid before his Majeſty, about the beginning of February, a propoſal for an expedition to try how far navigation was practicable towards the North Pole; which his Majeſty was pleaſed to direct ſhould be immediately undertaken, with every encouragement that could countenance ſuch an enterprize, and every aſſiſtance that could contribute to its ſucceſs.

As ſoon as I heard of the deſign, I offered myſelf, and had the honour of being entruſted with the conduct of this undertaking. The nature of the voyage requiring particular care in the choice and equipment of the ſhips, the Racehorſe and Carcaſs bombs were fixed upon as the ſtrongeſt, and therefore propereſt for the purpoſe. The probability that ſuch an expedition could not be carried on without meeting with much ice, made ſome additional ſtrengthening neceſſary: they were therefore immediately taken into dock, and fitted in the moſt compleat manner for the ſervice. The complement for the Racehorſe was fixed at ninety men, and the ordinary eſtabliſhment departed from, by appointing an additional number of officers, and entering effective men inſtead of the uſual number of boys.

I was allowed to recommend the officers; and was very happy to find, during the courſe of the voyage, by the great aſſiſtance I received on many occaſions from their abilities and experience, that I had not been miſtaken in the characters of thoſe upon whom ſo much depended in the performance of this ſervice. Two maſters of Greenlandmen were employed as pilots for each ſhip. The Racehorſe was alſo furniſhed with the new chain-pumps made by Mr. Cole according to Captain Bentinck's improvements, which were found to anſwer perfectly well. We alſo made uſe of Dr. Irving's apparatus for diſtilling freſh water from the ſea, with the greateſt ſucceſs. Some ſmall but uſeful alterations were made in the ſpecies of proviſions uſually ſupplied in the navy; an additional quantity of ſpirits was allowed for each ſhip, to be iſſued at the diſcretion of the commanders, when extraordinary fatigue or ſeverity of weather might make it expedient. A quantity of wine was alſo allotted for the uſe of the ſick. Additional clothing, adapted to that rigor of climate, which from the relations of former navigators we were taught to expect, was ordered to be put on board, to be given to the ſeamen when we arrived in the high latitudes. It was foreſeen that one or both of the ſhips might be ſacrificed in the proſecution of this undertaking; the boats for each ſhip were therefore calculated, in number and ſize, to be fit, on any emergency, to

 tranſport

transſport the whole crew. In ſhort, every thing which could tend to promote the ſucceſs of the undertaking, or contribute to the ſecurity, health, and convenience of the ſhips' companies, was granted.

The Board of Longitude agreed with Mr. Iſrael Lyons to embark in this voyage, to make aſtronomical obſervations. His reputation for mathematical knowledge was too well eſtabliſhed to receive any addition from the few opportunities which a voyage in ſuch unfavourable climates could afford. The ſame Board ſupplied him with ſuch inſtruments as they imagined might be uſeful for making obſervations and experiments. The Royal Society favoured me with ſuch information as they judged might ſerve to direct my enquiries, whenever the circumſtances of the voyage ſhould afford me leiſure and opportunity for making obſervations. Beſides theſe learned bodies, I was obliged to many individuals for hints; amongſt whom it is with pleaſure I mention Monſieur D'Alembert, who communicated to me a ſhort paper, which, from the conciſeneſs and elegance with which it was drawn up, as well as from the number of intereſting objects that it recommended to my attention, would have done honour to any perſon whoſe reputation was not already eſtabliſhed upon ſo ſolid a foundation as that learned philoſopher's. To Mr. Banks I was indebted for very full inſtructions in the branch of natural hiſtory, as I have ſince been for his

aſſiſtance

aſſiſtance in drawing up the account of the productions of that country; which I acknowledge with particular ſatisfaction, as inſtances of a very long friendſhip which I am happy in an opportunity of mentioning.

As a voyage of this kind would probably afford many opportunities of making experiments and obſervations in matters relative to navigation, I took care to provide myſelf with all the beſt inſtruments hitherto in uſe, as well as others which had been imperfectly, or never, tried.

The length of the Second Pendulum in ſo high a latitude as I was likely to reach, appearing to me an experiment too intereſting to be neglected, I deſired Mr. Cumming to make me ſuch an inſtrument as he thought would beſt anſwer the purpoſe. That modeſty and candour which always attend real merit, induced him to lend me the identical pendulum with which Mr. Graham had made his experiments, rather than furniſh me with one of his own conſtruction; but the judgment as well as ſkill with which the apparatus joined to it was contrived and executed, notwithſtanding the ſhortneſs of the time, will, I am ſure, do him credit.

The Board of Longitude ſent two watch machines for keeping the longitude by difference of time; one conſtructed by Mr. Kendal, on Mr. Harriſon's principles; the

the other by Mr. Arnold. I had alſo a pocket watch conſtructed by Mr. Arnold, by which I kept the longitude to a degree of exactitude much beyond what I could have expected; the watch having varied from its rate of going only 2′ 40″ in 128 days.

In the Journal which follows, I mean to confine myſelf to the occurrences of the voyage as they ſucceeded in order of time; which, for the convenience of the generality of readers, I have reduced from the nautical to the civil computation: to this I ſhall add, by way of Appendix, an account of all the experiments and obſervations under their reſpective heads, that thoſe who intereſt themſelves in any particular branch, may find whatever they want, unmixed with foreign matters; while thoſe who may wiſh only to trace the whole progreſs of the voyage, as well as thoſe who may be ſatiſfied with the general reſults of the experiments, will find the account unincumbered with that detail which I wiſh to ſubmit to others, who may chuſe to examine more minutely, and compare the facts with the concluſions.

A voyage of a few months to an uninhabited extremity of the world, the great object of which was to aſcertain a very intereſting point in geography, cannot be ſuppoſed to afford much matter for the gratification of mere

mere curiofity. The experiments and obfervations may poffibly from their novelty, and the peculiar circumftances of the climate in which they were made, afford fome entertainment to philofophers; and might perhaps have been more numerous and fatisfactory, if the purfuit of the great object of the voyage had not rendered them, however interefting in themfelves, but a fecondary confideration.

JOURNAL.

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JOURNAL.

APRIL 19th, 1773, I received my commiſſion for the Racehorſe, with an order to get her fitted with the greateſt diſpatch for a voyage of diſcovery towards the North Pole, and to proceed to the Nore for further orders. 1773. April.

23d. The ſhip was hauled out of dock.

May 21ſt. The ſhip being manned and rigged, and having got in all the proviſions and ſtores, except the Gunner's, we fell down to Galleons. May.

22d. We received on board the powder, with eight ſix-pounders, and all the gunner's ſtores. Lord Sandwich gave us the laſt mark of the obliging attention he had ſhewn during the whole progreſs of the equipment, by coming on board to ſatisfy himſelf, before our departure, that the whole had been compleated to the wiſh of thoſe who were embarked in the expedition. The Eaſterly

May. winds prevented our going down the river till the 26th, when I received my inſtructions for the voyage, dated the 25th; directing me to fall down to the Nore in the Racehorſe, and there taking under my command the Carcaſs, to make the beſt of my way to the Northward, and proceed up to the North Pole, or as far towards it as poſſible, and as nearly upon a meridian as the ice or other obſtructions might admit; and, during the courſe of the voyage, to make ſuch obſervations of every kind as might be uſeful to navigation, or tend to the promotion of natural knowledge: in caſe of arriving at the Pole, and even finding free navigation on the oppoſite meridian, not to proceed any farther; and at all events to ſecure my return to the Nore before the winter ſhould ſet in. There was alſo a clauſe authorizing me to proceed, in unforeſeen caſes, according to my own diſcretion; and another clauſe directing me to proſecute the voyage on board the Carcaſs, in caſe the Racehorſe ſhould be loſt or diſabled.

27th. I anchored at the Nore, and was joined by Captain Lutwidge, in the Carcaſs, on the 30th: her equipment was to have been in all reſpects the ſame as that of the Racehorſe, but when fitted, Captain Lutwidge finding her too deep in the water to proceed to ſea with ſafety, obtained leave of the Admiralty to put ſix more guns on ſhore, to reduce the complement to eighty men, and return a quantity of proviſions proportionable to that re-

 duction.

duction. The officers were recommended by Captain Lutwidge, and did justice to his penetration by their conduct in the course of the voyage. During our stay here, Mr. Lyons landed with the astronomical quadrant at Sheerness fort, and found the latitude to be 51° 31′ 30″, longitude 0° 30′ East. The Easterly winds prevented our moving this day and the following. May.

June 2d. Having the wind to the Westward of North, at five in the morning I made the signal to weigh; but in less than half an hour, the wind shifting to the Eastward and blowing fresh, I furled the topsails. The wind came in the afternoon to N b E; we weighed, but did not get far, the tide of flood making against us. June.

3d. The wind blowing fresh all day Easterly, we did not move.

4th. The wind coming round to the Westward at six in the morning, I weighed immediately, and sent the boat for Captain Lutwidge, to deliver him his orders. At 10 A. M. longitude by the watch 56′ E. At noon the latitude observed was 51° 37′ 36″ N. At eight in the evening we had got as far as Balsey Cliff, between Orford and Harwich. Little wind at night.

5th. Anchored in Hoseley Bay at half past seven in the evening, in five and an half fathom water. Orford Castle N E b N.

June.

Angle between Aldborough Church and Orford Light House.	7°	38′
Light House and Orford Church, - -	18	16
Orford Church and Castle, - -	2	20
Castle and Hoseley Church, - - -	100	59
Hoseley and Balsey Church, - - -	35	27

6th. At five in the morning, the wind at S S W, weighed, and stood out to sea, finding I might lose two tides by going through Yarmouth Roads. Examined the log line, which was marked forty-nine feet; the glass was found, by comparing it with the time-keeper, to run thirty seconds: at noon latitude observed 52° 16′ 54″, longitude by the watch 1° 30′ 15″ E.

Angle between Southwold and Walderswick,	10°	39′
Walderswick and Dunwich, - - -	20	21
Dunwich and Aldborough, - - -	46	53

Southwold N W ½ N, supposed distance three leagues. We concluded the latitude of Southwold to be 52° 22′, and longitude 1° 18′ 15″ E. The dip was 73° 22′.

7th. The wind was Northerly all day, and blew fresh in the morning. We had stood far out in the night and the day before, to clear the Lemon and Ower.

8th. Little wind most part of the day, with a very heavy swell. Stood in for the land. At half past ten longitude by the watch 0° 41′ 15″ E. At noon the latitude was

was 53° 38′ 37″. We ſaw the high land near the Spurn, in the evening. June.

9th. About noon Flamborough Head bore N W b N diſtant about ſix miles: we were by obſervation in latitude 54° 4′ 54″, longitude 0° 27′ 15″ E; which makes Flamborough Head, in latitude 54° 9′, longitude 0° 19′ 15″ E. In the afternoon we were off Scarborough. Almoſt calm in the evening.

10th. Anchored in the morning for the tide in Robin Hood's Bay, with little wind at N W: worked up to Whitby Road next tide, and anchored there at four in the afternoon, in fifteen fathom, with very little wind.

11th. Calm in the morning; compleated our water, live ſtock and vegetables. At nine in the morning longitude obſerved by the watch 1° 55′ 30″ W; Whitby Abbey bore S ½ W. Weighed with the wind at S E, and ſteered N E b N to get ſo far into the mid-channel as to make the wind fair Eaſterly or Weſterly, without being too near either ſhore, before we were clear of Shetland and the coaſt of Norway.

12th. The wind at S E, and the ſhip well advanced, I ordered the allowance of liquor to be altered, ſerving the ſhip's company one-fourth of their allowance in beer, and the other three-fourths in brandy; by which means the

beer

June.

beer was made to laſt the whole voyage, and the water conſiderably ſaved. One half of this allowance was ſerved immediately after dinner, and the other half in the evening. It was now light enough all night to read upon deck.

13th. The weather ſtill fine, but conſiderably leſs wind than the day before, and in the afternoon more Northerly. The longitude at ten in the morning was found by my watch 0° 6′ W. We took three obſervations of the moon and ſun for the longitude; the extremes differed from one another near two degrees: the mean of the three gave the longitude 1° 37′ E. At noon the latitude obſerved was 59° 32′ 31″. We found a difference of 36′ between the latitude by dead reckoning and obſervation, the ſhip being ſo much more Northerly than the reckoning. The diſtance by this log was too ſhort by forty-three miles. A log marked forty-five feet, according to the old method, would have agreed with the obſervation within two miles in the two days' run. The circumſtance of ſteering upon a meridian, which afforded me ſuch frequent opportunities of detecting the errors of the log, induced me to obſerve with care the comparative accuracy of the different methods of dividing the line, recommended by mathematicians, or practiſed by ſeamen. In the afternoon I went on board the Carcaſs to compare the time-keepers by my watch. At ſix in the evening the longitude by my watch 0° 4′ E. This evening the ſun ſet fet at twenty-four minutes paft nine, and bore about N N W by the compafs. The clouds made a beautiful appearance long after to the Northward, from the reflection of the fun below the horizon. It was quite light all night: the Carcafs made the fignal for feeing the land in the evening. June.

14th. Little wind, or calm, all day; but very clear and fine weather. Made feveral different obfervations for the longitude by the fun and moon, and by my watch. The longitude of the fhip was found by my watch, at ten in the morning, to be 1° 11′ 45″ W. The longitude by the lunar obfervations differed near two degrees from one another. By the mean of them the fhip was in longitude 2° 57′ 45″ W. Some Shetland boats came on board with fifh. At noon the latitude by obfervation was 60° 16′ 45″. At one in the afternoon the dip was obferved to be 73° 30′; and at eight, 75° 18′: the evening calm, and very fine; the appearance of the fky to the Northward very beautiful. Variation, by the mean of feveral obfervations, 22° 25′ W.

15th. By an obfervation at eight in the morning, the longitude of the fhip was by the watch 0° 39′ W: Dip 74° 52′. At half paft ten in the morning, the longitude, from feveral obfervations of the fun and moon, was 0° 17′ W; at noon being in latitude 60° 19′ 8″, by obfervation, I took the diftance between the two fhips by

June. the Megameter; and from that baſe determined the poſition of Hangcliff, which had never before been aſcertained, though it is a very remarkable point, and frequently made by ſhips. According to theſe obſervations it is in latitude 60° 9′, and longitude 0° 56′ 30″ W. In the Appendix I ſhall give an account of the manner of taking ſurveys by this inſtrument, which I believe never to have been practiſed before. At one, obſerved the dip to be 75°. A thick fog came on in the afternoon, with a flat calm; we could not ſee the Carcaſs, but heard her anſwer the ſignals for keeping company. Variation, from the mean of ſeveral obſervations, 25° 1′ W.

16th. A very thick fog in the morning; latitude obſerved at noon 60° 29′ 17″: the dip was obſerved at nine in the evening to be 76° 45′. In the afternoon, the weather clear, and the wind fair, ſteered N N E: ſent Captain Lutwidge his further orders and places of rendezvous.

17th. Wind fair, and blowing freſh at S S W, continued the courſe N N E: ordered the people a part of the additional clothing: ſaw an Engliſh ſloop, but had no opportunity of ſending letters on board, the ſea running high. At ten in the morning, longitude by the watch 0° 19′ 45″ W: at noon, the latitude obſerved was 62° 59′ 27″. The ſhip had out-run the reckoning

5 eleven

June.

eleven miles. I tried Bouguer's log twice this day, and found it give more than the common log. Variation 19° 22′ W.

18th. Little wind all day, but fair, from SSW to SE: ſtill ſteering NNE: latitude obſerved at noon 65° 18′ 17″. At three in the afternoon, ſounded with 300 fathom of line, but got no ground. Longitude by the watch 1° 0′ 30″ W.

19th. Wind to the NW. Took the meridian obſervation at midnight for the firſt time: the ſun's lower limb 0° 37′ 30″ above the horizon; from which the latitude was found 66° 54′ 39″ N: at four in the afternoon, longitude by the watch 0° 58′ 45″ W: at ſix the variation 19° 11′ W.

20th. Almoſt calm all day. The water being perfectly ſmooth, I took this opportunity of trying to get ſoundings at much greater depths than I believe had ever been attempted before. I ſounded with a very heavy lead the depth of 780 fathom, without getting ground; and by a thermometer invented by lord Charles Cavendiſh for this purpoſe, found the temperature of the water at that depth to be 26° of Fahrenheit's thermometer; the temperature of the air being 48° ½.

June.

We began this day to make ufe of Doctor Irving's apparatus for diftilling frefh water from the fea: repeated trials gave us the moft fatisfactory proof of its utility: the water produced from it was perfectly free from falt, and wholefome, being ufed for boiling the fhip's provifions; which convenience would alone be a defirable object in all voyages, independent of the benefit of fo ufeful a refource in cafe of diftrefs for water. The quantity produced every day varied from accidental circumftances, but was generally from thirty-four to forty gallons, without any great addition of fuel. Twice indeed the quantity produced was only twenty-three gallons on each diftillation; this amounts to more than a quart for each man, which, though not a plentiful allowance, is much more than what is neceffary for fubfiftence. In cafes of real neceffity I have no reafon to doubt that a much greater quantity might be produced without an inconvenient expence of fuel.

21ft. A frefh gale at S E all day; fteered N N E. At four in the morning we fpoke with a fnow from the feal fifhery, bound to Hamburg, by which we fent fome letters. At fix in the morning the variation, by the mean of feveral obfervations, was 23° 18′ W. Longitude by the watch at nine was 0° 34′ 30″ W. Latitude obferved at noon 68° 5′.

22d.

June.

22d. Calm moſt part of the day; rainy and rather cold in the evening. At noon obſerved the dip to be 77° 52′.

23d. Very foggy all day; the wind fair; altered the courſe and ſteered N E and E N E, to get more into the mid channel, and to avoid falling in with the Weſtern ice, which, from the increaſing coldneſs of the weather, we concluded to be near. At ſeven o'clock in the morning, being by our reckoning to the Northward of 72°, we ſaw a piece of drift wood, and a ſmall bird called a Redpoll. Dip obſerved at nine in the evening to be 81° 30′.

24th. Very foggy all the morning; the wind came round to the Northward. The dip obſerved at noon was 80° 35′. In the afternoon, the air much colder than we had hitherto felt it; the thermometer at 34°. A fire made in the cabin for the firſt time, in latitude 73° 40′.

25th. Wind Northerly, with a great ſwell; ſome ſnow, but in general clear. At eight in the morning, the longitude obſerved by the watch was 7° 15′ E. Made ſeveral obſervations on the variation, which we found, by thoſe taken at ſeven in the morning, to be 17° 9′ W; by others at three in the afternoon, only 7° 47′ W. I could not account for this very ſudden and extraordinary

decreaſe,

June.

decreaſe, as there were ſeveral different obſervations taken both in the morning and evening, which agreed perfectly well with each other, without any apparent cauſe which could produce an error affecting all the obſervations of either ſet. At eight in the evening the longitude by the moon was 12° 57′ 30″ E, which differed 2° 35′ from that by the watch. Little wind at night.

26th. Little wind all day; the weather very fine and moderate. The latitude obſerved at noon was 74° 25′. The thermometer expoſed to the ſun, which ſhone very bright, roſe from 41° to 61° in twenty minutes. By each of two lunar obſervations which I took with a ſextant of four inches radius, at half paſt one, the longitude was 9° 57′ 30″ E; which agreed within thirty-ſeven minutes with an obſervation made by the watch at half an hour after three, when the longitude was 8° 52′ 30″ E. Dip 79° 22′.

27th. At midnight the latitude obſerved was 74° 26′. The wind came to the S W, and continued ſo all day, with a little rain and ſnow. The cold did not increaſe. We ſteered N b E. At ſeven in the morning the variation, by a mean of ſeveral obſervations, was found to be 20° 38′ W. We were in the evening, by all our reckonings, in the latitude of the South part of Spitſbergen, without any appearance of ice or ſight of land, and with a fair wind.

28th.

28th. Less wind in the morning than the day before, with rain and sleet: continued steering to the Northward. At five in the afternoon picked up a piece of drift wood, which was fir, and not worm-eaten: sounded in 290 fathom; no ground. At six the longitude by the watch was 7° 50′ E: between ten and eleven at night, saw the land to the Eastward at ten or twelve leagues distance. At midnight, dip 81° 7′.

June.

29th. The wind Northerly; stood close in with the land. The coast appeared to be neither habitable nor accessible; it was formed by high, barren, black rocks, without the least marks of vegetation; in many places bare and pointed, in other parts covered with snow, appearing even above the clouds: the vallies between the high cliffs were filled with snow or ice. This prospect would have suggested the idea of perpetual winter, had not the mildness of the weather, the smooth water, bright sunshine, and constant day-light, given a chearfulness and novelty to the whole of this striking and romantick scene.

I had an opportunity of making many observations near the Black Point. Latitude observed at noon 77° 59′ 11″. The difference of latitude, from the last observation on the 27th at midnight to this day at noon, would according to the old method of marking the log have been

two

June.

two hundred and thirteen miles; which agrees exactly with the obſervation. At three in the afternoon, brought to and ſounded 110 fathom; ſoft muddy ground: hoiſted out the boat and tried the ſtream; found it, both by the common and Bouguer's log (which agreed exactly) to run half a knot North; Black Point bearing E N E. At four the longitude by the watch was 9° 31′ E: at eight the variation, by the mean of nineteen obſervations, 11° 53′ W. I could not account from any apparent cauſe for this great change in the variation: the weather was fine, the water ſmooth, and every precaution we could think of uſed to make the obſervations accurate. The dip was 80° 26′. Plying to the Northward.

30th. At midnight the latitude by obſervation was 78° 0′ 50″. At four in the morning, by Lord Charles Cavendiſh's thermometer the temperature of the water at the depth of 118 fathoms was 31° of Fahrenheit's; that of the air was at the ſame time 40°½. At nine in the morning we ſaw a ſhip in the N W, ſtanding in for the land. Having little wind this morning, and that Northerly, I ſtood in for the land, with an intention to have watered the ſhip, and got out immediately, but was prevented by the calm which followed. At noon the latitude obſerved was 78° 8′; the dip 79° 30′. At two in the afternoon we ſounded in 115 fathom; muddy bottom: at the ſame time we ſent down Lord Charles Cavendiſh's thermometer, by which we found the temperature

June.

temperature of the water at that depth to be 33°; that of the water at the ſurface was at the ſame time 40°, and in the air 44° $\frac{3}{4}$. Fahrenheit's thermometer plunged in water brought up from the ſame depth, ſtood at 38° $\frac{1}{2}$. This evening the maſter of a Greenland Ship came on board, who told me, that he was juſt come out of the ice which lay to the Weſtward about ſixteen leagues off, and that three ſhips had been loſt this year, two Engliſh, and one Dutch. The weather fine, and rather warm. At ſix in the evening the longitude by my watch was 9° 28′ 45″ E.

July.

July 1ſt. Little wind Northerly, or calm, all day: the weather very fine, and ſo warm that we ſat without a fire, and with one of the ports open in the cabin. At noon the latitude obſerved was 78° 13′ 36″; Black Point bearing S 78° E; which makes the latitude of that point nearly the ſame as that of the ſhip, and agrees very well with the chart of this coaſt in Purchas.

2d. Little wind, and calms, all day; the weather very fine. At ſix in the morning five ſail of Greenlandmen in ſight. At noon the latitude obſerved was 78° 22′ 41″. I took a ſurvey of the coaſt, as far as we could ſee: I took alſo with the megameter the altitudes of ſeveral of the mountains: but as there is nothing particularly intereſting to navigators in this part of the coaſt, I ſhall only mention the height of one mountain, which was

 fifteen

July.

fifteen hundred and three yards. This may serve to give some idea of the appearance and scale of the coast. At half past six the longitude by the watch was 9° 8′ 30″ E: Variation 14° 55′ W.

3d. Latitude at midnight 78° 23′ 46″: Dip 80° 45′. The weather fine, and the wind fair all day. Running along by the coast of Spitsbergen all day: several Greenlandmen in sight. Between nine and ten in the evening we were abreast of the North Foreland, bearing E b S ½ S, distance 1 ½ mile. Sounded in twenty fathom; rocky ground.

4th. Very little wind in the morning. At noon the latitude by observation was 79° 31′. Magdalena Hook bore N 39° E distant about four miles; which gives the latitude of that place 79° 34′; the same as Fotherby observed it to be in 1614. Stood in to a small bay to the Southward of Magdalena and Hamburgher's Bay: anchored with the stream anchor, and sent the boat for water. About three in the afternoon, when the boat was sent on shore, it appeared to be high water, and ebbed about three feet. This makes high water full and change at half an hour past one, or with a S S W moon; which agrees exactly with Baffin's observation in 1613. The flood comes from the Southward. Went ashore with the astronomer, and instruments, to observe the variation. A thick fog came on before we had completed the observations. The

The ſhip driving, I weighed and ſtood out to ſea under an eaſy ſail, firing guns frequently to ſhew the Carcaſs where we were; and in leſs than two hours joined her. Soon after (about four in the morning of the 5th) the Rockingham Greenland Ship ran under our ſtern, and the maſter told me he had juſt ſpoke with ſome ſhips from which he learnt, that the ice was within ten leagues of Hacluyt's Head Land, to the North Weſt. In conſequence of this intelligence, I gave orders for ſteering in towards the Head Land; and if it ſhould clear up, to ſteer directly for it; intending to go North from thence, till ſome circumſtance ſhould oblige me to alter my courſe.

July.

5th. At five the officer informed me, that we were very near ſome iſlands off Dane's Gat, and that the pilot wiſhed to ſtand farther out; I ordered the ſhip to be kept N b W, and hauled farther in, when clear of the iſlands. At noon I ſteered North, ſeeing nothing of the land; ſoon after I was told that they ſaw the ice: I went upon deck, and perceived ſomething white upon the bow, and heard a noiſe like the ſurf upon the ſhore; I hauled down the ſtudding ſails, and hailed the Carcaſs to let them know that I ſhould ſtand for it to make what it was, having all hands upon deck ready to haul up at a moment's warning: I deſired that they would keep cloſe to us, the fog being ſo thick, and have every body up ready to follow our motions inſtantaneouſly, determining to ſtand on under ſuch ſail as ſhould enable us to keep

F 2 the

July. the ſhips under command, and not riſk parting company. Soon after two ſmall pieces of ice not above three feet ſquare paſſed us, which we ſuppoſed to have floated from the ſhore. It was not long before we ſaw ſomething on the bow, part black and part covered with ſnow, which from the appearance we took to be iſlands, and thought that we had not ſtood far enough out; I hauled up immediately to the N N W and was ſoon undeceived, finding it to be ice which we could not clear upon that tack; we tacked immediately, but the wind and ſea both ſetting directly upon it, we neared it very faſt, and were within little more than a cable's length of the ice, whilſt in ſtays. The wind blowing freſh, the ſhips would have been in danger on the lee ice, had not the officers and men been very alert in working the ſhip. The ice, as far as we could then ſee, lay nearly E b N and W b S. At half paſt ſeven in the evening, the ſhip running entirely to the Southward, and the weather clearing a little, I tacked, and ſtood for the ice. When I ſaw it, I bore down to make it plain; at ten the ice lay from N W to Eaſt, and no opening. Very foggy, and little wind, all day; but not cold. At eleven came on a thick fog. At half paſt midnight, heard the ſurge of the ice, and hauled the wind to the Eaſtward.

6th. Clear weather all day, and the wind Eaſterly off the ice. In the morning I ſtood in to make the land plain. At ſix, was within four miles of the ice, which bore

bore from E N E to W N W: at ten near Vogel Sang: at noon, latitude obſerved 79° 56′ 39″; wind Eaſterly. Continued plying to windward between the land and the ice: was within a quarter of a mile of the ice, which lay from E N E to N N W, when I tacked at two in the afternoon; and within half a cable's length at midnight: the Carcaſs was a great way aſtern and to leeward all day. Being ſo near the laſt rendezvous, I did not chuſe to bring to for her, but was very anxious to avail myſelf of this favourable opportunity, having the wind off the ice and clear weather, to ſee whether there was any opening to the N E of the Head Land. By all the accounts from the Greenlandmen this year, and particularly the laſt account from the Rockingham, as well as from what we had ſeen ourſelves, the ice appeared to be quite cloſe to the N W. We had ſeen it from E S E to W N W. It was probable that the ſea, if open any where, would be ſo to the Eaſtward, where the Greenlandmen do not often venture, for fear of being prevented from returning by the ice joining to Spitſbergen. I determined therefore, ſhould the wind continue in the ſame quarter next day, to find whether the ice joined to the land, or was ſo detached as to afford me an opportunity of paſſing to the Eaſtward. In caſe of the ice being faſt I could, with the wind Eaſterly, range cloſe along the edge of it to the Weſtward. The weather exceedingly fine. At ſix in the afternoon, the longitude by the watch was 9° 43′ 30″ E.

July.

7th.

July.

7th. At five in the morning the wind was Northerly, and the weather remarkably clear. Being near the ice I ranged along it. It appeared to be cloſe all round; but I was in hopes that ſome opening might be found to get through to a clear ſea to the Northward. I ran in amongſt the ſmall ice, and kept as cloſe as poſſible to the main body, not to miſs any opening. At noon, Cloven Cliff W ½ S ſeven leagues. At one in the afternoon, being ſtill amongſt the looſe ice, I ſent the boat to one of the large pieces to fill water. At four we ſhoaled the water very ſuddenly to fourteen fathom: the outer part of Cloven Cliff bore W ½ N: Redcliff, S ¾ E. The looſe ice being open to the E N E, we hauled up, and immediately deepened our water to twenty-eight fathom; muddy ground, with ſhells. At half paſt four, the ice ſetting very cloſe, we ran between two pieces, and having little wind were ſtopped. The Carcaſs being very near, and not anſwering her helm well, was almoſt on board of us. After getting clear of her, we ran to the Eaſtward. Finding the pieces increaſe in number and ſize, and having got to a part leſs crowded with the drift ice, I brought to, at ſix in the evening, to ſee whether we could diſcover the leaſt appearance of an opening: but it being my own opinion, as well as that of the pilots and officers, that we could go no farther, nor even remain there without danger of being beſet, I ſent the boat on board the Carcaſs for her pilots, to hear their opinion; they both

 declared

declared that it appeared to them impracticable to proceed that way, and that it was probable we ſhould ſoon be beſet where we were, and detained there. The ice ſet ſo faſt down, that before they got on board the Carcaſs we were faſt. Captain Lutwidge hoiſted our boat up, to prevent her being ſtove. We were obliged to heave the ſhip through for two hours, with ice anchors, from each quarter; nor were we quite out of the ice till midnight. This is about the place where moſt of the old diſcoverers were ſtopped. The people in both ſhips being much fatigued, and the Carcaſs not able to keep up with us, without carrying ſtudding-ſails, I ſhortened ſail as ſoon as we were quite out, and left orders to ſtand to the Northward under an eaſy ſail: I intended, having failed in this attempt, to range along the ice to the N W, in hopes of an opening that way, the wind being fair, and the weather clear; reſolving, if I found it all ſolid, to return to the Eaſtward, where probably it might by that time be broken up, which the very mild weather encouraged me to expect.

8th. Little wind in the morning, and a ſwell ſetting on the ice, we were obliged to get the boats a-head, to tow the ſhip clear; which they effected with difficulty. A breeze ſpringing up when we were within two cables lengths of the main body of the ice, ſtood in for the land, and tacked at two, to ſtand to the N W for the ice; but the weather coming thick between five and ſix, I ſtood

July.

ftood in again for the land. It clearing up foon after, I bore away again N W for the ice. At ten, fpoke with a Greenland Ship which had juft left the ice all clofe to the N N W. Between eleven and twelve the wind came to the S W, with an heavy fwell, and thick weather. Double-reefed the topfails, and tacked at twelve, to ftand in for Hacluyt's Head Land, not thinking it proper to run in with the faft ice to leeward in thick weather, without even the probability of an opening; and propofing if that weather continued, to complete the fhip's water, and be ready with the firft wind, off or along the ice, to look out for an opening, and run in. To avoid any inconvenience which from the experience of the preceding day I perceived might happen, from too many running to one place on any fudden order, I divided the people into gangs under the midfhipmen, and ftationed them to the ice hooks, poles, crabs, and to go over upon the ice when wanted.

9th. Having a fair opportunity, and S W wind, ftood to the Weftward; intending, when the weather was clear, to make the ice to the Northward, and run along it. About twelve, clearer; faw the faft ice to the Northward, and the appearance of loofe ice to the N W: ftood directly for it, and got amongft it between two and three; fteering as much to the Northward as the fituation of the ice would permit. At fix obferved the dip 81° 52′. At half paft feven, found the ice quite faft to the Weft, being in in longitude 2° 2′ E, by our reckoning, which was the fartheſt to the Weſtward of Spitſbergen that we got this voyage. At eight the fog was ſo very thick, that we could neither ſee which way to puſh for an opening, nor where the Carcaſs was, though very near us. That we might not riſk parting company with her, I was obliged to ply to windward under the topſails, tacking every quarter of an hour to keep in the opening in which we were, and clear of the ice which ſurrounded us. At four in the afternoon we were in 80° 36′. July.

10th. We loſt the Carcaſs twice in the night, from the very thick fog, and were working all night amongſt the ice, making very ſhort tacks; the opening being ſmall, and the floating ice very thick about the ſhip. The ſituation of the people from the very fatiguing work and wet weather, made the moſt minute precautions neceſſary for the preſervation of their health: we now found the advantage of the ſpirits which had been allowed for extraordinary occaſions; as well as the additional cloathing furniſhed by the Admiralty. Notwithſtanding every attention, ſeveral of the men were confined with colds, which affected them with pains in their bones; but, from the careful attendance given them, few continued in the ſick liſt above two days at a time. At nine in the morning, when it cleared a little, we ſaw the Carcaſs much to the Southward of us. I took the opportunity of the clear

July.

weather to run to the Weſtward, and found the ice quite ſolid there; I then ſtood through every opening to the Northward, but there alſo ſoon got to the edge of the ſolid ice. I was forced to haul up to weather a point which ran out from it. After I had weathered that, the ice cloſing faſt upon me, obliged me to ſet the foreſail, which, with the freſh wind and ſmooth water, gave the ſhip ſuch way as to force through it with a violent ſtroke. At one in the afternoon, immediately on getting out into the open ſea, we found a heavy ſwell ſetting to the Northward; though amongſt the ice, the minute before, the water had been as ſmooth as a mill pond. The wind blew ſtrong at SSW. The ice, as far as we could ſee from the maſt head, lay ENE: we ſteered that courſe cloſe to it, to look for an opening to the Northward. I now began to conceive that the ice was one compact impenetrable body, having run along it from Eaſt to Weſt above ten degrees. I purpoſed however to ſtand over to the Eaſtward, in order to aſcertain whether the body of ice joined to Spitſbergen. This the quantity of looſe ice had before rendered impracticable; but thinking the Weſterly winds might probably by this time have packed it all that way, I flattered myſelf with the hopes of meeting with no obſtruction till I ſhould come to where it joined the land; and in caſe of an opening, however ſmall, I was determined at all events to puſh through it. The weather clearer, and the land in ſight.

11th.

11th. At half paſt four in the morning the longitude by the lunar obſervation was 9° 42′ E. And at the ſame time by my watch 9° 2′ E. Cloven Cliff S S E, diſtant eight miles. This would make the longitude of Cloven Cliff 9° 38′ E; which is within twenty minutes of what it was determined by the obſervations and ſurvey taken in Fair Haven. At noon the latitude obſerved was 80° 4′; Vogel Sang W S W. Little wind and a great ſwell in the morning. Calm moſt part of the day. July.

12th. Calm all day, with a great ſwell from the S W, and the weather remarkably mild. At eight in the evening longitude by the watch 10° 54′ 30″ E: Cloven Cliff S W b S. The Carcaſs drove with the current ſo near the main body of the ice, as to be obliged to anchor; ſhe came to in twenty-ſix fathom water.

13th. Calm till noon, the ſhip driving to the Weſtward with the current, which we obſerved to be very irregular, the Carcaſs being driven at the ſame time to the Eaſtward. Near the main body of the ice, the detached pieces probably affect the currents, and occaſion the great irregularity which we remarked. We had found an heavy ſwell from the S W theſe two days. At two in the afternoon it came on very ſuddenly to blow freſh from that quarter, with foggy weather: we worked into Vogel

July.

Sang, and anchored with the beſt bower in eleven fathom, ſoft clay.

The place where we anchored is a good road-ſtead, open from the N E to the N W. The Northeaſternmoſt point is the Cloven Cliff, a bare rock ſo called from the top of it reſembling a cloven hoof, which appearance it has always worn, having been named by ſome of the firſt Dutch navigators who frequented theſe ſeas. This rock being entirely detached from the other mountains, and joined to the reſt of the iſland by a low narrow iſthmus, preſerves in all ſituations the ſame form; and being nearly perpendicular, it is never diſguiſed by ſnow. Theſe circumſtances render it one of the moſt remarkable points on the coaſt. The Northweſternmoſt land is an high bluff point, called by the Dutch, Vogel Sang. This ſound, though open to the Northward, is not liable to any inconvenience from that circumſtance, the main body of the ice lying ſo near as to prevent any great ſea; nor are ſhips in any danger from the looſe ice ſetting in, as this road communicates with ſeveral others formed by different iſlands, between all which there are ſafe paſſages. To all the ſounds and harbours formed by this knot of iſlands, the old Engliſh navigators had given the general name of Fair Haven; of which Fotherby took a *plat* in 1614: that in which the Racehorſe and Carcaſs lay at this time they called the North Harbour; the harbour of Smeerenberg, diſtant about eleven miles, (in which we anchored in Auguſt) they named the

the South Harbour. Befides thefe, there are feveral others; particularly two, called, Cook's Hole, and the Norways, in both which feveral Dutch fhips were lying at this time. Here the fhore being fteep-to, we completed our water with great eafe, from the ftreams which fall in many places down the fides of the rocks, and are produced by the melting of the fnow. I fixed upon a fmall flat ifland, or rock, about three miles from the fhip, and almoft in the center of thofe iflands which form the many good roads here, as the propereft place for erecting a tent, and making obfervations. The foggy weather on the 14th prevented us from ufing the inftruments that day. I regretted this circumftance much, fearing it would deprive me of the only probable opportunity of making obfervations on fhore in thofe high latitudes, as our water was nearly recruited: however, having little wind, with the weather very fair from the 15th to the 18th in the morning, I made the beft ufe of that time. Even in the cleareft weather here, the fky was never free from clouds, which prevented our feeing the moon during the whole of our ftay, or even being fure of our folar obfervations, Mr. Lyons never having been able to get equal altitudes for fettling the rates of going of the time-keepers. Once indeed we were fortunate enough to obferve a revolution of the fun, of which I availed myfelf to determine the going of the pendulum adjufted to vibrate feconds at London. During the courfe of this experiment, a particular and conftant attention was paid

to

July.

to the ſtate of the thermometer, which I was ſurpriſed to find differ ſo little about noon and midnight; its greateſt height was 58°½, at eleven in the forenoon; at midnight it was 51°.

On the 16th, at noon, the weather was remarkably fine and clear. The thermometer in the ſhade being at 49°, when expoſed to the ſun roſe in a few minutes to 89°½, and remained ſo for ſome time, till a ſmall breeze ſpringing up, made it fall 10° almoſt inſtantly. The weather at this time was rather hot; ſo that I imagine, if a thermometer was to be graduated according to the feelings of people in theſe latitudes, the point of temperature would be about the 44th degree of Fahrenheit's ſcale. From this iſland I took a ſurvey, to aſcertain the ſituation of all the points and openings, and the height of the moſt remarkable mountains: the longeſt baſe the iſland would afford was only 618 feet, which I determined by a croſs baſe, as well as actual meaſurement, and found the reſults not to differ above three feet. To try how far the accuracy of this ſurvey might be depended upon, I took in a boat, with a ſmall Hadley's ſextant, the angles between ſeven objects, which interſected exactly when laid down upon the plan. I had a farther proof of its accuracy ſome days after, by taking the bearings of Vogel Sang and Hacluyt's Head Land in one, which correſponded exactly with their poſition on my chart.

On

July.

On the 17th, the weather being very clear, I went up one of the hills, from which I could ſee ſeveral leagues to the N E: the ice appeared uniform and compact, as far as my view extended. During our ſtay here, we found the latitude of the iſland on which the obſervations were made, to be 79° 50′; longitude 10° 2′ 30″ E; variation 20° 38′ W; dip 82° 7′: latitude of Cloven Cliff 79° 53′; longitude 9° 59′ 30″ E: Hacluyt's Head Land 79° 47′; longitude 9° 11′ 30″ E. The tide roſe about four feet, and flowed at half an hour after one, full and change. The tide ſet irrregularly, from the number of iſlands between which it paſſed; but the flood appeared to come from the Southward.

18th. The calm weather ſince the 14th had given us full time to finiſh the obſervations, and complete our water: a breeze ſpringing up in the morning, I went aſhore to get the inſtruments on board. Between one and two we weighed, with the wind Weſterly, and ſtood to the Northward. Between eleven and twelve at night, having run about eight leagues, we were prevented by the ice from getting farther. We ſtood along the edge of it to the Southward. At two in the morning, being embayed by the ice, I tacked, and left orders to ſtand to the Eaſtward along the edge of the ice, as ſoon as we could weather the point; hoping, if there ſhould be no opening

 between

July.

between the land and the ice, that I ſhould at leaſt be able to aſcertain where they joined, and perhaps to diſcover from the land, whether there was any proſpect of a paſſage that way: At that time the ice was all ſolid as far as we could ſee, without the leaſt appearance of water to the Northward.

19th. At ſix in the morning we had got to the Eaſtward among the looſe ice which lay very thick in ſhore, the main body to the Northward and Eaſtward: the land near Deer Field not four miles off, and the water ſhoaled to twenty fathoms. Here we found ourſelves nearly in the ſame place where we had twice been ſtopped, the ice ſituated as before, locked with the land, without any paſſage either to the Eaſtward or Northward: I therefore ſtood back to the Weſtward. At noon the Northernmoſt part of Vogel Sang bore S W b S, diſtant about ſeven leagues. The weather being very fine, and the wind to the Eaſtward, we were enabled to coaſt along the ice to the Weſtward, hauling into all the bays, going round every point of ice in ſearch of an opening, and ſtanding cloſe along by the main body all day, generally within a ſhip's length.

20th. At half after three in the morning the land was out of ſight, and we imagined ourſelves in rather more than eighty degrees and an half; ſome of the openings being near

View of the Land from Cloven Cliff to Hakluits' Headland taken July 18.th at 10 P.M.

View of the Land round the Bay where the Racehorse anchored July 4.th at 6 P.M.

July.

near two leagues deep, had flattered us with hopes of getting to the Northward; but thefe openings proved to be no more than bays in the main body of the ice. About one in the afternoon, we were by our reckoning in about 80° 34′, nearly in the fame place where we had been on the 9th. About three we bore away for what appeared like an opening to the S W; we found the ice run far to the Southward.

21ft. We ftill continued to run along the edge of the ice, which trended to the Southward. At noon we were in the latitude of 79° 26′, by obfervation, which was twenty-five miles to the Southward of our reckoning. Finding that the direction of the ice led us to the Southward, and that the current fet the fame way, I ftood to the Northward and Weftward clofe along the ice, to try whether the fea was opened to the Northward by the wind from that quarter. At nine in the evening we had no ground with 200 fathom of line. At ten we got into a ftream of loofe ice. The weather fine, but cool all day, and fometimes foggy.

22d. At two in the morning we bore away to the N E, for the main body of the ice; the weather became foggy foon afterwards. At fix we faw the ice; and the weather being ftill foggy, we hauled up to the S S E, to avoid being embayed in it. The air very cold.

July.

23d. At midnight, tacked for the body of the ice. Latitude obferved 80° 13′ 38″ Rainy in the morning; fair in the afternoon: ftill working up to the Northward and Eaftward, with the wind Eafterly. At fix in the evening, the Cloven Cliff bearing South about fix leagues, founded in 200 fathom, muddy ground; the lead appeared to have funk one third of its length in the mud. At two in the morning, with little wind, and a fwell from the South Weft, I ftood to the Northward amongft the loofe ice: at half paft two the main body of the ice a cable's length off, and the loofe ice fo clofe that we wore fhip, not having room or way enough to tack; ftruck very hard againft the ice in getting the fhip round, and got upon one piece, which lifted her in the water for near a minute, before her weight broke it. The fhips had been fo well ftrengthened, that they received no damage from thefe ftrokes; and I could with the more confidence pufh through the loofe ice, to try for openings. Hacluyt's Head Land bore S 50° W diftant about feven leagues.

24th. By this fituation of the ice we were difappointed of getting directly to the Northward, without any profpect after fo many fruitlefs attempts of being able to fucceed to the Weftward; nor indeed, could I with an Eafterly wind and heavy fwell attempt it, as the wind from that quarter would not only pack the loofe ice clofe to the Weftward, but by fetting the fea on it, make it as improper to be approached

approached as a rocky lee ſhore. To the Eaſtward on the contrary it would make ſmooth water, and detach all the looſe ice from the edges; perhaps break a ſtream open, and give us a fair trial to the Northward; at all events, with an Eaſterly wind we could run out again, if we did not find it practicable to proceed. Finding the ice ſo faſt to the Northward and Weſtward, it became a deſirable object to aſcertain how far it was poſſible to get to the Eaſtward, and by that means purſue the voyage to the Northward. Theſe conſiderations determined me to ply to the Eaſtward, and make another puſh to get through where I had been three times repulſed. In working to the Eaſtward, we kept as near the body of the ice as poſſible. At noon the Cloven Cliff bore S W b S about ſeven leagues. At ſix we were working to the N E, and at nine we ſteered to the S E, the ice appearing more open that way: we had freſh gales and cloudy weather. The ſhip ſtruck very hard in endeavouring to force through the looſe ice. At midnight the wind freſhened, and we double reefed the topſails. It was probably owing to the freſh gales this day, as well as to the ſummer being more advanced, that we were enabled to get farther than in any of our former attempts this way. We continued coaſting the ice, and at two in the morning the north part of Vogel Sang and Hacluyt's Head Land in one bore S 65° W; Cloven Cliff S 52° W; the neareſt part of the ſhore about three leagues off. When I left the deck, at four in the morning, we were very near the ſpot where the ſhips had been faſt in the ice

July.

H 2 on

July.

on the 7th in the evening, but rather farther to the Eaftward; we had paffed over the fame fhoal water we had met with that day, and were now in twenty fathom, rocky ground; ftill amongft loofe ice, but not fo clofe as we had hitherto found it.

25th. At feven in the morning we had deepened our water to fifty-five fathom, and were ftill amongft the loofe ice. At noon we had deepened our water to feventy fathom, with muddy bottom, at the diftance of about three miles from the neareft land. By two in the afternoon we had paffed Deer Field, which we had fo often before attempted without fuccefs; and finding the fea open to the N E, had the moft flattering profpect of getting to the Northward. From this part, all the way to the Eaftward, the coaft wears a different face; the mountains, though high, are neither fo fteep or fharp-pointed, nor of fo black a colour as to the Weftward. It was probably owing to this remarkable difference in the appearance of the fhore, that the old navigators gave to places hereabouts the names of *Red Beach*, *Red Hill*, and *Red Cliff*. One of them, fpeaking of this part, has defcribed the whole country in a few words: "Here (fays "he) I faw a more natural earth and clay than any that I "have feen in all the country, but nothing growing "thereupon more than in other places." At two in the afternoon we had little wind, and were in fight of Moffen Ifland, which is very low and flat.

The

July.

The Carcaſs being becalmed very near the iſland in the evening, Captain Lutwidge took that opportunity of obtaining the following exact account of its extent, which he communicated to me.

" At 10 PM, the body of Moffen Iſland bearing " E b S diſtant two miles; ſounded thirteen fathoms; " rocky ground, with light brown mud, and broken ſhells. " Sent the maſter on ſhore, who found the iſland to be " nearly of a round form, about two miles in diameter, " with a lake or large pond of water in the middle, all " frozen over, except thirty or forty yards round the edge " of it, which was water, with looſe pieces of broken ice, " and ſo ſhallow they walked through it, and went over " upon the firm ſolid ice. The ground between the ſea " and the pond is from half a cable's length to a quarter " of a mile broad, and the whole iſland covered with " gravel and ſmall ſtones, without the leaſt verdure or " vegetation of any kind. They ſaw only one piece of " drift wood (about three fathom long, with a root on it, " and as thick as the Carcaſs's mizen maſt) which had " been thrown up over the high part of the land, and lay " upon the declivity towards the pond. They ſaw three " bears, and a number of wild ducks, geeſe, and other " ſea fowls, with birds neſts all over the iſland. There " was an inſcription over the grave of a Dutchman, who " was buried there in July 1771. It was low water at eleven " o'clock when the boat landed, and the tide appeared to " flow eight or nine feet; at that time we found a current

July.

"carrying the Ship to the N W from the iſland, which "before carried us to the S E (at the rate of a mile an "hour) towards it. On the Weſt ſide is a fine white "ſandy bottom, from two fathoms, at a ſhip's length "from the beach, to five fathoms, at half a mile's "diſtance off."

The ſoundings all about this iſland, and to the Eaſtward, ſeem to partake of the nature of the coaſt. To the Weſtward the rocks were high, and the ſhores bold and ſteep to; here the land ſhelved more, and the ſoundings were ſhoal, from thirty to ten fathom. It appears extraordinary that none of the old navigators, who are ſo accurate and minute in their deſcriptions of the coaſt, have taken any notice of this iſland, ſo remarkable and different from every thing they had ſeen on the Weſtern coaſt; unleſs we ſhould ſuppoſe that it did not then exiſt, and that the ſtreams from the great ocean up the Weſt ſide of Spitſbergen, and through the Waygat's Straits, meeting here, have raiſed this bank, and occaſioned the quantity of ice that generally blocks up the coaſt hereabouts.—At four in the afternoon, hoiſted out the boat, and tried the current, which ſet N E b E, at the rate of three quarters of a mile an hour. At midnight, Moffen Iſland bore from S E b S to S b W, diſtant about five miles.

26th. About two in the morning, we had little wind, with fog; made the ſignals to the Carcaſs for keeping

keeping company. At half an hour after three in the afternoon, we were in longitude 12° 20′ 45″ E; variation, by the mean of five azimuths, 12° 47′ W. At nine we ſaw land to the Eaſtward; ſteering to the Northward with little wind, and no ice in ſight, except what we had paſſed.

27th. Working ſtill to the NE, we met with ſome looſe ice; however from the openneſs of the ſea hitherto, ſince we had paſſed Deer Field, I had great hopes of getting far to the Northward; but about noon, being in the latitude of eighty and forty-eight, by our reckoning, we were ſtopped by the main body of the ice, which we found lying in a line, nearly Eaſt and Weſt, quite ſolid. Having tacked, I brought to, and ſounded cloſe to the edge of the ice, in 79 fathom, muddy bottom.

The wind being ſtill Eaſterly, I worked up cloſe to the edge of the ice, coaſting it all the way. At ſix in the evening we were in longitude 14° 59′ 30″ E, by obſervation.

28th. At midnight the latitude obſerved was 80° 37′. The main body of the ice ſtill lying in the ſame direction, we continued working to the Eaſtward, and found ſeveral openings to the Northward, of two or three miles deep; into every one of which we ran, forcing the ſhip, wherever we could, by a preſs of ſail, amongſt the looſe ice

July.

which we found here in much larger pieces than to the Weſtward. At ſix in the morning the variation, by the mean of ſix azimuths, was 11° 56′ W; the horizon remarkably clear. At noon, being cloſe to the main body of the ice, the latitude by obſervation was 80° 36′: we ſounded in 101 fathom, muddy ground. In the afternoon the wind blew freſh at N E, with a thick fog; the ice hung much about the rigging. The looſe ice being thick and cloſe, we found ourſelves ſo much engaged in it, as to be obliged to run back a conſiderable diſtance to the Weſtward and Southward, before we could extricate ourſelves: we afterwards had both the ſea and the weather clear, and worked up to the North Eaſtward. At half paſt five the longitude of the ſhip was 15° 16′ 45″ E. At ſeven the Eaſternmoſt land bore E ½ N diſtant about ſeven or eight leagues, appearing like deep bays and iſlands, probably thoſe called in the Dutch charts the *Seven Iſlands*; they ſeemed to be ſurrounded with ice. I ſtood to the Southward, in hopes of getting to the South-eaſtward round the ice, and between it and the land, where the water appeared more open.

29th. At midnight the latitude by obſervation was 80° 21′. At four, tacked cloſe to the ice, hauled up the foreſail and backed the mizen topſail, having too much way amongſt the looſe ice. At noon, latitude obſerved 80° 24′ 56″. An opening, which we ſuppoſed to be the

July.

the entrance of Waygat's Straits, bore South; the Northernmoſt land NEbE; the neareſt ſhore diſtant about four miles. In the afternoon the officer from the deck came down to tell me, we were very near a ſmall rock even with the water's edge; on going up, I ſaw it within little more than a ſhip's length on the lee bow, and put the helm down: before the ſhip got round, we were cloſe to it, and perceived it to be a very ſmall piece of ice, covered with gravel. In the evening, ſeeing the Northern part of the iſlands only over the ice, I was anxious to get round it, in hopes of finding an opening under the land. Being near a low flat iſland oppoſite the Waygat's Straits, not higher, but much larger than Moffen Iſland, we had an heavy ſwell from the Southward, with little wind, and from ten to twenty fathom: having got paſt this iſland, approaching to the high land to the Eaſtward, we deepened our water very ſuddenly to 117 fathom. Having little wind, and the weather very clear, two of the officers went with a boat in purſuit of ſome ſea-horſes, and afterwards to the low iſland. At midnight we found by obſervation the latitude 80° 27′ 3″, and the dip 82° 2′ ½. At four in the morning I found, by Bouguer's log, that the current ſet two fathom to the Eaſtward. At ſix in the morning the officers returned from the iſland; in their way back they had fired at, and wounded a ſea-horſe, which dived immediately, and brought up with it a number of others. They all joined in an attack upon the boat, wreſted an oar from one of the

July.

men, and were with difficulty prevented from ftaving or overfetting her; but a boat from the Carcafs joining ours, they difperfed. One of that fhip's boats had before been attacked in the fame manner off Moffen Ifland. From Dr. Irving, who went on this party, I had the following account of the low ifland.

" We found feveral large fir trees lying on the fhore, " fixteen or eighteen feet above the level of the fea: fome " of thefe trees were feventy feet long, and had been torn " up by the roots; others cut down by the axe, and " notched for twelve-feet lengths: this timber was no " ways decayed, or the ftrokes of the hatchet in the leaft " effaced. There were likewife fome pipe-ftaves, and wood " fafhioned for ufe. The beach was formed of old timber, " fand, and whale-bones.

" The ifland is about feven miles long, flat, and " formed chiefly of ftones from eighteen to thirty inches " over, many of them hexagons, and commodioufly " placed for walking on: the middle of the ifland is " covered with mofs, fcurvy grafs, forrel, and a few " ranunculufes then in flower. Two rein-deer were " feeding on the mofs; one we killed, and found it fat, " and of high flavour. We faw a light grey-coloured " fox; and a creature fomewhat larger than a weafel, " with fhort ears, long tail, and fkin fpotted white and " black. The ifland abounds with fmall fnipes, fimilar " to the jack-fnipe in England. The Ducks were now

July.

" hatching their eggs, and many wild geeſe feeding by " the water ſide."

When I left the deck at ſix in the morning, the weather was remarkably clear, and quite calm. To the N E, amongſt the iſlands, I ſaw much ice, but alſo much water between the pieces; which gave me hopes that when a breeze ſprung up, I ſhould be able to get to the Northward by that way.

30th. Little winds, and calm all day; we got ſomething to the Northward and Eaſtward. At noon we were by obſervation in latitude 80° 31′. At three in the afternoon we were in longitude 18° 48′ E, being amongſt the iſlands, and in the ice, with no appearance of an opening for the ſhip. Between eleven and twelve at night I ſent the maſter, Mr. Crane, in the four-oared boat, amongſt the ice, to try whether he could get the boat through, and find any opening for the ſhip which might give us a proſpect of getting farther; with directions if he could reach the ſhore to go up one of the mountains, in order to diſcover the ſtate of the ice to the Eaſtward and Northward. At five in the morning, the ice being all round us, we got out our ice-anchors, and moored along-ſide a field. The maſter returned between ſeven and eight, and with him Captain Lutwidge, who had joined him on ſhore. They had aſcended an high mountain, from whence they commanded a proſpect extending to the Eaſt and North Eaſt

July. ten or twelve leagues, over one continued plain of ſmooth unbroken ice, bounded only by the horizon: they alſo ſaw land ſtretching to the S E, laid down in the Dutch Charts as iſlands. The main body of ice, which we had traced from Weſt to Eaſt, they now perceived to join to theſe iſlands, and from them to what is called the North Eaſt land. In returning, the ice having cloſed much ſince they went, they were frequently forced to haul the boat over it to other openings. The weather exceedingly fine and mild, and unuſually clear. The ſcene was beautiful and picturesque; the two ſhips becalmed in a large bay, with three apparent openings between the iſlands which formed it, but every-where ſurrounded with ice as far as we could ſee, with ſome ſtreams of water; not a breath of air; the water perfectly ſmooth; the ice covered with ſnow, low, and even, except a few broken pieces near the edges: the pools of water in the middle of the pieces were frozen over with young ice.

31ſt. At nine in the morning, having a light breeze to the Eaſtward, we caſt off, and endeavoured to force through the ice. At noon the ice was ſo cloſe, that being unable to proceed, we moored again to a field. In the afternoon we filled our caſk with freſh water from the ice, which we found very pure and ſoft. The Carcaſs moved, and made faſt to the ſame field with us. The ice meaſured eight yards ten inches in thickneſs at one end, and ſeven

yards

Jn. Cleveley Jun. delin. May 4th 1774. Pouncy Sculp.

View of the RACEHORSE and CARCASS July 31st 1773.

yards eleven inches at the other. At four in the afternoon the variation was 12° 24′ W: at the same time the longitude 19° 0′ 15″ E; by which we found that we had hardly moved to the Eastward since the day before. Calm most part of the day; the weather very fine; the ice closed fast, and was all round the ships; no opening to be seen any where, except an hole of about a mile and a half, where the ships lay fast to the ice with ice-anchors. We completed the water. The ship's company were playing on the ice all day. The pilots being much farther than they had ever been, and the season advancing, seemed alarmed at being beset. July.

August 1st. The ice pressed in fast; there was not now the smallest opening; the two ships were within less than two lengths of each other, separated by ice, and neither having room to turn. The ice, which had been all flat the day before, and almost level with the water's edge, was now in many places forced higher than the main yard, by the pieces squeezing together. Our latitude this day at noon, by the double altitude, was 80° 37′. August.

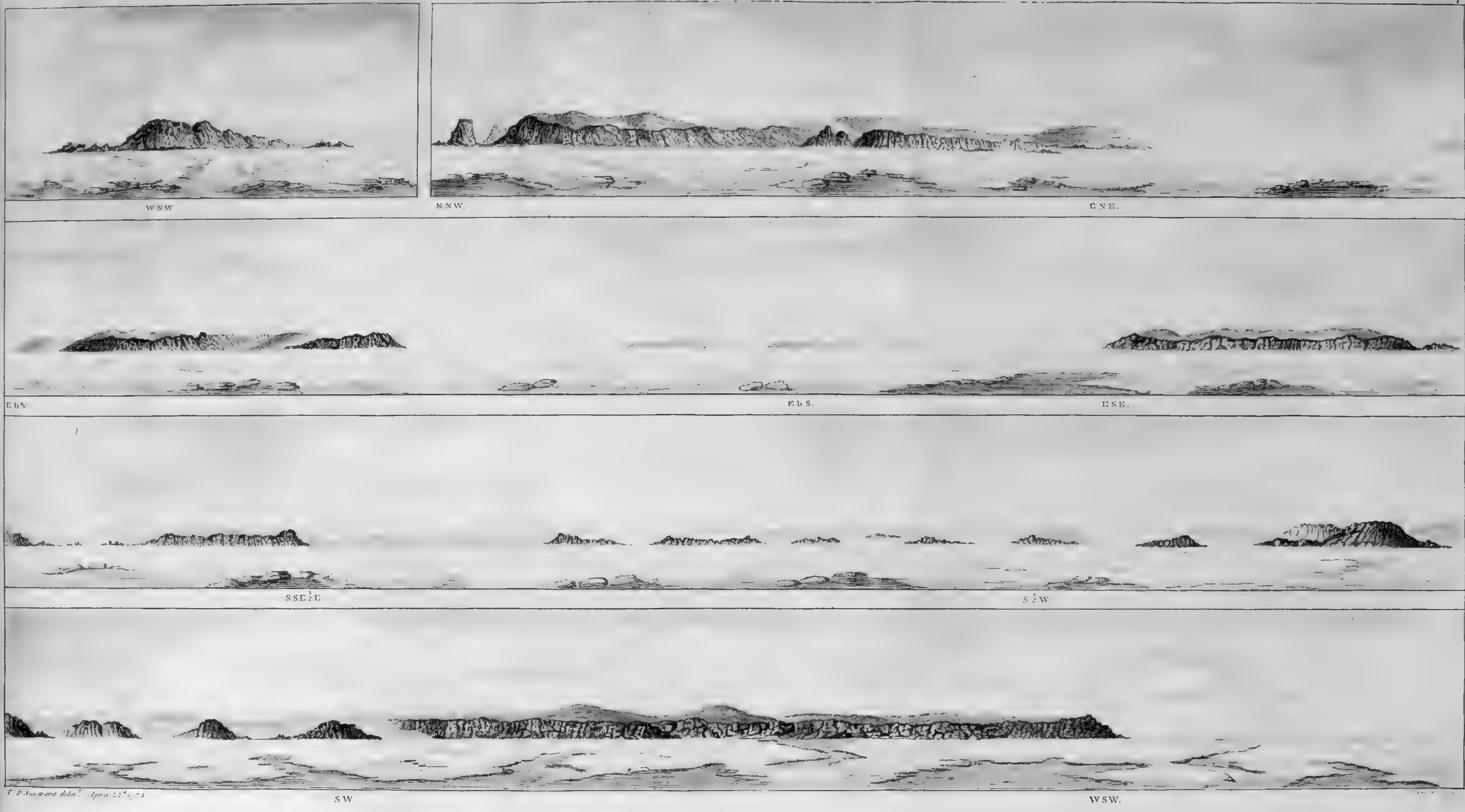
2d. Thick foggy wet weather, blowing fresh to the Westward; the ice immediately about the ships rather looser than the day before, but yet hourly setting in so fast upon us, that there seemed to be no probability of getting the ships out again, without a strong East, or North

August.

North Eaſt wind. There was not the ſmalleſt appearance of open water, except a little towards the Weſt point of the North Eaſt land. The ſeven iſlands and North Eaſt land, with the frozen ſea, formed almoſt a baſon, leaving but about four points opening for the ice to drift out, in caſe of a change of wind.

3d. The weather very fine, clear, and calm; we perceived that the ſhips had been driven far to the Eaſtward; the ice was much cloſer than before, and the paſſage by which we had come in from the Weſtward cloſed up, no open water being in ſight, either in that or any other quarter. The pilots having expreſſed a wiſh to get if poſſible farther out, the ſhips companies were ſet to work at five in the morning, to cut a paſſage through the ice, and warp through the ſmall openings to the Weſtward. We found the ice very deep, having ſawed ſometimes through pieces twelve feet thick. This labour was continued the whole day, but without any ſucceſs; our utmoſt efforts not having moved the ſhips above three hundred yards to the Weſtward through the ice, at the ſame time that they had been driven (together with the ice itſelf, to which they were faſt) far to the N E and Eaſtward, by the current; which had alſo forced the looſe ice from the Weſtward, between the iſlands, where it became packed, and as firm as the main body.

4th.



VIEWS of the *LAND* round the *SEVEN ISLANDS BAY* taken August the 6th at 10 P.M.

4th. Quite calm till evening, when we were flattered with a light air to the Eaſtward, which did not laſt long, and had no favourable effect. The wind was now at N W, with a very thick fog, the ſhip driving to the Eaſtward. The pilots ſeemed to apprehend that the ice extended very far to the Southward and Weſtward.

5th. The probability of getting the ſhips out appearing every hour leſs, and the ſeaſon being already far advanced, ſome ſpeedy reſolution became neceſſary as to the ſteps to be taken for the preſervation of the people. As the ſituation of the ſhips prevented us from ſeeing the ſtate of the ice to the Weſtward, by which our future proceedings muſt in a great meaſure be determined, I ſent Mr. Walden, one of the midſhipmen, with two pilots, to an iſland about twelve miles off, which I have diſtinguiſhed in the charts by the name of Walden's Iſland, to ſee where the open water lay.

6th. Mr. Walden and the pilots, who were ſent the day before to examine the ſtate of the ice from the iſland, returned this morning with an account, that the ice, though cloſe all about us, was open to the Weſtward, round the point by which we came in. They alſo told me, that when upon the iſland they had the wind very freſh to the Eaſtward, though where the ſhips lay it had been almoſt calm all day. This circumſtance conſiderably leſſened the

August. the hopes we had hitherto entertained of the immediate effect of an Easterly wind in clearing the bay. We had but one alternative; either patiently to wait the event of the weather upon the ships, in hopes of getting them out, or to betake ourselves to the boats. The ships had driven into shoal water, having but fourteen fathom. Should they, or the ice to which they were fast, take the ground, they must be inevitably lost, and probably overset. The hopes of getting the ships out was not hastily to be relinquished, nor obstinately adhered to, till all other means of retreat were cut off. Having no harbour to lodge them in, it would be impossible to winter them here, with any probability of their being again serviceable; our provisions would be very short for such an undertaking, were it otherwise feasible; and supposing, what appeared impossible, that we could get to the nearest rocks, and make some conveniences for wintering, being now in an unfrequented part, where ships never even attempt to come, we should have the same difficulties to encounter the next year, without the same resources; the remains of the ship's company, in all probability, not in health; no provisions; and the sea not so open, this year having certainly been uncommonly clear. Indeed it could not have been expected that more than a very small part should survive the hardships of such a winter with every advantage; much less in our present situation. On the other hand, the undertaking to move so large a body for so ſo conſiderable a diſtance by boats, was not without very ſerious difficulties. Should we remain much longer here, the bad weather muſt be expected to ſet in. The ſtay of the Dutchmen to the Northward is very doubtful: if the Northern harbours keep clear, they ſtay till the beginning of September; but when the looſe ice ſets in, they quit them immediately. I thought it proper to ſend for the officers of both ſhips, and informed them of my intention of preparing the boats for going away. I immediately hoiſted out the boats, and took every precaution in my power to make them ſecure and comfortable: the fitting would neceſſarily take up ſome days. The water ſhoaling, and the ſhips driving faſt towards the rocks to the N E, I ordered canvaſs bread-bags to be made, in caſe it ſhould be neceſſary very ſuddenly to betake ourſelves to the boats: I alſo ſent a man with a lead and line to the Northward, and another from the Carcaſs to the Eaſtward, to ſound wherever they found cracks in the ice, that we might have notice before either the ſhips, or the ice to which they were faſt, took the ground; as in that caſe, they muſt inſtantly have been cruſhed or overſet. The weather bad; moſt part of the day foggy, and rather cold. August.

7th. In the morning I ſet out with the Launch over the ice; ſhe hauled much eaſier than I could have expected; we got her about two miles. I then returned with the people for their dinner. Finding the ice rather

August. more open near the ſhips, I was encouraged to attempt moving them. The wind being Eaſterly, though but little of it, we ſet the ſails, and got the ſhips about a mile to the Weſtward. They moved indeed, but very ſlowly, and were not now by a great deal ſo far to the Weſtward as where they were beſet. However, I kept all the ſail upon them, to force through whenever the ice ſlacked the leaſt. The people behaved very well in hauling the boat; they ſeemed reconciled to the idea of quitting the ſhips, and to have the fulleſt confidence in their officers. The boats could not with the greateſt diligence be got to the water ſide before the fourteenth; if the ſituation of the ſhips did not alter by that time, I ſhould not be juſtified in ſtaying longer by them. In the mean time I reſolved to carry on both attempts together, moving the boats conſtantly, but without omitting any opportunity of getting the ſhips through.

8th. At half paſt four, ſent two pilots with three men to ſee the ſtate of the ice to the Weſtward, that I might judge of the probability of getting the ſhips out. At nine they returned, and reported the ice to be very heavy and cloſe, conſiſting chiefly of large fields. Between nine and ten this morning, I ſet out with the people, and got the Launch above three miles. The weather being foggy, and the people having worked hard, I thought it beſt to return on board between ſix and ſeven. The ſhips had in the mean time moved ſomething through the ice, and the

Jn.o Cleveley jun.r delin May 1st 1774

View of the RACEHORSE and CARCASS, August 7th 1773.

the ice itſelf had drifted ſtill more to the Weſtward. At night there was little wind, and a thick fog, ſo that I could not judge preciſely of the advantage we had gained; but I ſtill feared that, however flattering, it was not ſuch as to juſtify my giving up the idea of moving the boats, the ſeaſon advancing ſo faſt, the preſervation of the ſhips being ſo uncertain, and the ſituation of the people ſo critical. August.

9th. A thick fog in the morning: we moved the ſhip a little through ſome very ſmall openings. In the afternoon, upon its clearing up, we were agreeably ſurprized to find the ſhips had driven much more than we could have expected to the Weſtward. We worked hard all day, and got them ſomething more to the Weſtward through the ice; but nothing in compariſon to what the ice itſelf had drifted. We got paſt the Launches; I ſent a number of men for them, and got them on board. Between three and four in the morning the wind was Weſterly, and it ſnowed faſt. The people having been much fatigued, we were obliged to deſiſt from working for a few hours. The progreſs which the ſhips had made through the ice was, however, a very favourable event: the drift of the ice was an advantage that might be as ſuddenly loſt, as it had been unexpectedly gained, by a change in the current: we had experienced the inefficacy of an Eaſterly wind when far in the bay, and under the high land; but having now got through ſo much of the

 ice,

August. ice, we began again to conceive hopes that a briſk gale from that quarter would ſoon effectually clear us.

10th. The wind ſpringing up to the N N E in the morning, we ſet all the ſail we could upon the ſhip, and forced her through a great deal of very heavy ice: ſhe ſtruck often very hard, and with one ſtroke broke the ſhank of the beſt bower anchor. About noon we had got her through all the ice, and out to ſea. I ſtood to the N W to make the ice, and found the main body juſt where we left it. At three in the morning, with a good breeze Eaſterly, we were ſtanding to the Weſtward, between the land and the ice, both in ſight; the weather hazey.

11th. Came to an anchor in the harbour of Smeerenberg, to refreſh the people after their fatigues. We found here four of the Dutch ſhips, which we had left in the Norways when we ſailed from Vogel Sang, and upon which I had depended for carrying the people home in caſe we had been obliged to quit the ſhips. In this Sound there is good anchorage in thirteen fathom, ſandy bottom, not far from the ſhore: it is well ſheltered from all winds. The iſland cloſe to which we lay is called Amſterdam Iſland, the Weſternmoſt point of which is Hacluyt's Head Land: here the Dutch uſed formerly to boil their whale-oil, and the remains of ſome conveniencies erected by them for that purpoſe are ſtill viſible. Once they attempted to make an eſtabliſhment, and left ſome people

Jn.º Cleveley Jun.r del. May 4th 1774. P. C. Canot sculp.

The RACEHORSE and CARCASS forcing through the ICE, August 10th 1773.

to winter here, who all periſhed. The Dutch ſhips ſtill reſort to this place for the latter ſeaſon of the whale fiſhery.

August.

12th. Got the inſtruments on ſhore, and the tent pitched; but could not make any obſervations this day or the next, from the badneſs of the weather.

13th. Rain, and blowing hard: two of the Dutch ſhips ſailed for Holland.

14th. The weather being fine and little wind, we began our obſervations.

18th. Completed the obſervations. Calm all day. During our ſtay, I again ſet up the pendulum, but was not ſo fortunate as before, never having been able to get an obſervation of a revolution of the ſun, or even equal altitudes for the time. We had an opportunity of determining the refraction at midnight, which anſwered within a few ſeconds to the calculation in Dr. Bradley's table, allowing for the barometer and thermometer. Being within ſight of Cloven Cliff, I took a ſurvey of this part of Fair Haven, to connect it with the plan of the other part. Dr. Irving climbed up a mountain, to take its height with the barometer, which I determined at the ſame time geometrically with great care. By repeated obſervations here we found the latitude to be 79° 44′, which by the ſurvey correſponded

August. corresponded exactly with the latitude of Cloven Cliff, determined before; the longitude 9° 50′ 45″ E; dip 82° 8′ ¾; variation 18° 57′ W; which agrees also with the observation made on shore in July. The tide flowed here half past one, the same as in Vogel Sang harbour.

Opposite to the place where the instruments stood, was one of the most remarkable Icebergs in this country. Icebergs are large bodies of ice filling the vallies between the high mountains; the face towards the sea is nearly perpendicular, and of a very lively light green colour. That represented in the engraving, from a sketch taken by Mr. D'Auvergne upon the spot, was about three hundred feet high, with a cascade of water issuing out of it. The black mountains, white snow, and beautiful colour of the ice, make a very romantick and uncommon picture. Large pieces frequently break off from the Icebergs, and fall with great noise into the water: we observed one piece which had floated out into the bay, and grounded in twenty-four fathom; it was fifty feet high above the surface of the water, and of the same beautiful colour as the Iceberg.

A particular description of all the plants and animals will have a place in the Appendix. I shall here mention such general observations as my short stay enabled me to make. The stone we found was chiefly a kind of marble, which dissolved easily in the marine acid. We perceived no marks of minerals of any kind, nor the least appearance of present, or remains of former Volcanoes. Neither did we meet with insects, or any species of reptiles;

View of an Iceberg.

reptiles; not even the common earthworm. We ſaw no ſprings or rivers, the water, which we found in great plenty, being all produced by the melting of the ſnow from the mountains. During the whole time we were in theſe latitudes, there was no thunder or lightning. I muſt alſo add, that I never found what is mentioned by Marten (who is generally accurate in his obſervations, and faithful in his accounts) of the ſun at midnight reſembling in appearance the moon; I ſaw no difference in clear weather between the ſun at midnight and any other time, but what aroſe from a different degree of altitude; the brightneſs of the light appearing there, as well as elſewhere, to depend upon the obliquity of his rays. The ſky was in general loaded with hard white clouds; ſo that I do not remember to have ever ſeen the ſun and the horizon both free from them even in the cleareſt weather. We could always perceive when we were approaching the ice, long before we ſaw it, by a bright appearance near the horizon, which the pilots called the *blink of the ice.* Hudſon remarked, that the ſea where he met with ice was blue; but the green ſea was free from it. I was particularly attentive to obſerve this difference, but could never diſcern it. August.

The Driftwood in theſe ſeas has given riſe to various opinions and conjectures, both as to its nature and the place of its growth. All that which we ſaw (except the pipe-ſtaves taken notice of by Doctor Irving on the Low Iſland) was fir, and not worm-eaten. The place of its growth I had no opportunity of aſcertaining.

The

August.

The nature of the ice was a principal object of attention in this climate. We found always a great ſwell near the edge of it; but whenever we got within the looſe ice, the water was conſtantly ſmooth. The looſe fields and flaws, as well as the interior part of the fixed ice, were flat, and low: with the wind blowing on the ice, the looſe parts were always, to uſe the phraſe of the Greenlandmen, *packed*; the ice at the edges appearing rough, and piled up; this roughneſs and height I imagine to proceed from the ſmaller pieces being thrown up by the force of the ſea on the ſolid part. During the time that we were faſt amongſt the Seven Iſlands, we had frequent opportunities of obſerving the irreſiſtible force of the large bodies of floating ice. We have often ſeen a piece of ſeveral acres ſquare lifted up between two much larger pieces, and as it were becoming one with them; and afterwards this piece ſo formed acting in the ſame manner upon a ſecond and third; which would probably have continued to be the effect, till the whole bay had been ſo filled with ice that the different pieces could have had no motion, had not the ſtream taken an unexpected turn, and ſet the ice out of the bay.

19th. Weighed in the morning with the wind at N N E. Before we got out of the bay it fell calm. I obſerved for theſe three or four days, about eleven in the evening, an appearance of duſk.

20th.

P. D'Auvergne delin. _ May 4th 1774.

J. Cheevers Sculp.

20th. At midnight, being exactly in the latitude of Cloven Cliff, Mr. Harvey took an obſervation for the refraction; which we found to agree with the tables. The wind Southerly all day, blowing freſh in the afternoon. About noon fell in with a ſtream of looſe ice, and about four made the main ice near us. We ſtood to the W N W along it at night, and found it in the ſame ſituation as when we ſaw it before; the wind freſhened and the weather grew thick, ſo that we loſt ſight of it, and could not venture to ſtand nearer, the wind being S S W.

21ſt. At two in the morning we were cloſe in with the body of the Weſt ice, and obliged to tack for it; blowing freſh, with a very heavy ſea from the Southward. The wind abated in the afternoon, but the ſwell continued, with a thick fog.

22d. The wind ſprung up Northerly, with a thick fog; about noon moderate and clearer; but coming on to blow freſh again in the evening, with a great ſea, and thick fog, I was forced to haul more to the Eaſtward, leſt we ſhould be embayed, or run upon lee ice.

The ſeaſon was ſo very far advanced, and fogs as well as gales of wind ſo much to be expected, that nothing more could now have been done, had any thing been left untried. The ſummer appears to have been uncommonly

August. ſavourable for our purpoſe, and afforded us the fulleſt opportunity of aſcertaining repeatedly the ſituation of that wall of ice, extending for more than twenty degrees between the latitudes of eighty and eighty-one, without the ſmalleſt appearance of any opening.

I ſhould here conclude the account of the voyage, had not ſome obſervations and experiments occurred on the paſſage home.

In ſteering to the Southward we ſoon found the weather grow more mild, or rather to our feelings warm. Auguſt 24th, we ſaw Jupiter: the ſight of a ſtar was now become almoſt as extraordinary a phenomenon, as the ſun at midnight when we firſt got within the Arctic circle. The weather was very fine for ſome part of the voyage;

September. on the 4th of September, the water being perfectly ſmooth with a dead calm, I repeated with ſucceſs the attempt I had made to get ſoundings in the main ocean at great depths, and ſtruck ground in ſix hundred and eighty-three fathoms, with circumſtances (which will be mentioned in the Appendix) that convince me I was not miſtaken in the depth; the bottom was a fine ſoft blue clay. From the 7th of September, when we were off Shetland, till the 24th, when we made Orfordneſs, we had very hard gales of wind with little intermiſſion, which were conſtantly indicated ſeveral hours before they came on by the fall of the barometer, and riſe of the manometer: this

September.

proved to me the utility of thoſe inſtruments at ſea. In one of theſe gales, the hardeſt, I think, I ever was in, and with the greateſt ſea, we loſt three of our boats, and were obliged to heave two of our guns overboard, and bear away for ſome time, though near a lee ſhore, to clear the ſhip of water. I cannot omit this opportunity of repeating, that I had the greateſt reaſon on this, as well as every other critical occaſion, to be ſatisfied with the behaviour both of the officers and ſeamen. In one of theſe gales on the 12th of September, Dr. Irving tried the temperature of the ſea in that ſtate of agitation, and found it conſiderably warmer than that of the atmoſphere. This obſervation is the more intereſting, as it agrees with a paſſage in Plutarch's Natural Queſtions, not (I believe) before taken notice of, or confirmed by experiment, in which he remarks, "that the ſea becomes warmer "by being agitated in waves."

The frequent and very heavy gales at the latter end of the year, confirmed me in the opinion, that the time of our ſailing from England was the propereſt that could have been choſen. Theſe gales are as common in the Spring as in the Autumn: there is every reaſon to ſuppoſe therefore, that at an early ſeaſon we ſhould have met with the ſame bad weather in going out as we did on our return. The unavoidable neceſſity of carrying a quantity of additional ſtores and proviſions, rendered the ſhips ſo deep in the water, that in heavy gales the boats, with many of the ſtores, muſt probably have been thrown

 overboard;

September.

overboard; as we experienced on our way home, though the ſhips were then much lightened by the conſumption of proviſions, and expenditure of ſtores. Such accidents in the outſet muſt have defeated the voyage. At the time we ſailed, added to the fine weather, we had the further advantage of nearly reaching the latitude of eighty without ſeeing ice, which the Greenlandmen generally fall in with in the latitude of ſeventy-three or ſeventy-four. There was alſo moſt probability, if ever navigation ſhould be practicable to the Pole, of finding the ſea open to the Northward after the ſolſtice; the ſun having then exerted the full influence of his rays, though there was enough of the ſummer ſtill remaining for the purpoſe of exploring the ſeas to the Northward and Weſtward of Spitſbergen.

APPENDIX.

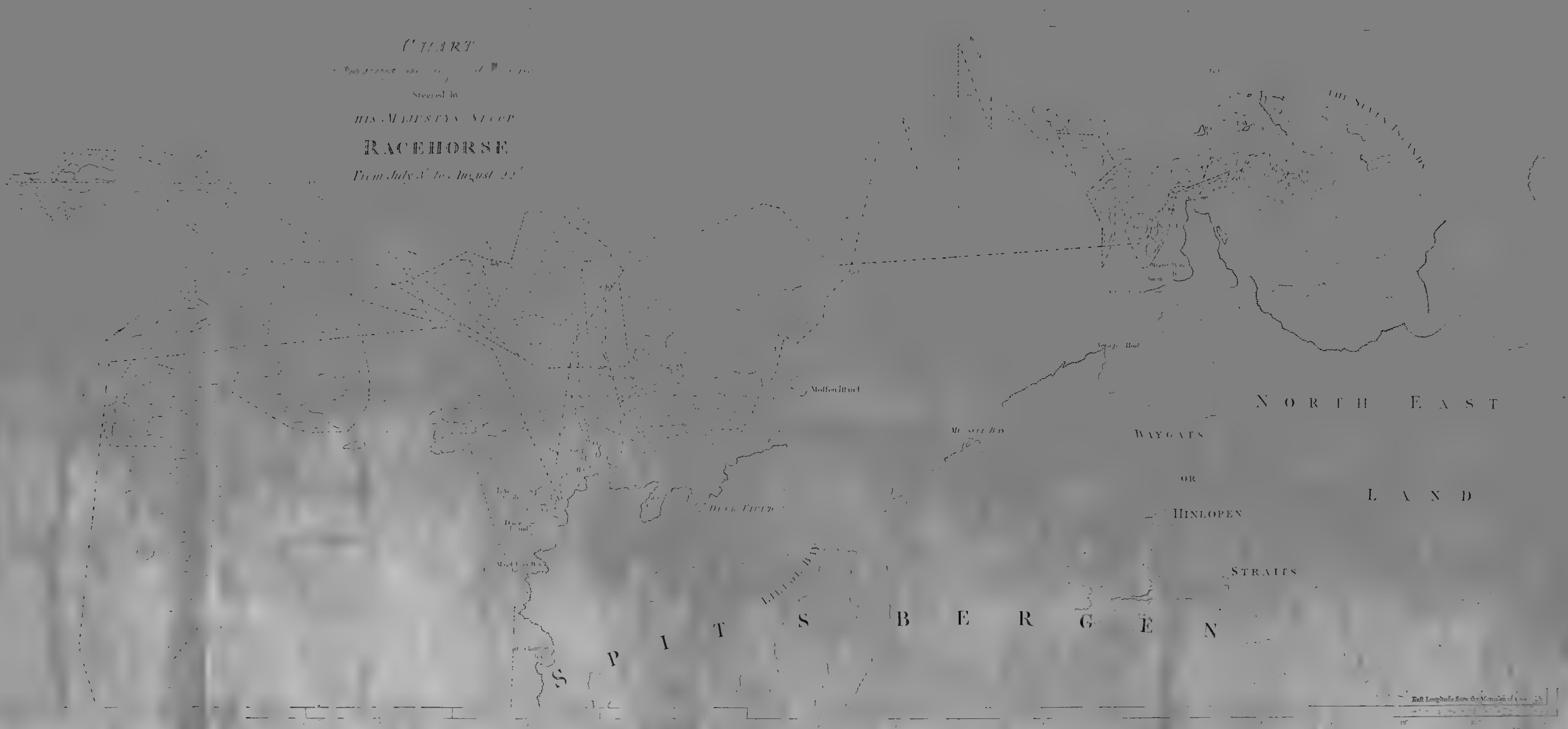


CHART
Steered by
HIS MAJESTYS SLOOP
RACEHORSE
From July 3d to August 22d
Moffen Island
NORTH EAST
LAND
WAYGATS
OR
HINLOPEN
STRAITS
SPITSBERGEN

Sep

APPENDIX.

Eſtabliſhment of Officers and Men for the Racehorse.

ONE Commander.
Three Lieutenants.
One Maſter.
One Boatſwain.
One Gunner.
One Carpenter.
One Purſer.
One Surgeon.
One Surgeon's Mate.
One Cook.
Three Maſter's Mates.
Six Midſhipmen.
One Captain's Clerk.
Two Quarter Maſters.
One Quarter Maſter's Mate.
Two Boatſwain's Mates.
One Coxſwain.
One Maſter Sail-maker.
One Sail-maker's Crew.
One Gunner's Mate.
One Yeoman of the Powder Room.
One Quarter Gunner.
One Armourer.

Two

Two Carpenter's Mates.
Two Carpenter's Crew.
One Steward.
One Corporal.
Fifty Seamen.
Two Pilots.
In all Ninety-two.

Comparative Table of the Latitudes and Longitudes of ſome remarkable Places.

Places.	By Sir Jonas Moore.		By the Atlas Maritimus.		By Robertſon's Navigation.		By Obſervations made this Voyage.	
	Latitude.	Longitude.	Latitude.	Longitude.	Latitude.	Longitude.	Latitude.	Longitude.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Queenborough,	51 30	0 37E	. .	. . .	. .	. . .	. .	. . .
Sheerneſs,	. .	0 37E	. .	. . .	. .	. . .	51 31	0 30E
Orfordneſs,	52 20	1 11E	52 14	1 36E	52 17	1 11E	. .	. . .
Southwold,	. .	. . .	. .	. . .	. .	. . .	. .	1 18E
Flamborough Head,	54 8	0 49W	54 9	0 10E	54 8	0 11E	54 9	0 19E
Whitby,	54 35	1 14W	54 28	0 22W	54 30	0 50W	. .	1 55W
Hangcliff,	. .	. . .	. .	. . .	. .	. . .	60 9	0 56W
Black Point,	78 32	13 10E	77 58	. . .	78 0	10 50E	78 13	10 33E
Hakluyt's Head Land,	. .	. . .	. .	. . .	79 55	12 0E	79 47	9 11E

TABLE

Table of Days Works.

Day of the Month.	Course.	Distance.	Latitude in	Longitude, By the Watch.	By Kendal.	By Arnold.	By Lunar Observations.	By the Reckoning.	Magnetic Observations. Dip.	Variation West.	Bearings and Distances.
			° ′	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′	° ′	° ′	
June 6	...	...	52 17 obs.	1 30 15E	1 59 0E	1 45 15E	...	...	73 22	...	Southwold, WNW ½ N, distance 3 leagues.
7	N 27° E	107	54 0 obs.	...	...	...	...	2 39 E	...	...	Southwold, S 27° W, distance 36 leagues.
8	S 54 W	70	53 39 obs.	0 37 0E	1 19 45	1 5 15	...	0 56	...	...	Southwold, S 10° 30′ E, distance 22 leagues.
9	NW	45	54 5 obs.	...	...	...	...	0 12	...	...	Southwold, S 22° 10′ E, distance 35 leagues.
10	NW	36	54 27	...	...	...	...	0 31 W	...	...	Southwold, S 27° 50′ E, distance 47 leagues.
11	...	...	...	1 55 30W	1 22 30	1 33 15	...	...	...	...	In Whitby Road.
12	N 15 E	123	56 28	...	...	...	...	1 0	...	...	Whitby, S 15° W, distance 41 leagues.
13	N by E	190	59 32 obs.	0 3 0W	0 36 15E	0 27 15E	1 39 15E	0 10 E	...	...	Whitby, S 12° 40′ W, distance 103 leagues.
14	N 29 W	48	60 17 obs.	0 56 45W	0 25 0W	0 17 0W	2 42 30E	0 40 W	73 30	21 53	Whitby, S 6° 10′ W, distance 122 Leagues. Hangcliff, S 59° W, 10 or 11 miles.
15	...	...	60 19 obs.	0 39 0W	0 10 15W	0 15 45W	0 26 0W	...	75 0	23 46	Hangcliff, S 55° W, distance 10 or 11 miles.
16	N 27 E	27	60 29 obs.	...	...	...	...	0 31	76 45	...	Hangcliff, S 27° W, distance 9 leagues.
17	N 6 E	147	62 59 obs.	0 19 45W	0 26 45E	0 22 15E	...	0 2 W	...	19 22	Hangcliff, S 9° 34′ W, distance 56 leagues.
18	N 4 W	141	65 18 obs.	1 0 30W	0 11 45W	0 15 15W	...	0 17	...	...	Hangcliff, S 3° 30′ W, distance 102 leagues.
19	N 4 W	54	66 14	1 7 0W	0 19 45W	0 31 30W	...	0 27	...	19 11	Hangcliff, S 2° 52′ W, distance 121 leagues.
20	N 30 E	59	67 5	...	...	...	...	0 46 E	...	...	Hangcliff, S 6° 14′ W, distance 138 leagues.
21	N 5 W	60	68 5 obs.	0 37 0W	0 20 0E	0 22 0E	...	0 32	...	23 18	Hangcliff, S 3° 44′ W, distance 157 leagues.
22	North	161	70 45	...	...	...	...	0 32	77 52	...	Hangcliff, S 28′ W, distance 211 leagues.
23	N 2 E	97	72 22	...	...	...	...	0 46	...	...	Hangcliff, S 28′ W, distance 243 leagues.
24	N 41 E	81	73 22	...	...	...	...	3 53	81 30	...	Hangcliff, S 7° 59′ W, distance 265 leagues.
25	N 68 E	116	74 5 obs.	8 14 0E	9 29 30	9 43 0	11 11 30E	9 44	79 30	17 9	Hangcliff, S 16° 9′ W, distance 289 leagues.
26	N 58 E	33	74 25 obs.	9 18 15	10 44 45	11 1 0	10 10 0	11 46	79 22	7 47	Hangcliff, S 18° 38′ W, distance 296 leagues.
27	N 21 W	51	75 21	...	...	...	...	9 43	...	...	Hangcliff, S 15° 17′ W, distance 314 leagues.
28	N 10 W	137	77 36	8 0 15	9 29 45	9 53 45	...	8 52	81 7	...	Hangcliff, S 11° 6′ W, distance 350 leagues.
29	N 26 E	28	77 59 obs.	9 1 0	10 35 30	11 4 30	...	9 48	80 26	...	Hangcliff, S 11° 24′ W, distance 360 leagues.
30	N 37 E	20	78 8 obs.	9 18 0	10 57 30	11 28 0	...	10 58	79 30	11 38	Black Point, ENE ¼ E, distance 9 miles.
July 1	N 7 W	11	78 13 obs.	...	...	...	...	10 53	...	...	Black Point, East, distance 18 miles.
2	N 31 W	15	78 23 obs.	9 35 30	11 57 15	10 17 30	...	10 15	...	...	Black Point, S 61° E, distance 27 miles.
3	North	12	78 36	...	...	...	...	10 15	80 45	14 55	Black Point, S 42° E, distance 11 leagues.
4	N 2 E	57	79 31 obs.	...	...	...	...	9 57	...	...	Magdalena Hook, N 25° E, distance 4 miles.
5	N 33 W	17	79 55	...	...	...	...	9 7	...	...	Magdalena Hook, S 33° E, distance 17 miles.
6	...	...	79 57 obs.	9 5 0	10 50 30	11 49 45	...	...	...	...	Vogel Sang Point, S 83° E, distance 5 leagues.
7	...	...	...	...	...	...	...	...	...	...	Cloven Cliff S 65° W, distance 5 leagues.
8	...	...	...	...	...	...	...	...	...	...	Cloven Cliff, S 26° W. Vogel Sang Point, S 48° W, distance 7 or 8 miles.
9	N 47 W	55	80 29 obs.	...	...	...	...	5 56	81 52	...	Vogel Sang Point, S 47° E, distance 55 miles.
10	West	35	80 29	...	...	...	...	2 21	...	...	Vogel Sang Point, S 63° 15′ E, distance 84 miles.
11	...	...	80 4 obs.	...	...	...	9 32 E	...	...	...	Vogel Sang Point, S 48° W, distance 9 miles.
12	...	...	...	10 54 30	13 13 15	14 18 15	...	...	...	...	Vogel Sang Point, S 25° W, distance 6 miles.

Table of Days Works.

Day of the Month.	Course.	Distance.	Latitude in	Longitude, By the Watch.	Longitude, By Kendal.	Longitude, By Arnold.	Longitude, By Lunar Observations.	Longitude, By the Reckoning.	Magnetic Observations. Dip.	Magnetic Observations. Variation West.	Bearings and Distances.
			° ′	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′	° ′	° ′	
July 13											
14											
15									81 52½		
16			79 53	10 2 30E	12 6 30E	13 55 0E			82 7	20 38	In Vogel Sang.
17											
18											
19											The North End of Vogel Sang, S 15° W, distance 8 leagues.
20	N 58 W	65	80 27					4 52 E			Cloven Cliff, S 58° E, distance 22 leagues.
21	S 10 E	64	79 27 obs.					4 29			Cloven Cliff, N 63° 18′ E, distance 21 leagues.
22	N 32 E	40	80 1					6 32			Cloven Cliff, S 82° 15′ E, distance 10 leagues.
23	N 57 E	43	80 24								Vogel Sang, S 4° W, distance 9 leagues.
24			80 16								Cloven Cliff, S 15° W, 7 leagues.
25											The Westernmost Land off Cloven Cliff, S 88° W.
26			80 17								Cloven Cliff, S 61° W, distance 40 miles.
27	N 23 E	34	80 48	14 50 30	15 45 0			14 42		12 47	Cloven Cliff, S 42° W, distance 23 leagues.
28	N 70 E	17	80 36 obs.	15 13 45	17 6 0			15 30		11 56	Cloven Cliff, S 58° 46′ W, distance 26 leagues.
29	S 58 E	21	80 25 obs.					18 18			Northernmost Land, N 44° E, distance 10 miles. The middle of the Opening, supposed the Waygat, S 12° E.
30			80 31 obs.	18 33 0	20 18 0				80 2½		The Westernmost of the Seven Islands, N 3° E. Table Island, N 14° E.
31				19 0 15	20 45 0						The Westernmost of the Seven Islands, N 60° W, distance 7 miles.
August 1			80 37 obs.							12 24	Black Point, S 75° W, Table Island, N 45° E, distance 7 miles.
2											Black Point, N 80° W, distance 4 leagues.
3											Black Point, S 50° W, Great Table Island, N 23° W.
4											Black Point, S 78° W, Great Table Island, N 19° W.
5											Great Table Island, N 27° W.
6											Black Point, S 61° W, Table Island, N 39° W.
7											Black Point, S 61° W, Table Island, N 46° W.
8											Table Island, N 35° W, Black Point, N 62° W.
9											A thick Fog.
10											The Westernmost of the Seven Islands, N 16° W. Black Point, S 32° E, distance 3 leagues.
11											Hakluyt's Head Land, S 31° W, distance 3 miles. The North End of Vogel Sang, N 67° E.
12											
13											
14											
15											
16			79 44	9 50 45	12 46 15				82 8¾	18 57	At Smeerenberg.
17											
18											
19											

Table

Table of Days Works.

Day of the Month.	Courfe.	Diftance.	Latitude in	Longitude, By the Watch.	By Kendal.	By Arnold.	By Lunar Obfervations.	By the Reckoning.	Magnetic Obfervations. Dip.	Variation Weft.	Bearings and Diftances.
			° '	° ' "	° ' "	° ' "	° ' "	° '	° '	° '	
Auguft 20	N 34° W	30	80 11					7 40E			Hakluyt's Head Land, S 34° E, diftance 10 leagues.
21	S 83 W	50	80 5					2 54			Hakluyt's Head Land, S 74° E, diftance 70 miles.
22	S 14 W	42	79 24					1 56			Hakluyt's Head Land, N 74° 27′ E, diftance 82 miles.
23	S 15 E	139	77 10					4 58			Hakluyt's Head Land, N 16° 20′ E, diftance 188 miles.
24	S 12 E	77	75 58 obf.					6 13			Hakluyt's Head Land, N 9° 34′ E, diftance 232 miles.
25	S 25 W	48	75 15 obf.					4 51			Hakluyt's Head Land, N 11° 30′ E, diftance 278 miles.
26	S 23 W	127	73 19					1 46			Hakluyt's Head Land, N 14° 30′ E, diftance 133 leagues.
27	S 28 W	57	72 29 obf.					0 14			Hakluyt's Head Land, N 15° 18′ E, diftance 151 leagues.
28	S 61 W	44	72 9					1 49W			Hakluyt's Head Land, N 19° 21′ E, diftance 162 leagues.
29	S 5 E	70	70 59					1 28			Hakluyt's Head Land, N 16° 24′ E, diftance 183 leagues.
30	S 41 E	54	70 17 obf.					0 18E			Hakluyt's Head Land, N 14° 15′ E, diftance 195 leagues.
31	South	96	68 47 obf.	3 24 0E	6 28 30E			0 18	79 4		Hakluyt's Head Land, N 11° 44′ E, diftance 225 leagues.
Sept. 1	S 64 W	7	68 44					0 2		24 17	Hakluyt's Head Land, N 12° 16′ E, diftance 227 leagues.
2	S 12 E	33	68 11 obf.					0 38			Hakluyt's Head Land, N 10° 57′ E, diftance 237 leagues.
3	S 5 W	133	65 59 obf.	2 41 30E	6 8 45E			0 8			Hakluyt's Head Land, N 10° 14′ E, diftance 280 leagues.
4	S 8 W	60	64 59 obf.					0 12W		22 14	Hakluyt's Head Land, N 12° 51′ E, diftance 303 leagues.
5	S 17 W	63	64 0					0 54		25 46	Hakluyt's Head Land, N 10° 38′ E, diftance 321 leagues.
6	S 5 W	92	62 29	0 58 30E	4 7 15E			1 12			Hakluyt's Head Land, N 10° 12′ E, diftance 351 leagues.
7	S 17 W	142	60 14 obf.					2 35			Hakluyt's Head Land, N 10° 39′ E, diftance 394 leagues.
8	S 59 E	51	59 48 obf.					1 9			Hakluyt's Head Land, N 9° 16′ E, diftance 403 leagues.
9	S 32 E	31	59 22 obf.					0 37			Hakluyt's Head Land, N 8° 43′ E, diftance 413 leagues.
10	S 43 E	96	58 9 obf.					1 40E			Hakluyt's Head Land, N 6° 25′ E, diftance 435 leagues.
11	S 7 W	33	57 37 obf.					1 32			Hakluyt's Head Land, N 5° 15′ E, diftance 446 leagues.
12	S 17 E	42	56 57 obf.					1 55			Hakluyt's Head Land, N 6° 3′ E, diftance 459 leagues.
13	S 14 W	55	56 4 obf.					1 31			Hakluyt's Head Land, N 6° 15′ E, diftance 477 leagues.
14	S 66 W	61	55 40 obf.					0 0			Hakluyt's Head Land, N 7° 27′ E, diftance 486 leagues.
15	S 14 E	69	54 33					0 29			Hakluyt's Head Land, N 6° 56 E, diftance 507 leagues.
16	S 21 W	83	53 15					0 1			Hakluyt's Head Land, N 7° 2′ E, diftance 535 leagues.
17	S 59 W	6	53 12					0 7W			Hakluyt's Head Land, N 7° 4′ E, diftance 537 leagues.
18	S 8 W	19	52 53 obf.					0 11			Hakluyt's Head Land, N 7° 6′ E, diftance 543 leagues.
19	S 37 W	14	52 42					0 29			Hakluyt's Head Land, N 7° 5′ E, diftance 546 leagues.
20	S 36 E	15	52 31 obf.					0 16		20 47	Hakluyt's Head Land, N 7° E, diftance 550 leagues.
21	S 24 E	16	52 17 obf.					0 5			Hakluyt's Head Land, N 7° E, diftance 555 leagues.
22	W by N	55	52 28 obf.					1 35			Hakluyt's Head Land, N 8° E, diftance 552 leagues.
23	S 50 E	39	52 4 obf.					0 49			Catwick, N 62° E, diftance 12 leagues.
24	N 80 W	63	52 16					2 33			Orfordnefs, SW by S, diftance 5 miles.
25				0 43 45E	3 24 25						In Hofely Bay, Orfordnefs Lighthoufe N 36° 30′ E. Hofely Church, S 82° W, diftance from the fhore, 1 mile.

Observations on different Methods of meaſuring a Ship's Way.

THE degree of accuracy with which the diſtance run by a ſhip can be meaſured, is a thing of great importance, but unfortunately not eaſily to be aſcertained, from the great variety of circumſtances which may occaſion errors in the reckoning, and which, though not depending upon the meaſure of the ſhip's way, may in voyages not nearly upon a meridian be confounded with thoſe that do. The circumſtances of the preſent voyage gave me the faireſt opportunity of trying this experiment, the weather being fine, and the courſe very nearly upon a meridian; ſo that an error of one point could not make more than the difference of one mile in fifty in the diſtance. When the difference of latitude is the ſame as the diſtance, it gives frequent opportunities of comparing the reckoning with the obſervation, and whatever error is found muſt be attributed to the imperfections in the manner of meaſuring the diſtance. Moſt of the writers on this ſubject have attributed the errors to a faulty diviſion of the log-line.

Before Norwood meaſured a degree, the length of a minute had been erroneouſly ſuppoſed 5000 feet; in confequence of which, the log line, from the firft ufe of that inftrument about the year 1570, was invariably marked forty-two feet to thirty feconds. Norwood, when he publifhed his Seaman's Practice, ftated the true meafure to be fifty-one feet to thirty feconds; but, as the fhip would really run more than is given by the log, and it is right to have the reckoning ahead of the fhip, he recommended marking the log line fifty feet to thirty feconds. It does not appear at what time an alteration either in the marking the log, or the length of the glafs, took place in confequence of thefe obfervations: Sir Jonas Moore in his Navigation which was publifhed in the reign of Charles II. mentions, that the feamen, having found the old log not to anfwer, had fhortened the glafs to twenty-five feconds, which was equal to a line marked fifty feet with a glafs of thirty feconds; but he rather recommends reftoring the half minute glafs, and making the correction on the line. Since that time the feamen, whether from finding the allowance of one foot in fifty not a fufficient compenfation for the accidental errors to which the log is fubject, or from a preference of a meafure nearly equal to the ftatute mile, have ufed a line of forty-five feet to thirty feconds, or a glafs of twenty-eight feconds to forty-two feet.

All the writers I have met with, who have treated of the log, except Wilfon, have complained of the feamen not having adhered to Norwood's meafure. Norwood himfelf, himſelf, however, ſeems to have been aware of the neceſſity of ſubmitting to the teſt of experiment the advantages of a new meaſurement derived from theory. In the preface to his *Seaman's Practice* he ſays, "Becauſe I "am perſuaded we have at this day as many excellent navi- "gators in this kingdom, and as great voyages performed, "as from any other place in the world, I ſhould be glad "to hear of the experimental reſolution of this problem by "ſome of them, though it were but running eight or ten "degrees near the meridian; for ſo I doubt not but what "I have here written thereof, would receive further con- "firmation and better entertainment than happily it will "now, being ſo much different from the common "opinion."

Had the errors in the diſtance ariſen only from a fault in marking the line, nothing would have been more eaſy than to have removed that difficulty, by comparing carefully the different meaſures with the obſervations, and adhering to that which had been found to correſpond beſt with them. But the diſtance meaſured by the log being rendered uncertain by many accidental circumſtances, it becomes difficult, or rather impoſſible, to find any length of line which will ſhew invariably the diſtance run by the ſhip, or even to aſcertain with preciſion that meaſure which will at all times come neareſt the truth. Some of theſe circumſtances are:

1. The effects of currents.

2. The yawing of the ſhip going with the wind aft, or upon the quarter, when ſhe is ſeldom ſteered within a point each way: this I mention as an error in the diſtance, and not in the courſe; ſince, though the ſhip by being yawed equally each way may make the intended courſe good upon the whole, yet the diſtance will be ſhortened as the verſed ſine of the angle between the line intended and that ſteered upon.

3. By the ſhip being driven on by the ſwell, or the log during the time of heaving being thrown up nearer the ſhip.

4. By the log *coming home*, or being drawn after the ſhip, by the friction of the reel and the lightneſs of the log. Norwood mentions theſe two laſt, and ſays, "For "theſe cauſes, it is like, there may ſometimes be allowed "three or four fathoms more than is veered out; but this, "(as a thing mutable and uncertain) being ſometimes "more, ſometimes leſs, cannot be brought to any certain "rule, but ſuch allowance may be made as a man in his "experience and diſcretion finds fit."

5. By the log being only a mean taken every hour, and conſequently liable to error from the variations in the force of the wind during the intervals, for which an arbitrary correction is made by the officer of the watch; and though men of ſkill and experience come near the truth, yet this allowance muſt, from its nature, be inaccurate.

These

Theſe circumſtances did not eſcape M. Bouguer's attention, and his ingenuity ſuggeſted to him an improvement of the common log, which would correct the errors likely to ariſe from the moſt material of theſe circumſtances: a deſcription of this improvement he publiſhed at large in the Memoirs of the Academy of Sciences for the year 1747; it has ſince been abridged in the edition of his Navigation by De la Caille. It appears extraordinary that this log ſhould never have been made uſe of by others;—the great reputation of the author, as well as the very good reaſons he offers in favour of his improvement, were ſufficient inducements to me to try the experiment.

In the log which I made uſe of,

The length of the cone was	—	12 inches.
The diameter of the baſe	—	$5\frac{1}{10}$.
The weight of the cone	—	25 ounces.
The diagonal length of the diver	—	14 inches.
The length of each ſide	—	$9\frac{3}{4}$.
The weight of the diver	—	$26\frac{1}{2}$ ounces.

The length of line from the diver to the cone, 50 feet; the log line 51 feet to a knot.

Whether M. Bouguer's log will (as he expected) correct the errors ariſing from currents in the common log, I had no opportunity of diſcovering in this voyage.

The ſecond error, which no log will correct, cannot be attended with any bad effect, as it muſt make the reckoning,

reckoning, in whatever degree it takes place, ahead of the ſhip.

By obſerving M. Bouguer's rules in comparing it with the common log, which for that purpoſe muſt be reckoned at fifty-one feet, it will, I think, very fully correct the third and fourth, which are the moſt material errors; as the agitation of the ſea from winds does not exceed the depth to which the diver is let down, and the weight of the whole machine prevents the friction of the reel from having an effect in any degree equal to that which it has on the common log.

The fifth ariſes from the imperfection it has in common with the log generally uſed.

At firſt, on the paſſage out, I contented myſelf with heaving Bouguer's log occaſionally, to obſerve what precautions were neceſſary to be taken to prevent errors, as well as to find whether its variations from the common log were on the ſame ſide as the meridian obſervation required. I found that it was neceſſary to take care that the diver ſhould be of ſuch a weight as to let only the top of the cone ſwim; but not heavy enough to ſink it, as in that caſe it would be liable to an error in exceſs, by meaſuring the depth that the diver would ſink in addition to the ſhip's way. It was neceſſary to put a weight of lead to the bottom of the diver, to ſink it down to its

palce

place before the ſtray line was out. The line between the diver and the cone ſhould not be more than fifty feet, that being as great a depth as it will ſink to whilſt the ſtray line is running off the reel when the ſhip has much way through the water.

On the paſſage out, the longeſt period of my trying this log between two obſervations, was from the twenty-fifth to the thirtieth; in which time the ſhip had run four degrees, and the reckoning by Bouguer's log was eighteen miles aſtern of the ſhip: but as it appears that the ſhip on the twenty-ſixth, with the wind Northerly, and making barely an Eaſt courſe, was found by the obſervation to be twenty miles to the Northward of her reckoning, that diſtance muſt be attributed to a current; therefore if that current had not taken place, Bouguer's log would have been, inſtead of eighteen miles aſtern, two miles ahead of the ſhip.

On the paſſage home it was tried from the latitude of eighty degrees eleven minutes to ſixty-eight degrees eleven minutes; in which diſtance, though the ſhip was much yawed from the ſea being frequently upon the quarter, this log was only thirty-one miles ahead of the ſhip, which might be owing entirely to that circumſtance without any other cauſe.

The ſtate of the common log on the paſſage out, when the weather was remarkably fine and water in general ſmooth, was, from the latitude of ſixty degrees thirty-ſeven minutes to ſeventy-eight degrees eight minutes, with the line marked fifty-one feet to thirty ſeconds, one degree fifty-eight minutes aſtern of the ſhip, with the line marked forty-five feet to thirty ſeconds, four miles ahead of the ſhip. On the paſſage home, the log at fifty-one feet to thirty ſeconds, thirty-five miles aſtern of the ſhip; at forty-five to thirty ſeconds, one degree ſeven minutes ahead of the ſhip. As far therefore as the experience of this voyage extends, it appears that the errors of the log marked forty-five feet are always on the ſafe ſide, and that thoſe of the longer marked line are always ſhort of the run; but that Bouguer's is much more accurate than either.

It is not to be expected that the obſervations of a ſingle voyage can be ſufficient to determine the merit of any inſtrument, particularly one of ſo much conſequence as the log. I thought it right, however, to give an account of the trial I made of the different methods, and of ſuch remarks as occurred to me.

In the following table the courſe is put down, in the firſt column, for all the diſtances and latitudes; after the diſtance and latitude, according to each marking of the log, there is a column for the difference between that latitude, and the latitude obſerved. I thought it beſt to continue the reckonings without corrections, as if there had been no obſervation, in order to ſhew the difference upon the whole run, as well as from one obſervation to another.

TABLE.

TABLE.

Day of the Month.	Course.	By the Common Log, marked 49 Feet.			By the Common Log, marked 45 Feet.			By the Common Log, marked 51 Feet.			By Bouguer's Log, marked 51 Feet.		Difference of the Distance by the Common and Bouguer's Log, each marked 51 Feet.	Bouguer's Log, increased by ¼ of the Difference of the Distance by the Common and Bouguer's Log.			Latitude by Observation.
		Distance.	Latitude by Account.	Difference between the Latitude by Account and Observation.	Distance.	Latitude by Account.	Difference between the Latitude by Account and Observation.	Distance.	Latitude by Account.	Difference between the Latitude by Account and Observation.	Distance.	Latitude by Account.		Distance.	Latitude by Account.	Difference between the Latitude by Account and Observation.	
On the Voyage Out.																	
	°		° ′	° ′		° ′	° ′		° ′	° ′							° ′
June 16	N 27 E	27	60 37	0 8	29	60 39	0 10	26	60 36	0 7	. . .	. . .	. . . .	. . .	. . .	. . . .	60 29
17	N 7 E	136	62 52	0 7	147	63 5	0 6	131	62 46	0 13	. . .	. . .	. . . .	. . .	. . .	. . . .	62 59
18	N 7 W	131	65 2	0 16	141	65 25	0 7	126	64 51	0 27	. . .	. . .	. . . .	. . .	. . .	. . . .	65 18
19	N 4 W	54	65 56	. . . .	58	66 23	. . . .	52	65 43	. . . .	. . .	. . .	. . . .	. . .	. . .	. . . .	. . . .
20	N 30 E	59	66 47	. . . .	63	67 17	. . . .	57	66 32	. . . .	. . .	. . .	. . . .	. . .	. . .	. . . .	. . . .
21	N 5 W	60	67 47	0 18	65	68 22	0 17	58	67 30	0 35	. . .	. . .	. . . .	. . .	. . .	. . . .	68 5
22	North	149	70 16	. . . .	161	71 2	. . . .	143	69 53	. . . .	. . .	. . .	. . . .	. . .	. . .	. . . .	. . . .
23	N 2 E	89	71 45	. . . .	97	72 40	. . . .	86	71 19	. . . .	. . .	. . .	. . . .	. . .	. . .	. . . .	. . . .
24	N 41 E	81	72 46	. . . .	88	73 46	. . . .	78	72 18	. . . .	. . .	. . .	. . . .	. . .	. . .	. . . .	. . . .
25	N 73 E	99	73 15	0 50	107	74 18	0 13	95	72 42	1 23	. . .	. . .	. . . .	. . .	. . .	. . . .	74 5
26	East	33	73 15	1 10	36	74 18	0 7	32	72 42	1 43	33½	74 5	1½	34	74 5	0 20	74 25
27	N 21 W	59	74 10	. . . .	64	75 18	. . . .	57	73 35	. . . .	64½	75 5	7½	66½	75 7	. . . .	. . . .
28	N 10 W	126	76 14	. . . .	137	77 33	. . . .	121	75 34	. . . .	126	77 9	5	127¼	77 12	. . . .	. . . .
29	N 26 E	28	76 39	1 20	30	77 59	0 0	27	75 58	2 1	27	77 34	0	27	77 36	0 23	77 59
30	N 52 E	20	76 51	1 17	22	78 12	0 4	19	76 10	1 58	21	77 47	2	21¼	77 50	0 18	78 8
On the Voyage Home.																	
August 20	N 34 W	30	80 12	. . . .	32	80 14	. . . .	29	80 11	. . . .	. . .	. . .	. . . .	. . .	. . .	. . . .	. . .
21	S 83 W	50	80 5	. . . .	54	80 8	. . . .	48	80 5	. . . .	50	80 5	2	50½	80 4½	. . . .	. . .
22	S 14 W	42	79 24	. . . .	45	79 24	. . . .	40	79 26	. . . .	41	79 25	1	41¼	79 24½	. . . .	. . .
23	S 15 E	139	77 10	. . . .	151	76 59	. . . .	133	77 18	. . . .	142	77 8	9	144¼	77 6	. . . .	. . .
24	S 12 E	77	75 55	0 3	83	75 38	0 20	74	76 6	0 8	78	75 52	4	79	75 49	0 9	75 58
25	S 25 W	48	75 12	0 3	52	74 51	0 24	46	75 24	0 9	50	75 7	4	51	75 3	0 12	75 15
26	S 23 W	127	73 19	. . . .	137	72 45	. . . .	122	73 32	. . . .	130	73 7	8	132	73 1½	. . . .	. . .
27	S 37 W	45	72 40	0 11	49	72 6	0 23	43	72 58	0 28	46	72 30	3	46¾	72 24	0 5	72 29
28	S 61 W	44	72 19	. . . .	48	71 43	. . . .	42	72 38	. . . .	45	72 9	3	45¾	72 2	. . . .	. . .
29	S 5 E	70	71 9	. . . .	76	70 38	. . . .	67	71 31	. . . .	77	70 52	10	79½	70 43	. . . .	. . .
30	S 41 E	54	70 29	0 12	59	69 43	0 34	52	70 52	0 35	55	70 11	3	55¾	70 1	0 16	70 17
31	South	86	69 3	. . . .	93	68 10	. . . .	83	69 29	. . . .	86	68 45	3	86¾	68 34	. . . .	. . .
September 1	S 64 W	7	69 0	. . . .	7	68 7	. . . .	7	69 27	. . . .	4	68 43	3	3¼	68 32	. . . .	. . .
2	S 12 E	45	68 14	0 3	49	67 19	0 52	43	68 44	0 33	51	67 53	8	53½	67 40	0 31	68 11
3	S 5 W	138	65 57	0 2	148	64 52	1 7	131	66 34	0 35	. . .	. . .	. . . .	. . .	. . .	. . . .	65 59

I alſo tried two perpetual logs; one invented by Mr. Ruſſell, the other by Foxon, both conſtructed upon this principle, that a Spiral, in proceeding its own length in the direction of its axis through a reſiſting medium, makes one revolution round the axis; if therefore the revolutions of the ſpiral are regiſtered, the number of times it has gone its own length through the water will be known. In both theſe the motion of the ſpiral in the water is communicated to the clock-work within board, by means of a ſmall line, faſtened at one end to the ſpiral, which tows it after the ſhip, and at the other to a ſpindle which ſets the clock-work in motion. That invented by Mr. Ruſſell has a half ſpiral of two threads, made of copper, and a ſmall dial with clock-work, to regiſter the number of turns of the ſpiral. Foxon's has a whole ſpiral of wood with one thread, and a larger piece of clock-work, with three dials, two of them to mark the diſtance, and the other divided into knots and fathoms, to ſhew the rate by the half minute glaſs, for the convenience of comparing it with the log.

This log, like all others, is liable to the firſt error, as well as to the ſecond. The third it partakes of in a very ſmall degree, only affecting the reckoning by that quantity which the ſpiral is thrown towards the ſhip; whereas in the log the ſame circumſtance affects the whole rate for the hour. The fourth it is entirely free from, as well as the fifth. It will have the advantage of every other in ſmooth water and moderate weather, when it is neceſſary to ſtand on one courſe for any particular diſtance, eſpecially in the night, or a fog, as it meaſures exactly the diſtance run. It will alſo be very uſeful in finding the trim of a ſhip when alone; as well as in ſurveying a coaſt in a ſingle ſhip, or in meaſuring diſtances in a boat between headlands or ſhoals, when a baſe is not otherwiſe to be obtained; both which it will do with the greateſt accuracy in ſmooth water, with a large wind, and no tide or current. But notwithſtanding theſe advantages, which will make it very uſeful and worth having, I doubt much whether it might ever be ſubſtituted entirely in the room of the common log. Machines eaſily repaired or replaced have advantages at ſea, which ſhould not lightly be given up for others more ſpecious.

Observations on the Use of the Megameter in Marine Surveying.

THE greateſt difficulty in marine ſurveying is that of obtaining an accurate baſe, from the extremities of which the angles may be taken with preciſion, for aſcertaining the bearings and diſtance of headlands and ſhoals, when either want of time or other circumſtances make it impracticable to land and meaſure a baſe. The uſual way is, to eſtimate the diſtance by the log, and to take the angles by the compaſs. This method is liable to many errors, and affords no means of correcting or diſcovering them. The Megameter, conſtructed upon the principles of the object-glaſs micrometer, deſcribed by M. de Charniere and applied by him to find the longitude at ſea, I thought might be uſefully applied to marine ſurveying. That which I uſed was made by Ramſden, with ſome improvements. The advantages I imagined might be derived from this inſtrument were, a more correct and expeditious manner of determining the poſition of coaſts, and the diſtance of ſhoals or the ſhip from headlands. This inſtrument being divided to ten ſeconds, an angle may be taken by it with great accuracy to five ſeconds. The height of a ſhip's maſt-head above the water being known, it is eaſy to find with this inſtrument, by a ſingle obſervation, the diſtance between two ſhips, and conſequently to determine a baſe. The angles being taken with an Hadley's quadrant from each of the ſhips, to the objects whoſe ſituations are deſigned to be aſcertained, the diſtance may be found; and, conſequently, their relative ſituations. If there is a megameter in each ſhip, the altitudes taken from both ſhips at one inſtant, and the angles of the different parts of the coaſt intended to be ſurveyed obſerved with an Hadley's quadrant at the ſame time, will give the ſituation with more accuracy and expedition than any method of ſurveying from ſhips hitherto practiſed; with the farther advantage of the certain means of detecting any error in the obſervation, ſo as to judge whether it is of ſufficient importance to be attended to. The only precautions neceſſary are; to make the obſervations at the ſame inſtant, to prevent their being affected by any alteration in the relative poſition of the ſhips, as a very ſmall one there would occaſion a conſiderable error in the diſtance; and to be careful in chuſing objects ſufficiently defined and remarkable. This method of ſurveying has the further advantage of giving the ſcale of a coaſt; Seamen, though they judge very accurately of their diſtance from places upon coaſts well known to them, are very often miſtaken when they fall in with land they have never ſeen before; of which we had, at firſt, ſome inſtances in this voyage, the height of the mountains, before we knew the ſcale of the coaſt, making us always think ourſelves nearer the land than we really were. Where the coaſt is at all high, the megameter affords a very accurate and expeditious method of determining the height of all the points, when their diſtances are found; and thence, the heights being known, of aſcertaining immediately by a ſingle obſervation the ſituation of the ſhip, or the latitude of any point by the bearings at the time of a meridian obſervation: the direction and rate of currents or tides may alſo be found in this manner with great accuracy. I made ſeveral obſervations during this voyage with the megameter, ſome of which I ſhall give as examples; they were ſufficient to prove to me the great accuracy that may be attained with this inſtrument after ſome practice. The utility of ſuch a method of obtaining a ſurvey on an enemy's or undeſcribed coaſt, as well as that of being able to prove the truth of charts by a ſingle obſervation, is obvious.

June the fifteenth, the ſhip being in latitude 60° 19′, longitude 0° 39′ W, Hangcliff bore S 63° 00′ W; variation, 23° W.

The altitude of the Carcaſs's maſt, by the megameter, was 35′ 48″; height of the maſt, 102,75 feet; hence the diſtance between the Racehorſe and Carcaſs was 9861 feet: angle between the Carcaſs and Hangcliff, 85° 48′; between the Racehorſe and Hangcliff, 87° 00′; From whence the difference of latitude was found 10′ S; difference of longitude 17′ W. Therefore, the latitude of Hangcliff is 60° 9′; longitude 0° 56′ W.

July

July the ſecond, to try how far the megameter could be depended upon, I obſerved the altitude of the Carcaſs's maſt 2° 23′ 48″; the angle between the main-yard and main-topſail yard, 0° 44′ 26″; hence the diſtance between the main-yard and main-topſail yard came out — — 31,750 feet.
By meaſurement it was found — 34,125 feet.

Difference 2,375 feet.

The diſtance between the two ſhips, deduced from the altitude of the maſt, was — 2457 feet.
By the angle of the main and main-topſail yard, the diſtance between them being 34,125 feet, 2640 feet.

Difference 183 feet.

Which is not more than the ſhips might have changed their poſition in the time of reading off and ſetting down the firſt obſervation before taking the ſecond.

An error of ten ſeconds in the obſervation of the angle ſubtended by the maſt at this diſtance, would make an error of two feet and three quarters in the diſtance. At the diſtance of a nautical mile it would produce an error of ſixteen feet. At other diſtances the error decreaſes as the ſquares of the diſtances decreaſe; and at other heights it decreaſes as the heights decreaſe.

Whenever

Whenever the diſtance of the object, whoſe angle is taken by the megameter, does not exceed that of the viſible horizon, the very ſmall portion of the earth's ſurface intercepted between the object and obſerver, may be conſidered as a plane, to which the object is perpendicular, and the diſtance may be concluded by reſolving the right-angled triangle, formed by the upright object, and lines drawn from the obſerver's ſtation to the top and bottom of it.

But in greater diſtances, the bottom of the object being concealed from the ſight of the obſerver, it becomes neceſſary to have recourſe to a different calculation.

The only caſes which can occur in practice are two; the one when the height is given to find the diſtance; the other when, the diſtance being known, the height of the object is to be deduced from the obſervation: both which are eaſily ſolved by the following practical rules.

To find the Diſtance.

To the apparent altitude of the object above the ſenſible horizon, add the complement of the dip anſwering to the height of the obſerver's eye above the ſea; the ſum is the angle BAE (fig. 1:); and ſay: As the ſemidiameter of the earth increaſed by the height of the object, is to the ſemidiameter increaſed by the height of the eye;

eye; ſo is the ſine of B A E, to another ſine, which is that of the angle B; the difference between 180°, and the ſum of the two angles B A E and B, is the value, in degrees and minutes, of the arc G C of the earth's ſurface intercepted between the eye and object. Multiply the number of minutes and decimal parts of a minute in this arc by the value of one minute in miles, fathoms, or ſuch meaſure as may be moſt convenient, and you will have the diſtance in the like meaſure.

EXAMPLE.

The height of Snow Peak being 1503 yards, its apparent altitude above the horizon of the ſea was obſerved to be — — — 1° 47′ 6″

The height of the eye being 16 feet, the complement of the dip is - - - 82° 56′ 11″

The ſum is E A B 91° 43′ 17″

To the ſemidiameter of the earth in yards	6966382	- - - - -	6966382
Add the height of the object	1503	Add the height of the eye	$5\frac{1}{3}$
Semidiam.+height of the object	6667885	Semidiam.+height of the eye	$6966387\frac{1}{3}$

As

As 6967885			Co. Ar.	3,1568990
To 6966387 $\frac{1}{3}$				6,8430076
So is Sine E A B	90°	43′	17″	9,9998040
To sine B	87	54	30	19,9997106
	179	37	47	
Subtracted from	180	0	0	
	0	22	13	the distance.

Therefore the distance is 22,22 minutes, or nautical miles.
This multiplied by - 2040 the number of yards in one minute,
The product 45328,8 is the distance in yards.

To find the Height.

To the apparent altitude of the object above the sensible horizon, add the complement of the dip answering to the height of the observer's eye above the sea, the sum is the angle B A E; to this add the horizontal distance of the eye and object in degrees and minutes, and subtract the sum from 180°, the remainder is the angle B: then say, as the sine of B is to the sine of B A E, so is the semidiameter of the earth increased by the height of the eye to a fourth number; from which subtracting the semidiameter of the earth, the remainder is the height of the object.

S EXAMPLE.

EXAMPLE.

	°	′	″
July the second, the apparent altitude of Snow Peak was obſerved to be, at the diſtance of 37507 yards or 18′ 30″,	2°	12′	20″
The height of the eye being $5\frac{1}{3}$ yards, the complement of the dip is - -	89	56	11
Hence the angle B A E	92	8	31
Horizontal diſtance		18	30
	92	27	1
Subtracted from	180		
Angle B	87	32	59

Semidiameter of the earth	6966382
Height of the eye	$5\frac{1}{3}$
Semidiameter + height of the eye	$6966387\frac{1}{3}$

As ſine B 87° 32′ 59″ Co. Ar.	0,0003972
To ſine B A E 92 8 31	9,9996965
So is ſemidiameter + height of the eye = $6966387\frac{1}{3}$ yards	6,8430076
To 6967888	16,8431013

Semidiameter	6966382
Height	1506 in yards.

DEMON-

DEMONSTRATION.

Let G F C (plate I. fig. 1.) repreſent the ſurface of the earth, E its center, B C the height of a hill or other object riſing perpendicular from C; A is the place of the obſerver's eye, whoſe height above the level of the ſea is A G. Draw A H perpendicular to A E, and A F touching the circle G F C in F. Then H A F is the dip, E A F its complement, D A B is the apparent altitude of the object above the ſenſible horizon; to this add E A D, the ſum is E A B. In the triangle E A B, the ſide E A is the ſum of the ſemidiameter E G and G A the height of the obſerver's eye; E B the ſum of the ſemidiameter E C and C B the height of the object; the angle A E B is meaſured by G C the horizontal diſtance between the obſerver and object. Now in the firſt caſe there are given in the triangle E A B, the ſides E A, E B, and the angle B A E, to find the angle A E B; and in the ſecond there are given the angles B A E, A E B and the ſide E A, to find the ſide E B and conſequently B C. The trigonometrical ſolutions of theſe caſes are the above practical rules.

Observations on the Variation.

THE Variation of the compaſs, always an intereſting object to navigators and philoſophers, became peculiarly ſo in this voyage from the near approach to the Pole. Many of the theories that had been propoſed on this ſubject, were to be brought to the teſt of obſervations made in high latitudes, by which alone their fallacy or utility could be diſcovered. They of courſe engaged much of my attention, and gave me the fulleſt opportunity of experiencing, with regret, the many imperfections of what is called the Azimuth compaſs. This inſtrument, though ſufficiently accurate to enable us to obſerve the variations ſo as to ſteer the ſhip without any material error, with the precaution of always uſing the ſame compaſs by which they are taken, is far from being of ſuch a conſtruction as to give the variation with that degree of preciſion, which ſhould attend experiments on which a theory is to be founded, or by which it is to be tried. The obſervations taken in this voyage will fully evince this, by their great variations from one another in very ſhort intervals of time; nor is this diſagreement of ſucceſſive obſervations peculiar to the higher latitudes, and to be imputed to a near approach to the Pole, as I found it to take place even upon the Engliſh coaſt.

As to the obſervations themſelves, they were taken with the greateſt care, and the moſt ſcrupulous attention

to

to remove every circumſtance which might be ſuppoſed to create an accidental error; the obſervations being taken ſometimes by different people with the ſame compaſs, in the ſame and different places; ſometimes with different compaſſes, changing the places and the obſervers repeatedly, to try whether there was any error to be imputed to local attraction, or the different mode of obſervation by different perſons. I have ſince my return tried the compaſſes by a meridian as well as by taking azimuths, and find them to agree with one another, though the ſame compaſs ſometimes differs from itſelf a degree in ſucceſſive obſervations.

That every perſon may (as far as is poſſible without having been preſent at the time) be enabled to judge of the degree of accuracy to be expected in ſuch obſervations, as well as the degree of attention paid to thoſe made by us, I have ſet down every circumſtance that I thought material, giving every part of each obſervation, with each ſeparate reſult, and the mean of every ſet, with the weather at the time. Whenever I mention its blowing freſh, it was only comparatively with reſpect to the reſt of the voyage, no obſervation having been made in any weather which might not generally ſpeaking be called fine.

Having ſaid ſo much of the inaccuracy of the inſtrument, I muſt add, that I think ſome general and rather curious inferences may ſafely be drawn from theſe obſervations. One is, that the variation near the latitude of eighty, if it alters at all with time, does not alter in any degree as it does in theſe latitudes: the variation having been found by Poole in 1610 to be 22° 30′ W in latitude 78° 37′; 18° 16′ W in Croſs Road in latitude 79° 15′ N; and 17° 00′ within the foreland in latitude 78° 24′. By Baffin in 1613, in Horne Sound, latitude 76° 55″, the variation from the meridian was 12° 14′ W; but by his compaſs 17°: his compaſs "was touched 5½ Eaſterly," that being the variation in London at that time: in Green Harbour, latitude 77° 40′, he obſerved the variation 13° 11′ W. Fotherby in 1614, made the variation in Magdalena Bay, latitude 79° 34′ N, 25° 00′ W; and in latitude 79° 8′, two points. Neither Poole nor Fotherby mention whether their variations are reckoned from the meridian, or whether their compaſſes, like Baffin's, were fitted to the variation at that time in London. If Fotherby's were taken with a compaſs in which a correction was made for the variation at London, his obſervation agrees exactly with thoſe made by me in Vogel Sang and Smeerenberg; and thoſe of Poole and Baffin differ ſo little from mine, that the difference need not be regarded. But the variation in London now differs from what it was at that time above twenty-ſix degrees.

The other inference is, that in going to the Eaſtward in the latitude of eighty, the Weſterly variation decreaſes very conſiderably from a difference in the longitude.

Table of the Obſervations of the Variation.

Day of the Month.	Latitude in	Longitude in	Altitude of the Sun's Lower Limb.	Sun's Magnetic Azimuth.	Sun's true Azimuth from the North.	Weſt Variation from each Obſervation.	Mean of the Obſervations.	Remarks.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
June 6th at 7 AM.	52 20		36 50 37 4 37 39 37 56 38 20	S 62 15 E 62 20 61 0 61 30 60 30	100 42 101 2 101 54 102 19 102 55	17 3 16 37 17 5 16 10 16 34	} 16 55 } 16 22	The Weather very fine, and the Water ſmooth.
14th at 7 AM.	60 20	1 7 W	31 44 32 2 32 16 32 36 33 15 33 35	S 59 30 E 58 45 57 30 57 30 56 50 56 35	98 44 99 17 99 44 100 22 101 36 102 16	21 46 21 58 22 46 22 8 21 34 21 9	21 53	The Weather very fine, and the Water ſmooth.
14th at 6 PM.	60 20	0 39 W	13 51 13 25 13 3	N 44 5 W 43 15 43 0	67 16 66 30 65 30	23 11 23 15 22 30	22 58	
15th at 7 AM.	60 20	0 39 W	29 48 30 29 31 50 31 56 32 19 32 34 32 52	N 117 50 E 120 30 122 30 122 52 123 10 124 15 125 40	95 6 96 20 98 50 99 2 99 45 100 14 100 48	22 44 24 10 23 40 23 50 23 25 24 1 24 52	} 23 31 } 24 2	
15th at 1 PM.	60 20	0 39 W				26 16		
17th at 8 AM.	62 30	0 4 W	32 8 32 50 33 16 33 45	N 120 30 E 122 15 123 10 124 10	101 20 102 48 103 44 104 46	19 10 19 27 19 26 19 24	19 22.	Some Sea.
19th at 6 PM.							19 11	Freſh Breezes, and ſome ſwell.

Table of the Observations of the Variation.

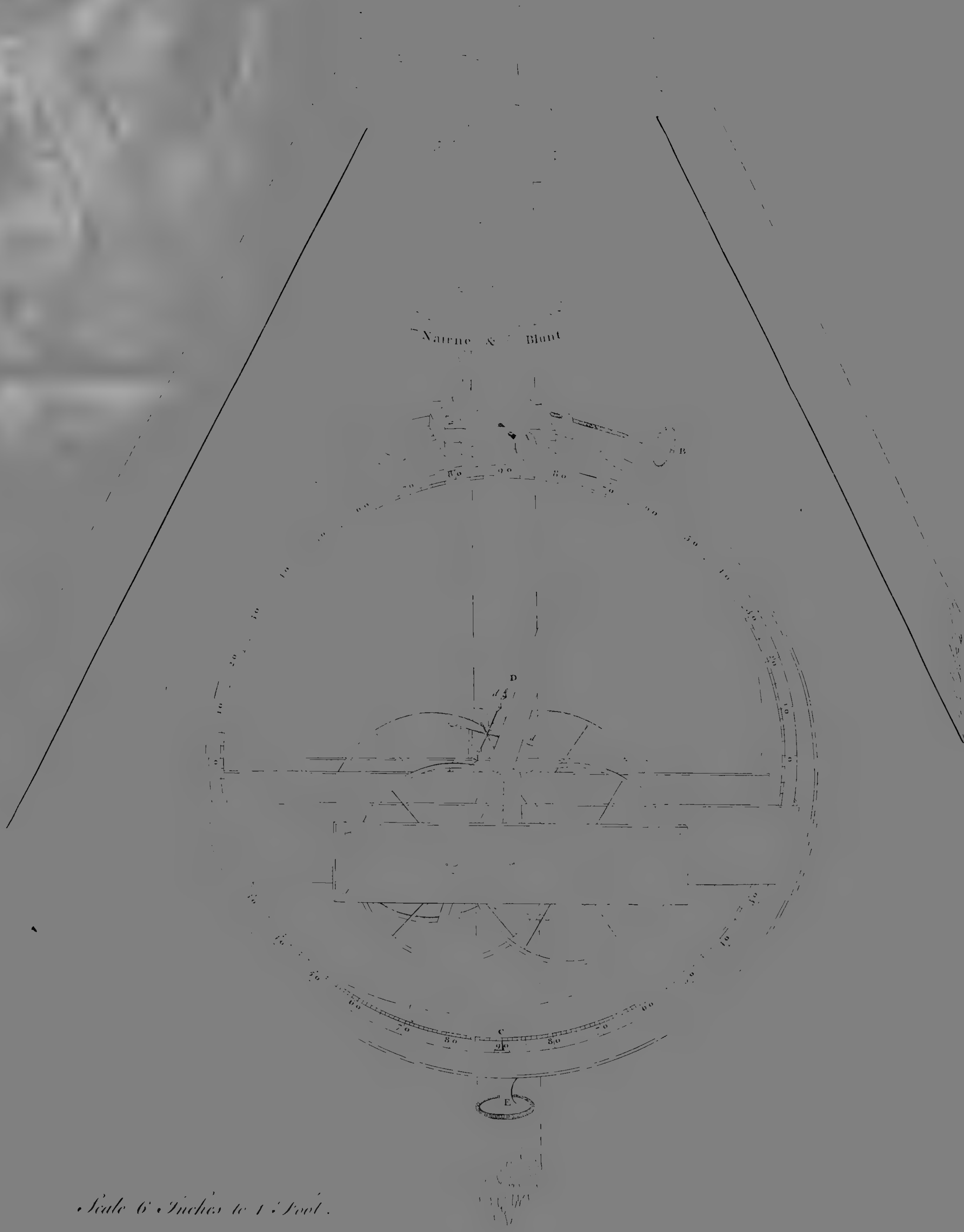
Day of the Month.	Latitude in.	Longitude in.	Altitude of the Sun's Lower Limb.	Sun's Magnetic Azimuth.	Sun's true Azimuth from the North.	West Variation from each Observation.	Mean of the Observations.	Remarks.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
June 21st at 6 AM.	68 12	0 37 W	17 20	N 95 30 E	70 20	25 10	23 18	Fresh Breezes, not much Sea.
			17 43	95 30	71 18	24 12		
			18 47	97 50	74 0	23 50		
			19 0	96 30	74 32	21 58		
			19 11	98 30	75 0	23 30		
			19 30	98 0	75 48	22 12		
			19 55	100 0	76 50	23 10		
			20 0	99 30	77 2	22 28		
25th at 7 AM.	73 55	7 15 E	28 12	E 34 30 S	103 36	20 54	17 9	Blowing fresh, a good deal of Sea.
			29 1	34 0	107 22	16 38		
			29 34	36 30	110 26	16 4		
			29 57	38 30	110 56	17 34		
			30 6	37 30	111 30	16 0		
			30 16	37 30	114 46	15 44		
25th at 3 PM.	74 10	8 36	19 36	N 65 30 W	73 46	8 16		Blowing fresh, with some Sea; but not enough, in my opinion, to have occasioned so great a difference.
			19 30	65 30	73 21	7 51	7 47	
			19 17	65 50	73 6	7 16		
			17 12	57 40	64 57	7 17		
			17 0	56 30	64 16	7 46		
			16 58	55 40	63 49	8 9	7 47	
			16 45	55 28	63 24	7 56		
27th at 7 AM.	74 20	9 43	25 40	E 24 30 S	95 25	19 5		
			25 26	22 30	96 24	16 6	17 15	
			26 2	23 20	96 45	16 35		
			26 16	25 30	97 36	17 54		
			26 35	25 30	98 52	16 38	16 50	
			26 55	26 0	100 2	15 58		
			27 8	29 30	100 50	18 40	17 22	
			27 36	28 40	102 36	16 4		
			28 35	35 35	106 20	19 15	19 0	
			28 50	36 5	107 20	18 45		

Table of the Obſervations of the Variation.

Day of the Month.	Latitude in.	Longitude in.	Altitude of the Sun's Lower Limb.	Sun's Magnetic Azimuth.	Sun's true Azimuth from the North.	Weſt Variation from the Obſervation.	Mean of the Obſervations.	Remarks.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
June 27th at 7 AM.	74 20	9 43 E	27 52	E 35 40 S	103 36	22 9	21 11	
			28 2	36 33	104 14	22 16		
			28 14	35 30	105 0	20 30		
			28 22	35 20	105 30	19 50		
27th at 7 AM.	74 20	9 43	30 1	E 46 0 S	112 2	23 58	23 8	
			30 17	47 20	113 7	24 19		
			30 41	46 1	114 47	21 13		
29th at 8 PM.	78 2	7 50	21 26	N 70 30 W	79 50	9 20	10 10	Light winds, the water ſmooth.
			21 9	67 30	78 31	11 1		
			21 0	68 30	77 48	9 11	9 34	
			20 50	67 40	77 0	9 20		
			20 42	66 20	76 24	10 4		
			17 13	47 5	59 2	11 57	12 36	
			17 10	45 45	58 46	13 1		
			17 5	45 30	58 20	12 50		
			16 58	44 15	57 42	13 27	12 57	
			16 55	44 35	57 26	12 51		
			16 51	44 30	57 4	12 54		
29th at 8 PM.	78 2	7 50	16 41	N 43 40 W	56 10	12 30	12 16	Light winds, the water ſmooth.
			16 38	43 30	56 52	12 22		
			16 30	43 0	55 8	12 8		
			16 29	43 0	55 4	12 4		
			16 24	41 42	54 35	13 13	12 16	
			16 20	41 0	54 12	13 12		
			16 14	41 15	53 38	12 23		
			16 4	40 30	52 42	12 12		
July 2d at 5 PM.	78 22	9 8	By the Mean of Three Obſervations.				14 55	Light winds, the water ſmooth.
	79 50	10 2	At the Iſland.				20 38	
26th at 4 PM.	80 18	12 12	22 37	S 84 0 W	109 14	13 14	12 47	Light airs, the water ſmooth.
			22 33	84 10	108 48	12 58		
			22 25	84 25	107 57	12 22		
			22 23	84 40	107 46	12 26		
			22 22	85 10	107 45	12 25		

Table of the Obſervations of the Variation.

Day of the Month.	Latitude in.	Longitude in.	Altitude of the Sun's Lower Limb.	Sun's Magnetic Azimuth.	Sun's true Azimuth from the North.	Weſt Variation from each Obſervation.	Mean of the Obſervations.	Remarks.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
June 28th at 6 AM.	80 30	15 14 E				11 28 12 54 11 24 11 24 11 56 12 30	11 56	Light Breezes, and the Water ſmooth.
July 31ſt at 4 PM.	80 35	19 0				12 24		The Weather very fine, and the Water quite ſtill.
	79 44	9 51	At Smeerenberg.			18 57		
Aug. 31ſt at 4 PM.	68 46	3 24	15 3	N 87 59 W	107 32	19 33		
31ſt at 6 PM.	68 47	3 24	4 35 4 31 4 10 4 2 3 51 3 44	N 53 45 W 53 30 53 35 53 15 53 30 52 30	79 49 78 37 77 41 77 19 76 51 76 30	25 4 25 7 24 6 24 4 23 21 24 0	24 17	Calm, and the Water very ſmooth.
Sept. 3d at 6 PM.	65 47	2 27	17 13 16 42 15 59 15 10 13 42 13 0	N 86 25 W 84 30 82 35 78 40 75 30 73 45	111 48 110 34 109 24 106 24 103 34 100 34	25 23 26 4 26 49 28 24 28 4 26 49	26 55	Light Breezes, not much ſwell.
4th at 8 AM.	65 4	2 21	18 33 19 2 19 27 19 56 20 45 21 45	S 43 30 E 41 0 40 30 39 15 37 45 33 30	114 56 116 12 117 14 118 32 120 40 123 38	21 31 22 48 22 16 22 13 21 35 23 2	22 14	Light Breezes, and the Water very ſmooth.
5th	63 45	2 16	Moon's true Amplitude		25 16	25 46		Freſh Breezes, and ſome Sea.
20th	52 57	1 30	. . . . . .	. . . . . .	. . . . . .	20 38 20 56	20 47	



Scale 6 Inches to 1 Foot.

Ph. Dumesme delin.

Basire

Account of the Observations made with the Marine Dipping Needle, conſtructed for the Board of Longitude by Mr. Nairne, from whom I received the following deſcription of the inſtrument.

"THE figure (plate 9.) is a repreſentation of the "inſtrument, hanging by an univerſal joint on a "triangular ſtand. It is adjuſted ſo as to hang in a plane "perpendicular to the horizon, by means of a plumb line, "which is to be ſuſpended on a pin above the divided "circle, and the dovetail work, which alters the poſition "of the inſtrument, by turning the button A. The two "90° on the divided circle, are adjuſted ſo as to be per- "pendicular to the horizon, by the ſame plumb line and "the adjuſting ſcrew B: and at the loweſt 90°, when "it is adjuſted, the pointer C is fixed. The length of the "magnetic needle is twelve inches, and its axis (the ends "of which were of gold alloyed with copper) reſted on "friction wheels of four inches diameter, each end on two "friction wheels; which wheels were balanced with great "care. The ends of the *axes* of the friction wheels were "likewiſe of gold alloyed with copper, and moved in ſmall "holes made in bell metal; and oppoſite the ends of the "*axes* of the needle and the friction wheels, were flat "agates finely poliſhed. The magnetic needle vibrated

" within a circle of bell metal, divided from the lower 90° " each way, as far as ſixty-five degrees, into degrees and " half-degree s: the other diviſions were two degrees and a " half; the needle being very nearly balanced before it was " made magnetical: but by means of the croſs D, fixed " on the axis of the needle (on the arms of which were cut " very fine ſcrews, to receive the ſmall buttons *d d*, that " might be ſcrewed nearer or farther from the axis) the " needle could be adjuſted both ways to a great nicety, " after it was made magnetical, by changing the ſides of " the needle, and reverſing the Poles. As this needle at " ſea could ſeldom remain at reſt; to remedy in a great " meaſure this inconvenience, the divided circle is made " moveable by turning the button E; ſo that when it is " uſed at ſea, the divided circle is moved till ſome prin- " cipal diviſion is the mean of the vibrations: then that " number of degrees and half-degrees diſtant from the " pointer, ſubtracted from ninety, gives the dip, if the " needle is properly balanced: but leſt it ſhould be ſome- " what out of balance, the moſt certain way is, firſt, to " take the dip with the face of the divided circle to the Eaſt, " and afterwards to the Weſt, and then changing the ends " of the needle by reverſing the Poles, and taking the dip " as before, with the divided circle fronting the Eaſt and " Weſt: and the mean of thoſe four dips will be the moſt " accurate. In each caſe, when the dip is taken, the in- " ſtrument muſt be ſo placed that the needle vibrates in " the magnetic meridian."

The obſervations on the dip of the needle, during this voyage, were made with great care: firſt the dip was obſerved with the divided arch to the Eaſt, the inſtrument being placed as near as poſſible in the magnetic meridian; it was then turned, and the obſervation made with the divided arch to the Weſt: the poles being changed, the obſervation was repeated in the ſame manner. The actual obſervations are expreſſed in the ſecond, third, fourth, and fifth columns; and the mean reſult in the ſixth. It appears by theſe obſervations that the dip increaſes in going North.

There is no reaſon at preſent to ſuppoſe that the dip is liable to any variation in the ſame place at different periods of time, it having been obſerved in London by Norman, who firſt diſcovered it in 1592, to be 71° 50′; and by Mr. Nairne, in 1772, about 72°. The difference between theſe obſervations, taken at ſuch diſtant periods, is ſmaller than that found between ſeveral of Mr. Nairne's obſervations compared with each other; and therefore we have no reaſon to conclude that the dip has altered ſince Norman's time: the care with which his inſtrument was conſtructed, and his obſervations made, leaves no room to doubt of their accuracy.

TABLE of the OBSERVATIONS made with the Marine DIPPING-NEEDLE.

Day of the Month.	West.		East.		West.		East.		Mean Dip.		Place of Observation.
	°	′	°	′	°	′	°	′	°	′	° ′
June 2 P. M.	73	0	73	15	73	20	74	30	73	31	Latitude 51 35 near the Buoy of the Upper Middle.
2 P. M.	74	30	73	0	73	20	73	30	73	35	
5 P. M.	70	20	73	0	73	15	72	15	72	12	Off Harwich.
6 P. M.	72	0	75	0	72	0	74	30	73	22	In Southwold Bay.
14 P. M.	72	30	73	30	74	0	74	0	73	30	Off Shetland.
8 P. M.	75	15	75	30	74	0	76	30	75	18	
15, 8 A. M.	74	30	74	30	75	0	75	30	74	52	Latitude 60° 18′
P. M.	74	30	75	30	75	0	75	0	75	0	
16 P. M.	77	0	76	30	76	30	77	0	76	45	
22 Noon	78	0	77	30	78	0	78	0	77	52	Latitude 70 45
23, 9 P. M.	81	30	80	0	83	0	81	30	81	30	Latitude 72 40
24 Noon	82	30	79	30	81	30	79	0	80	35	Latitude 73 22
P. M.	77	30	77	30	81	0	82	0	79	30	Latitude 73 36
26, 2 P. M.	77	30	80	0	82	0	78	0	79	22	Latitude 74 30
28 Mid.	83	30	80	0	82	0	79	0	81	7	Latitude 77 48
29, 2 P. M.	79	15	81	0	78	30	83	0	80	26	Latitude 78 2
30 Noon	76	45	79	30	82	30	79	45	79	30	Latitude 78 8
July 2, Mid.	80	30	82	30	80	30	79	30	80	45	Latitude 78 24
9, 6 P. M.	82	45	81	45	83	0	80	0	81	52	Latitude 80 12
15	81	45	81	15	82	0	82	30	81	52½	On Shore. Latitude 79 50
	82	45	81	15	82	50	81	10	82	7½	
29 Mid.	83	15	83	0	80	40	81	15	82	2½	Latitude 80 27
August 14	83	0	83	0	81	15	81	20	82	8¾	At Smeerenberg. Latitude 79° 44′ on shore.
31 P. M.	79	30	77	45	80	0	79	0	79	4	Latitude 69° 2′

ACCOUNT

Account of the Instruments made uſe of for keeping the Meteorological Journal.

THE Marine Barometer was made by Mr. Nairne, from whom I received the following deſcription:

"The bore of the upper part of the glaſs tube of this barometer, is about three-tenths of an inch in diameter, and four inches long. To this is joined a glaſs tube, with a bore about one-twentieth of an inch in diameter. The two glaſs tubes being joined together, form the tube of this barometer; and being filled with mercury, and inverted into a ciſtern of the ſame, the mercury falls down in the tube till it is counterbalanced by the atmoſphere.

"In a common barometer, the motion of the mercury up and down in the tube is ſo great at ſea, that it is not poſſible to meaſure its perpendicular height; conſequently, cannot ſhew any alteration in the weight of the atmoſphere: but in this marine barometer, that defect is remedied. The inſtrument is fixed in gimmals, and kept in a perpendicular poſition by a weight faſtened to the bottom of it.

"The perpendicular riſing or falling of the mercury is "meaſured by diviſions, on a plate divided into inches and "tenths, and by a Vernier diviſion into hundredths of an "inch, which is fixed to the ſide of the tube."

The HYGROMETER I was favoured with by M. De Luc; and the following account is a literal tranſlation of that which he gave me in French.

THE part of M. De Luc's Hygrometer which is affected by the impreſſions of the moiſture of the air, is a hollow cylinder of ivory, two inches eight lines long, and internally two lines and a half in diameter. It is open only at one end; and the thickneſs of its ſides, for the length of two inches ſix lines from the bottom, is but three-ſixteenths of a line. It is this thin part which does the office of an hygrometer; the remaining part of the cylinder, towards its orifice, muſt be kept a little thicker, being deſtined for joining it to a tube of glaſs, thirteen or fourteen inches long. This junction is effected by means of a piece of braſs, and the whole is cemented together with gum lac.

M. De Luc's reaſon for chuſing ivory as the hygrometer, is, that this matter appeared to him more proper than any other for receiving the impreſſions of the moiſture of the air, without ſuffering thereby any eſſential change.

The cylinder made of it becomes more capacious, in proportion as it grows moifter. This is the fundamental principle of the inftrument: M. De Luc has fince found, that upon letting this cylinder lie fome time in water of an uniform temperature, it fwells to a certain point, after which it dilates no further. This circumftance furnifhed him with a *maximum* of humidity; and, confequently, with one point of comparifon in the fcale of the hygrometer; and this point he has fixed at the temperature of melting ice. For meafuring the differences in the capacity of this ivory cylinder, and thereby difcovering its different degrees of moifture, M. De Luc makes ufe of quickfilver, with which he fills the cylinder, and a part of the communicating glafs tube. The more capacious this cylinder is, or, which is the fame, the moifter it is, the lower does the mercury ftand in the glafs tube; and *vice verfâ*. Now M. De Luc has found, that the loweft point to which it can fink, is that where it ftands when the ivory cylinder is foaked in melting ice: he therefore names this point *zero*, in the fcale of his hygrometer; and confequently, the degrees of this fcale are *degrees of drynefs*, counted from below upwards, as the quickfilver rifes in the glafs tube.

To give thefe degrees a determinate length, and thus render the hygrometers capable of being compared with each other, M. De Luc employs in conftructing them fuch glafs tubes as have been previoufly prepared, by being made into thermometers, and filled with mercury, fo as

to

to aſcertain upon them the points of melting ice and boiling water, and to take exactly the diſtance between thoſe points by any ſcale at pleaſure. That done, the bulb of this preparatory thermometer muſt be broken, and the quickſilver it contains exactly weighed. It is by knowing the weight of this, together with the diſtance between the fixed points of the thermometer, that the ſcale of the hygrometer is determined. For inſtance, let the weight of the quickſilver be one ounce, and the diſtance between the two abovementioned points, one thouſand parts of a certain ſcale: then ſuppoſe that the quickſilver in the hygrometer, to which this tube is to be applied, weighs only half an ounce; this will give a fundamental line, conſiſting of five hundred parts of the ſame ſcale. The fundamental line, thus found, is applied to the ſcale of the hygrometer, beginning at *zero*, and meaſuring it off about four times over, that the whole variation of the inſtrument may be comprehended. Each of thoſe ſpaces being afterwards divided into forty equal parts, gives ſuch degrees as M. De Luc has found moſt convenient. In general terms, the length of the fundamental line of the hygrometer, muſt be to the interval between the two fixed points of the preparatory thermometer, as the weight of the quickſilver in the hygrometer, is to the weight of the quickſilver in that thermometer.

This proportion between the ſcale of the hygrometer and that of the preparatory thermometer, furniſhes an eaſy

eaſy method of correcting in this inſtrument the effects of heat upon the mercury it contains.

It will eaſily be conceived, from the conſtruction of the ſcale of this hygrometer, that if its cylinder of ivory was ſuddenly changed into glaſs, the inſtrument would become a true thermometer, in which the interval between the points, anſwering to melting ice and boiling water, would be divided into forty parts. If, therefore, a thermometer, with a ſcale ſimilarly divided into forty parts between the fixed points, be placed near the hygrometer, it will ſhew immediately the correction to be made on that inſtrument for its variation as a thermometer; with ſome reſtrictions, however; of which M. De Luc has given an account in the paper he ſent to the Royal Society on the ſubject of this hygrometer.

That part of the frame of the inſtrument on which the ſcale is marked, is moveable; ſo that, before obſerving the points at which the mercury ſtands, it may be puſhed upwards or downwards, according as the thermometer has riſen or fallen with reſpect to the point of melting ice: and thus the indications of the hygrometer can at once be freed from the errors which would ariſe from the difference in the volume of the quickſilver, on account of the different degrees of heat.

Deſcription of the Manometer, conſtructed by Mr. Ramſden.

The Manometer uſed in this voyage was compoſed of a tube of a ſmall bore, with a ball at the end; the barometer being at 29,7, a ſmall quantity of quickſilver was put into the tube to take off the communication between the external air, and that confined in the ball and the part of the tube below this quickſilver. A ſcale is placed on the ſide of the tube, which marks the degrees of dilatation ariſing from the increaſe of heat in this ſtate of the weight of the air, and has the ſame graduation as that of Fahrenheit's thermometer, the point of freezing being marked 32. In this ſtate therefore it will ſhew the degrees of heat in the ſame manner as a thermometer. But if the air becomes lighter, the bubble incloſed in the ball, being leſs compreſſed, will dilate itſelf, and take up a ſpace as much larger, as the compreſſing force is leſs; therefore the changes ariſing from the increaſe of heat will be proportionably larger; and the inſtrument will ſhew the differences in the denſity of the air, ariſing from the changes in its weight and heat. Mr. Ramſden found, that a heat, equal to that of boiling water, increaſed the magnitude of the air from what it was at the freezing point $\frac{404}{1000}$ of the whole. From this it follows, that the ball and the part of the tube below the beginning of the ſcale

ſcale is of a magnitude equal to almoſt 414 degrees of the ſcale.

If we have the height of both the manometer and thermometer, the height of the barometer may be thence deduced by this rule; as the height of the manometer increaſed by 414, is to the height of the thermometer increaſed by 414; ſo is 29,7, to the height of the barometer.

This inſtrument, though far from complete, having been conſtructed in a hurry for the purpoſe of a firſt experiment, and liable to ſome inaccuracies in the obſervations from not having the thermometer with which it was compared attached to it, ſeldom differed from the marine barometer $\frac{1}{10}$ of an inch. Should it be improved to that degree of accuracy of which it ſeems capable, it will be of great uſe in determining refractions for aſtronomical obſervations, as well as indicating an approaching gale of wind at ſea.

Meteorological Journal.

Day of the Month.	Time.	Fahrenheit's Thermometer.	Barometer.	Hygrometer.	Manometer.	Latitude.	Longitude.	Winds and Weather.	Remarks, &c.
		°	In. dec.	°	■	° ′	° ′		
June 4th	6 A. M.	58½	...	...	...	...	...	NNW, hazy weather.	
	Noon.	58½	29,99	77	...	...	...	NW,	
	4 P. M.	58½	...	...	...	...	...	NW, } cloudy.	
	6 P. M.	58	29,95	81	...	...	...	NNW,	
	Midnight.	58	...	...	...	...	...	E by N,	
5th	6 A. M.	58½	...	...	...	...	...	N by W, cloudy.	
	Noon.	59½	29,93	75	...	...	...	NE, } hazy.	
	6 P. M.	54	29,90	79½	...	...	...	NE by E,	
6th	6 A. M.	54	...	...	...	...	...	SSW, fair.	
	Noon.	61	29,90	73½	...	57 17	1 30 E	SW, } hazy.	
	6 P. M.	56	29,93	73	...	...	...	SW by S,	
7th	Noon.	54	29,88	74	...	53 59	2 39	N by E, hazy.	
8th	Noon.	58	30,04	75	...	53 36	0 56	NNE, } hazy.	
	6 P. M.	53	30,08	7[illegible]½	...	...	...	SSE,	
9th	Noon.	58	30,05	70	...	54 2	0 12	SSE, } hazy.	
	6 P. M.	56	29,99	70	...	...	...	S by E,	
10th	Noon.	54½	30,05	68	...	54 27	0 31 W	NNE, cloudy.	
11th	Noon.	58	29,90	70	...	...	0 31	SE, cloudy.	
12th	Noon.	54	29,73	62	...	56 28	1 0	SE. hazy.	
13th	6 A. M.	51½	...	...	...	...	...		
	Noon.	57	30.07	65¼	...	59 34	0 10 E	} E, clear weather.	
	6 P. M.	51½	...	...	...	...	...		
14th	Noon.	60	30,16	62	...	60 21	0 40 W	N, clear weather.	
15th	Noon.	58½	29,96	64	...	60 19	0 48	NE, foggy.	
16th	6 A. M.	49	...	...	...	...	...	SSW, hazy.	
	Noon.	55	29,54	64	...	60 37	0 31	SW, foggy.	
17th	Noon.	52	29,64	63	...	63 0	0 2	SSW, } cloudy.	
	Midnight.	49	...	...	...	...	...	SSE,	
18th	6 A. M.	48½	...	...	...	...	...	SSE, cloudy.	
	Noon.	52	29,72	62	54½	65 20	0 17		
	6 P. M.	50	...	...	...	...	...	} SE, foggy.	
	Midnight.	48	...	...	...	...	...		
19th	Noon.	49	29,73	62½	54½	66 14	0 27	SE, cloudy.	

Meteorological

Meteorological Journal.

Day of the Month.	Time.	Fahrenheit's Thermometer.	Barometer.	Hygrometer.	Manometer.	Latitude.	Longitude.	Winds and Weather.	Remarks, &c.
		°	In. dec.	°	°	° ′	° ′		
June 20th	4 A. M.	43	...	...	...	...	...	N, fair weather.	
	Noon.	48½	29,90	62	47	67 5	0 46 E	Calm, cloudy,	
	Midnight.	44½	...	...	...	...	...	SSW, fair.	
21st	Noon.	50	29,85	65	47	68 4	0 32	SSE, freſh, cloudy.	
	Midnight.	41½	...	...	...	...	...	S, cloudy.	
22d	6 A. M.	41	...	...	...	...	...	W, } cloudy.	Thermometer in the air being 43°, in the ſurface water of the ſea it was 31°. At 6 A. M. Thermometer expoſed to the Sun 5′ roſe 12°.
	Noon.	42½	29,80	66	44	70 45	0 32	WSW, } cloudy.	
	Midnight.	37½	...	...	...	...	...	E, } cloudy.	
23d	6 A. M.	38	...	...	...	...	...	SE, } foggy.	
	Noon.	40	29,77	61	44	72 22	0 45	SSW, } foggy.	
	6 P. M.	38	...	...	...	...	...	SE, } foggy.	
	Midnight.	37	...	...	...	...	...	SE by E, } foggy.	
24th	6 A. M.	37½	...	...	...	...	...	SE by E, } foggy.	
	Noon.	40	30,03	63	38	73 22	3 53	WSW, } foggy.	
	6 P. M.	37	30,15	...	...	...	...	N, clear weather.	
	Midnight.	34	...	...	...	...	...	NNE, cloudy.	
25th	2 A. M.	41	...	...	...	...	...	NNE, } hazy.	
	3 A. M.	35	...	...	...	...	...	NE by N, } hazy.	
	4 A. M.	36	...	...	...	...	...	N, } cloudy.	
	6 A. M.	36	...	...	...	...	...	N by E, } cloudy.	
	Noon.	36	30,13	67	34	74 5	9 44	N, ſqually, hail and ſleet.	
	8 P. M.	37½	...	...	...	...	...	NNE, cloudy.	
26th	Noon.	40½	30,33	82½	39½	74 25	11 46	NE by N, fair weather.	
	8 P. M.	41	...	...	...	...	...	almoſt calm, cloudy.	
27th	Noon.	40	30,00	87	41½	75 21	9 43	WSW, cloudy and ſnow	
	6 P. M.	39	...	...	...	...	...	WSW, cloudy.	
	Midnight.	39	...	...	...	...	...	SSW, rain.	
28th	6 A. M.	38	...	...	...	...	...	SSW, rain.	
	Noon.	39	29,65	...	...	77 36	8 52	S, hazy and rain.	
	Midnight.	38½	...	...	...	...	...	ENE, cloudy.	
29th	Noon.	39	...	...	...	78 1	9 48	N by E, hazy.	At Midnight Thermometer expoſed to the Sun 30′ roſe 20°.
	Midnight.	37½	...	...	...	...	...	NNE, fair.	

Meteorological

Meteorological Journal.

Day of the Month.	Time.	Fahrenheit's Thermometer.	Barometer.	Hygrometer.	Manometer.	Latitude.	Longitude.	Winds and Weather.	Remarks, &c.
		°	In. dec.	°	°	° ′	° ′		
June 30th	Noon.	42	29,57	106	. .	78 8	10 58 E	Calm and cloudy.	The rise of the Hygrometer was occasioned by a fire being lighted in the cabin.
	Midnight.	42	. . .	. .	. .	. . .	. . .	{ Variable winds and fair.	
July 1st	Noon.	44	29,63	84	50	78 18	10 53	WSW, hazy weather.	At Noon, Thermometer exposed to the sun rose 10° in 10′.
	8 P. M.	50	. . .	. .	. .	. . .	. . .	Calm and fair.	
	Midnight.	49	. . .	. .	. .	. . .	. . .	N, fine weather.	
2d	Noon.	43½	29,71	79	50	78 22	10 15	SSW, fair weather.	At 6 P. M. Thermometer exposed 10′ to the Sun rose to 76°.
	Midnight.	45	. . .	. .	. .	. . .	. . .	Calm and cloudy.	
3d	Noon.	43½	. . .	. .	. .	78 36	10 15	S, hazy.	
	Midnight.	40½	. . .	. .	. .	. . .	. . .	SE, cloudy.	
4th	Noon.	44½	29,94	. .	. .	79 31	9 57	Calm and fair.	
	6 P. M.	40	. . .	. .	. .	. . .	. . .	Calm and clear.	
	Midnight.	40	. . .	. .	. .	. . .	. . .	Variable and foggy.	
5th	Noon.	41	29,94	. .	. .	79 55	9 17	SW, foggy.	
	Midnight.	37½	. . .	. .	. .	. . .	. . .	S, cloudy.	
6th	Noon.	39½	29,80	. .	. .	79 57	8 37	SE, fair.	
	6 P. M.	41	. . .	. .	. .	. . .	. . .	} SE, cloudy.	
	8 P. M.	38½	. . .	. .	. .	. . .	. . .		
7th	Noon.	39½	29,78	. .	. .	. . .	. . .	} N, rainy.	Thermometer placed close to a piece of ice, fell from 39°½ to 37°.
	6 P. M.	. . .	29,81	. .	. .	. . .	. . .		
	Midnight.	39½	. . .	. .	. .	. . .	. . .	N by E, cloudy.	
8th	6 A. M.	40	. . .	. .	. .	. . .	. . .	N by E, } cloudy.	Near the ice.
	Noon.	39½	29,83	. .	. .	. . .	. . .	W by S, } cloudy.	
	6 P. M.	37	. . .	. .	. .	. . .	. . .	SE, foggy.	
	Midnight.	39	. . .	. .	. .	. . .	. . .	SW, cloudy.	
9th	1 A. M.	. . .	29,78	. .	. .	. . .	. . .	SW, cloudy.	At 3 P. M. Thermometer exposed to the wind blowing from the ice, fell in 5′ from 42° to 39°.
	Noon.	40	29,83	. .	. .	80 7	5 5	} SW by S, cloudy.	
	6 P. M.	39	. . .	. .	. .	. . .	. . .		
			. . .	. .	. .	. . .		S by W, thick fog.	
	Midnight.	38					. . .		Near the ice.
10th	Noon.	39½	29,86	. .	. .	80 22	2 12	SSW, thick fog.	Among the ice.
	Midnight.	38½	. . .	. .	. .	. . .	. . .	SSW, cloudy.	

Meteorological

Meteorological Journal.

Day of the Month.	Time.	Fahrenheit's Thermometer.	Barometer.	Hygrometer.	Manometer.	Latitude.	Longitude.	Winds and Weather.	Remarks, &c.
		°	In. dec.	°	°	° ′	° ′		
July 11th	3 A. M.	41	. . .	. .	. .	. . .	. . .	SSW, with rain.	At 10 A. M. Thermometer exposed to the Sun 30′ rose 26°. At 7 P. M. Thermometer fell suddenly to 37°, then rose again about 8°.
	4 A. M.	37	. . .	. .	. .	. . .	. . .		
	Noon.	42	29,66	. .	. .	80 4	. . .	Calm and fair.	
	Midnight.	44	. . .	. .	. .	. . .	. . .	Light airs and fair.	
12th	Noon.	45	29,58	. .	. .	. . .	. . .	ENE, cloudy.	Light winds.
	8 P. M.	45	. . .	. .	. .	. . .	. . .	Calm, cloudy.	
	Midnight.	44	. . .	. .	. .	. . .	. . .	Calm and fair.	
13th	Noon.	46	29,63	. .	. .	. . .	. . .	Calm and cloudy.	
	8 P. M.	42	. . .	. .	. .	. . .	. . .	SW by S, squally and cloudy.	
14th	Noon.	36	. . .	. .	. .	. . .	. . .	ENE, foggy.	Thermometer exposed to the Sun rose to 86°½.
	Midnight.	38	. . .	. .	. .	. . .	. . .	ENE, cloudy.	
15th	Noon.	45	. . .	. .	. .	. . .	. . .	NNE, fair.	
	Midnight.	46	. . .	. .	. .	. . .	. . .	W, fair.	
16th	Noon.	49	. . .	. .	. .	. . .	. . .	Light airs and clear.	Thermometer exposed to the Sun rose to 89°½.
	Midnight.	48	. . .	. .	. .	. . .	. . .		
17th	Noon.	49	. . .	. .	. .	. . .	. . .	Light airs and clear.	
	Midnight.	45	. . .	. .	. .	. . .	. . .		
18th	Noon.	45½	. . .	. .	. .	. . .	. . .	NW by W, cloudy.	
	Midnight.	42	. . .	. .	. .	. . .	. . .		Among the loose ice.
19th	Noon.	42	29,60	. .	. .	. . .	. . .	SE, foggy.	Thermometer exposed to the Sun 30′ rose to 89°.
	Midnight.	39	. . .	. .	. .	. . .	. . .	E, cloudy.	
20th	Noon.	37	29,70	. .	37½	80 30	3 26 E	NE, snow and sleet.	Near the ice. The rising of the Hygrometer was occasioned by a fire lighted in the cabin.
	Midnight.	33½	. . .	110	. .	. . .	. . .	E, snow and sleet.	
21st	4 A. M.	33	. . .	. .	. .	. . .	. . .	E, hazy and snow.	
	9 A. M.	33½	. . .	. .	34½	. . .	. . .	SW, hazy.	
	Noon.	34	29,74	73	34	79 27	4 29	NW, hazy.	
	6 P. M.	35	. . .	. .	. .	. . .	. . .	WNW, cloudy.	
	10 P. M.	32½	. . .	. .	. .	. . .	. . .	SW, hazy.	Close to the ice.
	Midnight.	32½	29,77	73	. .	. . .	. . .	SW by S, cloudy.	

Meteorological Journal.

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		°	In. dec.	°	°	° ′	° ′		
July 22d	6 A. M.	34	. . .	. .	30½	. . .	. . .	SW by S, cloudy.	Thermometer placed near the frozen ropes fell to 32°½.
	Noon.	35	29,76	. .	33	80 1	6 32	SW, } foggy.	
	6 P. M.	39½	. . .	. .	. .	. . .	. . .	S }	
	Midnight.	35½	. . .	. .	. .	. . .	. . .	E by N, hazy.	
23d	4 A. M.	37	. . .	. .	36	. . .	. . .	E by N, hazy.	Hygrometer placed in Bittacle.
	Noon.	36	29,74	48	40	80 24	9 59 E	} E, rain.	
	6 P. M.	36½	. . .	. .	39½	. . .	. . .		
	Midnight.	37½	. . .	44	. .	. . .	. . .	E, cloudy.	
24th	Noon.	39	29,41	43	41	. . .	. . .	E, } cloudy.	Near the floating ice.
	Midnight.	37	. . .	. .	44	. . .	. . .	ENE, }	
25th	Noon.	39½	29,64	39	41	. . .	. . .	NW by N, hazy.	
	4 P. M.	38	. . .	. .	41	. . .	. . .	N, cloudy.	
	Midnight.	39½	. . .	39½	. .	. . .	. . .	Light airs and foggy.	
26th	Noon.	39	29,90	39	32½	80 17	13 22	NNW, foggy.	
	Midnight.	39	. . .	. .	41	. .	. . .	SSE, cloudy.	
27th	4 A. M.	39	. . .	. .	40¾	. . .	. . .	E, cloudy.	
	Noon.	38	30,17	. .	. .	80 48	14 42	ENE, } hazy.	
	8 P. M.	39	. . .	. .	32	. . .	. . .	E, }	
	Midnight.	. . .	30,30	. .	. .	. . .	. . .	E by N, cloudy.	
28th	4 A. M.	36	. . .	. .	26¼	. . .	. . .	Hazy.	6 A. M. Thermometer expoſed to the Sun 15′ roſe 9°½. Among the ice.
	8 A. M.	37	. . .	. .	27½	. . .	. . .	Foggy.	
	Noon.	37	30,35	62	33	80 36	15 30	E by N, foggy.	
	4 P. M.	35½	. . .	. .	26¾	. . .	. . .	} SE, hazy.	
	6 P. M.	36	. . .	. .	27	. . .	. . .		
	Midnight.	40	. . .	. .	. .	. . .	. . .		
29th	Noon.	42	30,43	. .	33	80 25	18 18	ESE, clear.	
	Midnight.	42	. . .	. .	. .	. . .	. . .	SSE, fair.	
30th	Noon.	48	30,43	86½	27	80 31	. . .	NE by N, clear.	
	Midnight.	44	. . .	. .	. .	. . .	. . .	Calm and fair.	
31st	Noon.	48	30,43	92	40	. . .	. . .	Light airs at E, fair.	
	Midnight.	48	30,45	. .	. .	. . .	. . .	Calm and fair.	
Auguſt 1st	Noon.	48	30,45	73	36½	80 37	. . .	Light airs at E, hazy.	
	Midnight.	. . .	30,43	. .	. .	. . .	. . .	NNW, foggy.	
2d	Noon.	44	30,34	. .	. .	. . .	. . .	NW, } foggy.	
	Midnight.	45	30,33	. .	. .	. . .	. . .	NNW, }	
3d	Noon.	47	30,17	96	38	. . .	. . .	} Light airs and fair weather.	
	6 P. M.	. . .	30,13	. .	. .	. . .	. . .		

Meteorological Journal.

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		°	In. dec.	°	°	° ′	° ′		
August 4th	Noon.	46	. . .	88	30	. . .	. . .	ENE, foggy.	
7th	Midnight.	38	. . .	. .	. .	. . .	. . .	W, foggy.	
8th	8 A. M.	32	. . .	. .	. .	. . .	. . .	Calm and foggy.	
	8 P. M.	36½	. . .	. .	. .	. . .	. . .		
9th	4 A. M.	35	. . .	. .	. .	. . .	. . .	SE, foggy.	
	Noon.	34	30,02	47	. .	. . .	. . .	Variable and foggy.	
	Midnight.	32	. . .	. .	. .	. . .	. . .	NE, cloudy.	
10th	Noon.	33	29,87	53	27	. . .	. . .	NNE, cloudy and fnow.	
	8 P. M.	33	. . .	. .	. .	. . .	. . .	ENE, cloudy.	
	Midnight.	33	. . .	. .	. .	. . .	. . .	NE, cloudy.	
11th	Noon.	33	29,70	46	32	. . .	. . .	ENE, hazy weather.	
	8 P. M.	33	. . .	. .	. .	. . .	. . .		
12th	Noon.	36	29,60	46	31	At Smeerenberg, Latitude 79° 44′. Longitude 9° 50′ 45″ E.		NE, fnow.	
13th	Noon.	37	29,68	46	32			NE, cloudy, fnow and fleet.	
	8 P. M.	35	. . .	. .	. .				
14th	Noon.	40	29,68	47	35			Calm, and fair.	
	8 P. M.	45	. . .	. .	. .			N, hazy.	
15th	Noon.	39	29,85	43	34			NE, hazy.	
	8 P. M.	35	. . .	. .	. .			Variable and cloudy.	
16th	Noon.	38	29,97	41	34			ENE, hazy.	
	8 A. M.	37	. . .	. .	. .			E, cloudy.	
17th	Noon.	40	29,80	54	35			NE, hazy.	
18th	Noon.	46	29,78	45	37			NE, clear.	
19th	Noon.	37	29,70	35	35			NNW, rain.	
	Midnight.	39	. . .	. .	. .			ESE, cloudy.	
20th	Noon.	40	29,50	35	35	80 12	7 40 E	SW, cloudy.	
	8 P. M.	38	. . .	. .	. .	. . .	. . .	SSW, rain.	
21st	4 A. M.	38	. . .	. .	34	. . .	. . .	SE, hazy and rain.	
	8 A. M.	40	. . .	. .	35	. . .	. . .		
	Noon.	40	29,06	29	34	80 5	2 54	SE by S, foggy.	
	4 P. M.	36	. . .	. .	35	. . .	. . .	SE, foggy.	
	Midnight.	36	. . .	. .	. .	. . .	. . .	SE, foggy.	

Meteorological Journal.

Day of the Month.	Time.	Fahrenheit's Thermometer.	Barometer.	Hygrometer.	Manometer.	Latitude.	Longitude.	Winds and Weather.	Remarks, &c.
		°	In. dec.	°	°	° ′	° ′		
Aug. 22d	Noon.	37	...	...	...	79 24	1 56 E	NE, hazy.	
	Midnight.	$36\frac{1}{2}$	...	...	...	...	...	NNE, rain.	
23d	2 A. M.	$32\frac{1}{2}$	...	...	...	...	...	NNE, rain and sleet.	
	Noon.	37	29,98	30	31	77 10	4 58	W by N, cloudy.	
	4 P. M.	$35\frac{1}{2}$	...	...	34	...	...	W by N, cloudy.	
	Midnight.	35	...	...	...	...	...	W by N, cloudy.	
24th	4 A. M.	35	...	...	$31\frac{1}{2}$	...	...	SW, cloudy.	
	Noon.	42	29,79	31	33	75 59	6 13	Calm and cloudy.	
25th	4 A. M.	$36\frac{1}{2}$	...	...	...	...	...	E, cloudy.	
	Noon.	42	29,79	31	$40\frac{1}{2}$	75 12	4 51	S by E, cloudy.	
	Midnight.	37	...	...	$35\frac{1}{2}$	...	...	SE, rain and sleet.	
26th	Noon.	42	29,71	26	42	73 19	1 46	SE by S, rainy.	
	6 P. M.	45	29,71	25	41	...	...	S, hazy.	
	Midnight.	42	29,78	$25\frac{1}{2}$	...	...	...	S, cloudy.	
27th	4 A. M.	43	...	...	$47\frac{1}{2}$	...	...	SW by S, hazy.	
	Noon.	45	29,79	23	42	72 40	0 14	SSW, hazy.	
	Midnight.	46	...	...	...	...	...	SSW, hazy.	
28th	4 A. M.	$45\frac{1}{4}$	...	...	$42\frac{1}{4}$	...	...	SSW, foggy.	
	Noon.	46	29,93	25	42	72 19	1 49 W	W by S, fog and rain.	
	4 P. M.	45	...	...	$42\frac{1}{2}$	...	...	NW, hazy.	
	8 P. M.	$41\frac{1}{2}$	...	...	...	...	...	NW, hazy.	
	Midnight.	42	...	...	...	...	...	NW, hazy.	
29th	Noon.	$40\frac{1}{2}$	30,00	28	35	71 9	1 28	SW, fair.	
30th	4 A. M.	44	...	...	$35\frac{1}{2}$	...	...	W by S, cloudy.	
	8 A. M.	44	...	...	$35\frac{1}{4}$	...	...	W by S, cloudy.	
	Noon.	53	30,28	33	39	70 29	0 18 E	W by S, cloudy.	
	8 P. M.	48	...	...	...	...	...	WNW, cloudy.	
31st	4 A. M.	44	...	...	...	...	...	WNW, cloudy.	
	8 A. M.	48	...	...	$42\frac{1}{2}$	...	...	WNW, cloudy.	
	Noon.	55	30,23	39	38	69 3	0 18	Variable and fair.	
Sept. 1st	Noon.	50	30,23	54	38	69 0	0 2	S, cloudy.	
	9 P. M.	$46\frac{1}{2}$	...	...	38	...	...	WNW, cloudy.	
2d	Noon.	57	30,09	$32\frac{1}{2}$	49	68 14	0 38	E, cloudy.	
	6 P. M.	52	...	$44\frac{1}{2}$	39	...	...	ESE, hazy.	
	8 P. M.	$52\frac{1}{2}$	...	$40\frac{3}{4}$	$39\frac{3}{4}$	...	...	ESE, foggy.	

Meteorological Journal.

Day of the Month.	Time.	Fahrenheit's Thermometer.	Barometer.	Hygrometer.	Manometer.	Latitude.	Longitude.	Winds and Weather.	Remarks, &c.
		°	In. dec.	°	°	° ′	° ′		
Sept. 3d	1 A. M.	52½	. . .	25	39½	. . .	. . .	ESE, foggy.	
	4 A. M.	52¼	. . .	23½	40	. . .	. . .	ESE, } hazy.	
	Noon.	65	30,06	34½	59	65 57	0 8 E	SE, } hazy.	
	8 P. M.	56	. . .	32½	48½	. . .	. . .	SSE, cloudy.	
	Midnight.	53	. . .	30	48¾	. . .	. . .	ESE, clear.	
4th	8 A. M.	62	. . .	29	51	. . .	. . .	ESE, clear.	
	Noon.	58	30,00	37	51	64 58	0 12 W	Calm and cloudy.	
5th	4 A. M.	56	. . .	. .	51½	. . .	. . .	SE, cloudy.	
	8 A. M.	58	. . .	. .	51	. . .	. . .	SE, clear.	
	Noon.	57	29,81	30	52	63 58	0 54	SE by E, cloudy and rain.	
	Midnight.	56	. . .	44	51	. . .	. . .	SE by E, cloudy.	
6th	2 A. M.	55½	. . .	44	51	. . .	. . .	} SE by E, cloudy.	
	4 A. M.	56½	. . .	45	52	. . .	. . .	} SE by E, cloudy.	
	Noon.	59	29,13	39	60	62 27	1 12	} E by S, hazy.	
	8 P. M.	56	. . .	. .	54	. . .	. . .	} E by S, hazy.	
	Midnight.	56½	. . .	. .	58	. . .	. . .	} E by S, hazy.	
7th	8 A. M.	58	. . .	. .	61	. . .	. . .	} SE, hazy.	
	Noon.	61	29,02	36	64	60 1	2 35	} SE, hazy.	
8th	4 A. M.	54	. . .	33½	65	. . .	. . .	SW, fmall rain.	
	8 A. M.	54½	. . .	33	64½	. . .	. . .	Squally and rain.	
	Noon.	56	28,71	36	66	59 35	1 9	SW by S, hazy.	Frefh gales.
9th	Noon.	56	28,70	41	66½	59 9	0 37	WSW, hazy.	Frefh gales.
10th	. . .	. . .	. . .	. .	. .	. . .	. . .	. . . .	The weather was fo bad, and the fhip had fo much motion, that the arometer could not be obferved this day.
11th	Noon.	58	29,20	41	59	57 25	1 32 E	SW, hazy.	Frefh gales.
12th	Noon.	57	29,30	39	61	56 57	1 55	NW, fqually.	
13th	Noon.	56	29,70	30	53	56 4	1 31	SSW, rain.	At 1 A. M. a very hard gale of wind. Squally weather.
14th	9 A. M.	. . .	29,79	. .	. .	. . .	. . .	} NW, ditto.	} Hard gales.
	Noon.	52	29,89	30	55	55 40	. . .	} NW, ditto.	} Hard gales.

Meteorological

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Day of the Month.	Time.	Fahrenheit's Thermometer.	Barometer.	Hygrometer.	Manometer.	Latitude.	Longitude.	Winds and Weather.	Remarks, &c.
			In. dec.	°	°	° ′	° ′		
15th	Noon.	57	29,59	32	53	54 33	0 29 E	WSW, rain.	Very hard gales.
16th	Noon.	57	29,90	40	53	53 13	0 1	W, cloudy.	Moderate.
	9 P. M.	. . .	29,70	. .	. .	. . .	. . .	Rain.	Squally.
	10 P. M.	. . .	29,60	. .	. .	. . .	. . .		
17th	Noon.	55	29,50	37	54	53 12	0 7	WNW, hazy and rain.	
18th	Noon.	57	29,77	44	. .	52 53	0 11 W	W by S, cloudy.	
19th	Noon.	61	30,08	50	. .	52 42	0 29	W by S, cloudy.	
20th	Noon.	61	30,00	48	. .	52 31	0 16	SW by W, hazy.	Fresh gales.
	Midnight.	. . .	29,90	. .	. .	. . .	. . .	W by S, cloudy.	Moderate.
21st	10 A. M.	61	. . .	44	. .	. . .	. . .	SW by W, cloudy.	Fresh gales.
	Noon.	63	29,88	44	. .	52 17	0 5	SW by S, moderate.	
	10 P. M.	. . .	29,23	. .	. .	. . .	. . .	S, hazy.	Fresh gales.
22d	Noon.	60	29,23	45	. .	52 28	1 35	SW by S, hard gales and squally.	Squally.
	6 P. M.	. . .	29,43	. .	. .	. . .	. . .	WNW, rain.	Strong gales.
23d	Noon.	51	29,91	50	. .	52 2	0 49	W, cloudy.	Moderate.
	6 P. M.	. . .	29,70	. .	. .	. . .	. . .	SW by W, ditto.	
24th	Noon.	57	29,50	45	. .	52 16	2 33	SSW, cloudy.	
25th	8 A. M.	. . .	29,66	. .	. .	. . .	. . .	SW, cloudy.	
	Noon.	61	29,66	44	. .	. . .	. . .	SW by W, cloudy.	
	11 P. M.	. . .	29,80	. .	. .	. . .	. . .	WSW, cloudy.	

MISCELLANEOUS

MISCELLANEOUS OBSERVATIONS.

Observations for determining the refraction in high latitudes.

JUNE the thirtieth, at midnight, the diſtance of the two oppoſite horizons, taken by me with Ramſden's ſextant, was 179° 54′; the height of the eye being ſixteen feet above the level of the ſea.

Auguſt the fifteenth, at midnight, by the aſtronomical Quadrant, the altitude of the ſun's upper limb 4° 16′ 55″ lower limb 3° 46′ 0″

Error of the Quadrant		—	32	- -		—	32
	4	16	23	- -	3	45	28
Semidiameter		— 15	51	- -	+	15	51
App. Alt. Sun's center - -	4	0	32	- -	4	1	19
Co. Declin. -	75	56	13	- -	75	56	13
App. Lat. -	79	56	45	- -	79	57	32
True Lat. -	79	44	3	- -	79	44	3
Refraction - -		12	42	- -		13	29
By Dr. Bradley's tables		11	18	- -		12	27
Allowing for the therm.		11	53	- -		13	2

Barometer, 29,6 Thermometer, 37°

August the twentieth, at midnight, the sun's meridian altitude by Mr. Harvey, 2° 25′ 00″

altitude by Mr. Harvey,	2°	25′	00″
Dip —		3	49
	2	21	11
Semidiameter +		15	52
Altitude of the Sun's center	2	37	3
Co. Declin.	77	31	26
App. Latitude	80	8	29
Refr. by the tables		16	44
True Latitude	79	51	45

Hakluyt's Head-land SBE
Cloven Cliff - - - EBS½S
Variation - - - - 19° 30′ S.

It may not be improper to mention here that Baffin, in 1613, made an observation of the refraction when the sun was in the horizon, in latitude 78° 46′, which also agrees exactly with Dr. Bradley's tables. It may therefore be presumed that the refractions in the higher latitudes follow the same law as in these.

Specific

Specific Gravity of Ice, tried by Dr. Irving.

A piece of the moſt denſe ice he could find, being immerſed in ſnow water, thermometer thirty-four degrees,—fourteen fifteenth parts ſunk under the ſurface of the water.

In brandy juſt proof, it barely floated: in rectified ſpirits of wine it fell to the bottom at once, and diſſolved immediately.

September the fourth, at two in the afternoon, we ſounded with all the lines, above eight hundred fathom. Some time before the laſt line was out, we perceived a ſlack, and that it did not run off near ſo quick as before. When we got the lines in again, the firſt coil came in very eaſily, and twenty fathom of the next, after which it took a great ſtrain to move the lead; a mark was put on at the place where the weight was perceived, and the line meaſured, by which the depth was found to be ſix hundred and eighty-three fathoms. The lead weighed above one hundred and fifty pounds, and had ſunk, as appeared by the line, near ten feet into the ground, which was a very fine blue ſoft clay. A bottle fitted properly by

Dr. Irving (none of thoſe ſent out having given ſatisfaction) was let down, faſtened to the line, about two fathom from the lead. A thermometer plunged into the water from the bottom ſtood at forty degrees:—in water from the ſurface at fifty-five degrees;—-in the ſhade, the heat of the air was ſixty-ſix degrees.

Experiments to find the Temperature of the Water at different Depths, made with Lord Charles Cavendiſh's Thermometer.

Day of the Month.	Depth in Fathoms to which it was ſunk.	Temperature of the Water as ſhewn by the Inſtrument.	Correction for Compreſſion and unequal Expanſion of Spirits.	Temperature of the Sea at the greateſt Depth to which it was ſunk, corrected for Compreſſion and Expanſion.	Heat of the Air.
		°	°	°	°
June 20	780	15	11	26	48½
30 A.M.	118	30	1	31	40½
P.M.	115	33	0	33	44¾
Auguſt 31	673	22	10	32	59½

It appears from the Experiment of July 1ſt, in which the Inſtrument was compared with Fahrenheit's Thermometer at different Heats, that the Experiment cannot be depended on to leſs than two or three Degrees, as the Reſults drawn from the different Compariſons would differ by about five Degrees.

Experiments

Experiments to determine the Temperature of the Water at different Depths of the Sea, and Quantity of Salt it contains; made with the Bottle fitted by Dr. Irving. A Meafure, containing 29 Ounces 59 Grains of pure Snow-water, was ufed as a Standard; Thermometer 59°, Barometer 30,06.

Day of the Month.	Weight of the Water.	Depth in Fathoms.	Thermometer at the Surface.	Thermometer in Water from the Bottom.	Thermometer in the Air.	Weight of the Salt.	Latitude, &c.
1773	Oz. Grs.		°	°	°	Grs.	° ′
June 1	29 404				59	393	51 31 Nore
9	30 2					500	54 8 Off Flamborough Head.
11		32	51	49	55		
12	29 440	Surface	50		50	490	60 Off Shetland.
	29 442	65		44		490	
26	29 462				36	496	74 At Sea.
July 3	29 454		40		44	500	78
19	29 369				44	476	80 Near the Ice.
Aug. 4	30 15	60	36	39	32	510	80 30 Under the Ice.
31	12 360	80	51		48	220	
Sept. 4	12 365	683	55	40	66½	192	75 At Sea.
	12 365					216	
7		56	57	50	60		60 14

Sea water taken up at the back of Yarmouth Sands, was in the following ratio to diftilled water:

	oz.	dwts.	grs.	
Sea-water - - -	21	16	13,7	Thermometer, 53°;
Diftilled water	21	4	16	

which is, as 10192 : 10477,7; or, as 1 : 1,02803. The quantity of dry falt produced from the above water, was 13 dwts. 15 grs; it appears, therefore, that fea-water contains more air than diftilled water.

 The

The results of the experiments made with Lord Charles Cavendish's thermometer, and those with the bottle fitted by Dr. Irving, differ materially as to the temperature of the sea at great depths; I shall give an account, therefore, of the precautions used by Dr. Irving to prevent the temperature from being altered, as well as of the allowance made by Mr. Cavendish for compression, as they communicated them to me.

The following is the account of the precautions taken by Dr. Irving to prevent the temperature of the water being changed in bringing up from the bottom:

"The bottle had a coating of wool, three inches thick, "which was wrapped up in an oiled skin, and let into a "leather purse, and the whole inclosed in a well-pitched "canvass-bag, firmly tied to the mouth of the bottle, so "that not a drop of water could penetrate to its surface. "A bit of lead shaped like a cone, with its base downwards "and a cord fixed to its small end, was put into the bottle; "and a piece of valve leather, with half a dozen slips of "thin bladder, were strung on the cord, which, when "pulled, effectually corked the bottle in the inside."

The

The following is Mr. Cavendiſh's account of the corrections to be made for Lord Charles Cavendiſh's thermometer.

" The Thermometer uſed in theſe experiments is fully " deſcribed in the Philoſophical Tranſactions, Vol. L. Page " 308; ſo that I imagine it is unneceſſary to mention it " here. But ſince the publication of that volume, the late " Mr. Canton diſcovered, that ſpirits of wine and other " fluids are compreſſible; which muſt make the thermometer " appear to have been colder than it really was, and renders " a correction neceſſary on that account. There is another " ſmaller correction neceſſary, owing to the expanſion of " ſpirits of wine by any given number of degrees of " Fahrenheit's thermometer being greater in the higher " degrees than the lower. As the method of computing " theſe two corrections is not explained in that paper, it " may be proper juſt to mention the rule which was made " uſe of in doing it.

" In adjuſting the degrees on the ſcale of this thermo- " meter, the tube was intirely full of Mercury, or the " Mercury ſtood at no degrees on the ſcale, when its real heat " was 65° of Fahrenheit. Let the bulk of the Mercury con- " tained at that time in the cylinder be called M, and that " of the ſpirits, S; let the expanſion of ſpirits of wine by " 1° of Fahrenheit, about the heat of 65°, be to its whole

" bulk

" bulk at that heat, as s to 1; and let its expansion by one " degree at any other heat, as $65^\circ - x$, be to its bulk at 65°, " as $s \times \overline{1 - dx}$ to 1; let the expansion of Mercury by one " degree of heat be to its bulk at 65°, as m to 1; and let " $\frac{Ss + Mm}{Ss}$ be called G; let the compression of spirits of " wine by the pressure of 100 fathom of sea-water, " when the heat of the spirits is nearly the same as " that of the sea at the depth to which the thermo- " meter was let down, be to its bulk at 65°, as C to 1; " the compression of the Mercury is so small that it may " be neglected; let the thermometer be let down N " hundred fathom, and when brought up and put into water " of 65°—F degrees of heat let the Mercury in the tube " stand at E degrees; consequently the heat, as shewn by " the thermometer, is $65^\circ - F - E$: and let the real heat of " the sea at the depth to which it was sunk be $65 - x$ degrees; " then $65^\circ - x = 65^\circ - F - E + \frac{CN}{sG} - \frac{Ed \times \overline{E + F + x}}{2G} + \frac{CNd \times \overline{F + x}}{2sG^2}$.

" In this thermometer $S = 1160$; $M = 97$; the expansion of " the spirits used in making it by 1° at the heat of 65°, was " found to be $\frac{1}{1786}$ of their bulk at that heat; that is $s =$ " $\frac{1}{1786}$; $m = \frac{1}{11500}$; therefore $G = 1{,}013$. From M. De Luc's " experiments * it appears, that the expansion of spirits of " wine by 1° at any degree of heat, as $65^\circ - x$, is to its " expansion by 1° at 65°, nearly as $1 - \frac{x}{315}$ to 1: there- " fore, $d = \frac{1}{315}$. The compressibility of the spirits used for " this thermometer at the heat of 58°, was found to be

* Modifications de l'Atmosphere, vol. I. page 252.

" exactly

" exactly the ſame as Mr. Canton determines it to be at that " heat; and therefore its compreſſibility at all other degrees " of heat is ſuppoſed to be the ſame as he makes it. According to his experiments *, the compreſſion of ſpirits of " wine by the preſſure of $29\frac{1}{2}$ inches of Mercury at the " heat of 32°, *id eſt*, nearly the heat of the ſea in theſe experiments, is $59\frac{1}{4}$ millionth parts of its bulk at that heat; " therefore $\frac{C}{sG} = 1,9$ and $65 - x = 65 - F - E + N \times$ " $1,9 - \frac{E \times \overline{E+F+x}}{638} + \frac{N \times 1,9 \times \overline{F+x}}{638}$."

Observations made by Dr. Irving of the heat of the ſea agitated by a gale of wind, and that of the atmoſphere.

September the twelfth, the thermometer plunged into a wave of the ſea, roſe to 62°; the heat of the atmoſphere 50°.

This experiment was frequently repeated during the gale, and it gave nearly the ſame difference. At night, when the weather became moderate, the heat of water 30 fathoms below the ſurface was 55°; the ſurface and the atmoſphere were 54°.

September the twenty-ſecond. The ſea-water was 60°; the atmoſphere, 59°: the wind at S W, a freſh gale.

* Philoſophical Tranſactions, Vol. LIV. page 261.

OBSERVATIONS for determining the height of a Mountain in Latitude 79° 44′; by the Barometer, and Geometrical Meaſurement.

Obſervations taken by the Barometer, by Dr. Irving.

AUGUST the eighteenth, the day remarkably clear:

	Inches.
At 6^h in the morning, the barometer by the ſea ſide ſtood at - - - - -	30,040
The thermometer 50°	
On the ſummit of the mountain, about an hour and three quarters later than the firſt obſervation below, - - - - -	28,266
Thermometer 42°	
About an hour later at the ſame place - -	28,258
Thermometer 42°	
By the ſea ſide, where the firſt obſervation was made, and about three hours later - -	30,032
Thermometer 44°	

Height of the mountain calculated by M. De Luc from

the firſt obſervation - - -	1585 feet
From the ſecond obſervation - -	1592
Mean - - - - -	1588½ feet

 Means

Means uſed to aſcertain the Height of the Mountain Geometrically.

A point was fixed upon, in the moſt convenient place the ground would admit of between the ſummit of the mountain (a well-defined object) and the ſea ſide; from hence, in a right line from the mountain, a ſtaff was placed at the ſea ſide, by a Theodolite made by Ramſden, with two teleſcopes and double Vernier diviſions. The inſtrument was carefully adjuſted; firſt, by levelling the ſtand with a circular level, and afterwards the whole inſtrument by the croſs levels. From hence (A) at right angles to the ſtation at the ſea ſide (C) and the top of the mountain (E), a baſe was meaſured each way to (B) and (D) of eight lines of ſeventeen fathom each; in all, five hundred and forty-four yards. The diviſions of both the Verniers were carefully examined, both at ſetting off the ſtation by the ſea ſide, and thoſe at the extremities of each baſe, the fixed teleſcope being kept directed to the ſummit of the mountain, and the moveable one directed at right angles each way, both diviſions of the Vernier coinciding exactly. Station ſtaves were fixed perpendicular by the vertical hair of the teleſcope. The altitude of the mountain was then taken with the vertical arch, as a means of detecting any error in the obſervation, and was found to be

Z . . . . 8° 50′.

8° 50′. The diſtance not enabling me to take the depreſſion of any particular part of the ſtaff by the ſea ſide under the land on the other ſide accurately, I ſent a man to ſtand cloſe before it, and took the depreſſion nearly to his eye, which was found to be 1° 54′. The inſtrument was then removed to the ſtation on the right (B). The inſtrument being adjuſted with the ſame precautions as before, and the fixed teleſcope pointing to the center ſtation (A); the angle to the mountain was 84° 58′, the angle to the ſtation by the water ſide (C) 294° 44′. The inſtrument was then removed to the ſtation by the ſea ſide (C), the ſame precautions uſed in adjuſting, and the fixed teleſcope pointing to the center (A) in one with the mountain, the angle to the ſtaff on the right (B) was 24° 44′. Intending to make the triangle B C D iſoſceles, and imagining there might be ſome little error from the unevenneſs of the ground, I ſet off on the theodolite an angle equal to the laſt, having a perſon ready with a ſtaff on the baſe line to fix it where that angle ſhould interſect on looking through the teleſcope; I found it cut exactly at the ſtaff D 335° 16′, and from thence concluded the meaſure of the baſe to be exact. I then took the altitude of the mountain by the vertical arch 7° 44′. I then removed the inſtrument to the ſtation (D) to take the third angle; but from the badneſs of the ground, I could not place the inſtrument exactly over the ſpot where the ſtaff ſtood; from hence I took the third angle of the triangle; the fixed teleſcope pointing to (A) and the ſame precau-

 tions

tions of adjuſtment being obſerved, the angle to C came out 65° 15′; leſs by one minute than it ſhould have been. I then took from the ſame place the angle to the mountain (E) 275° 1′; more by one minute than the correſponding angle at the oppoſite ſtation (B): but the errors correcting each other, the whole angle CDE=150° 14′= the whole angle CBE.

By the triangle ABC, AC comes out 1771,4 feet:
By the triangle ABE, AE comes out 9265,0 feet:
Therefore the diſtance CE is - 11036,4 feet.
Angle of the mountain's elevation ſeen from C 7° 44′:
Height of the mountain above C - 1498,8 feet:
+ height of C above the water's edge 5:
Height of the mountain above the water's edge 1503,8 feet.

I prefer this obſervation to the others, becauſe the three angles of the triangle ABC came out exactly 180 degrees by the obſervation. The diſtance AC found by the computation, differed only four feet from that by the meaſure; but, the ground being uneven, I did not depend upon the meaſure, but took it merely as a check upon the operation, to detect an error, in caſe of any great difference.

The diſtance found by the ſimilar triangles BCE and CDE comes out - 11037 feet;
The angle of the mountain's elevation ſeen from A was - - 8° 50′;
Hence the height of the mountain above A was found - - - 1439,8 feet:
Depreſſion of C ſeen from A was 1° 54′;

Hence the height of A above C is - 58,7 feet;
Height of the mountain above C 1498,5 feet:
+ height of C above water's edge - 5;
Height of mountain above the level of the ſea 1503,5 feet; which differs from that found by the ſingle angle three tenths of a foot.

I cannot account for the great difference between the geometrical meaſure and the barometrical one according to M. De Luc's calculation, which amounts to 84,7 feet. I have no reaſon to doubt the accuracy of Dr. Irving's obſervations, which were taken with great care. As to the geometrical meaſure, the agreement of ſo many triangles, each of which muſt have detected even the ſmalleſt error, is the moſt ſatisfactory proof of its correctneſs. Since my return, I have tried both the theodolite and barometer, to diſcover whether there was any fault in either, and find them upon trial, as I had always done before, very accurate.

Fig I.

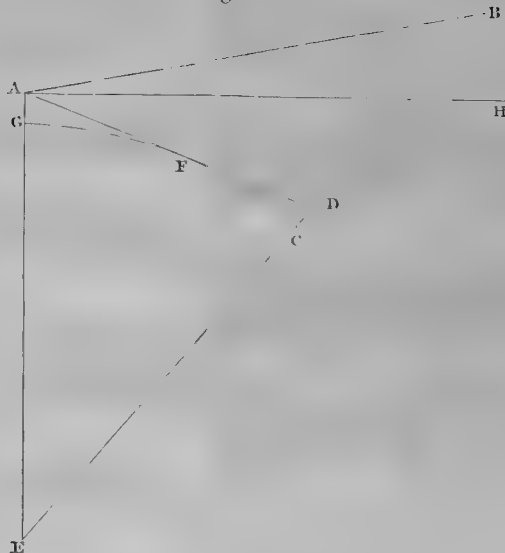
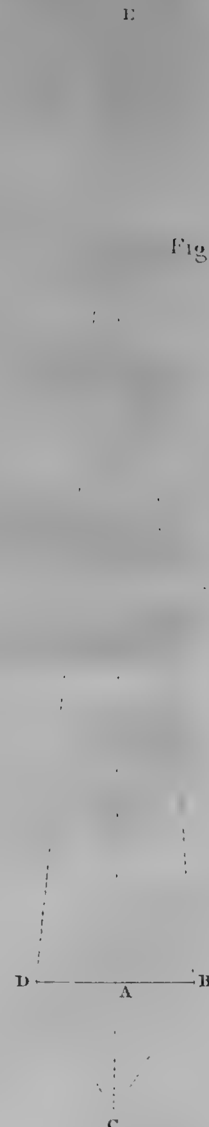


Fig II



Observations for determining the Acceleration of the Pendulum.

Defcription of the Pendulum with which the Obfervations were made, by Mr. Cumming.

"THE apparatus with which the following experi-
" ments were made, was prepared for the voyage
" with all the care which the fhortnefs of the time
" would admit, and particular attention was paid to its
" fimplicity. The pendulum was that which the late Mr.
" George Graham had conftructed, to afcertain the exact
" diftance between the center of motion and center of
" ofcillation of a pendulum to vibrate feconds at London.

" The ball is a fphere of folid brafs, whofe diameter is
" three inches and ninety two hundredth parts of an inch;
" and whofe weight is nine pounds and one quarter.

" The rod is a round fteel wire, one tenth of an inch
" thick, and is fo firmly fcrewed into the ball, that it
" cannot be unfcrewed by hand, nor the length of the
" pendulum altered without the application of proper
" inftruments for that purpofe, there being no adjufting
" fcrew as in clock-pendulums.

" The

"The axis of the pendulum is of hard-tempered ſteel, " nearly two inches long, and moves on angular or knife- " pivots, whoſe edges are formed with great care, ſo as to " lie exactly in the ſame right line; the pivots are formed " nearly to an angle of thirty-eight degrees from the edge " to the back; the ſharpneſs of the edges is taken off, " and they are carefully rounded, ſo that the lower parts " of both (on which the pendulum moves) form parts of " one continued cylinder, whoſe diameter is rather leſs " than the two hundredth part of an inch.

"Thoſe pivots move in angular notches made in two " pieces of hardened ſteel, each a quarter of an inch thick; " the notches are formed to an angle of one hundred " and twenty degrees, with their bottoms ſomewhat " rounding, and formed ſo that the whole length of the " pivot has an equal bearing in them; the ends or extremi- " ties of the pivots are ſloped from the edges on which " they move, towards the backs, or upper ſide; and " two plates of hardened ſteel are ſcrewed againſt the " angular notches in which the pivots move, ſo as to " confine them always to the ſame place in the notches, " and prevent ſuch irregularities as might otherwiſe happen " if the ſhoulders of the pivots ſhould chance to touch.

"Towards one end of the axis is pierced an oblong " ſquare hole, from the upper to the under ſide, into " which the upper end of the pendulum rod (having its

" ſides

" ſides ſomewhat flattened) is fitted, without ſhake, but
" in ſuch manner that it moves freely therein from back
" to front, round a ſteel pin which paſſes horizontally
" through it and the axis, that both the pivots may
" have an equal bearing, and the pendulum may hang
" truely perpendicular, without any tendency to bend its
" rod, and by that means alter its time of vibration, even
" though the axis be not accurately adjuſted to a level
" poſition: The error which might ariſe from accidental
" friction on the above ſuppoſition, of an inaccurate
" levelling of the axis, is obviated by means of the ſteel
" plates againſt which the *very central point* of the loweſt
" pivot muſt in ſuch caſe act.

" To the other end of the axis, is ſcrewed a pair of
" pallets, conſtructed nearly on Mr. Graham's principle
" of the *dead-beat*, but differing from it in having a
" degree of recoil which tends to render the longer vibra-
" tions of the pendulum as quick as the ſhorter: but
" this precaution is the leſs neceſſary, becauſe the weight
" which keeps the machine in motion is ſo adjuſted, as
" to make the angle of conſtant vibrations as nearly as
" poſſible the ſame with the angle of ſcapement; that is,
" to make the vibrations the ſhorteſt, that will admit
" of the wheel to eſcape the pallets: by this means,
" if the oil applied ſhould become glutinous, ſo as to
" diminiſh the action of the wheel on the pendulum, or
" if any other circumſtance ſhould happen to ſhorten the

" arc

" arc of vibration of the pendulum, the weight which " keeps it in motion muſt be increaſed, till it is found juſt " ſufficient to keep the machine going; by which means " there is a certainty that the pendulum vibrates ſimilar " arcs in each experiment, even if the obſerver ſhould not " attend to that circumſtance.

" The ſwing-wheel is made of tempered ſteel, and the " points of its teeth are left much thicker than they " uſually are in clocks, in order to avoid accidents; it " has thirty teeth, and carries with it a divided circle " which ſhews ſeconds.

" On the axis of the ſwing-wheel there is a pinion, on " which another wheel acts: and in the axis of this laſt, " there is a ſmall pulley, in the groove of which is applied " the line which keeps the machine going, by means of " a weight and counter-weight, in the manner deſcribed " by Huygens in the eighth and eighteenth pages of his " *Horologium oſcillatorium:* this method is the ſimpleſt " of any for keeping the wheels in motion while the " weight is winding up, and is peculiarly advantageous " in ſuch machines as this, which require frequent " winding: the weight applied to this machine was ſix " ounces Troy, which with a deſcent of thirty-two inches " kept it going for three hours, with a vibration of three " degrees.

" The whole is contained in a ſtrong braſs frame, " ſcrewed on the top of a three-legged wooden ſtand, " three feet four inches high: the front legs extend three " feet eight inches in the direction of the vibration, and " the back leg extends three feet four inches from each of " the front legs, at which diſtance the three legs are " ſo connected at bottom, by horizontal rods, that " they cannot poſſibly alter their relative poſition; by " theſe means the point of ſuſpenſion of the pendulum " is rendered much more immovable than could be " done in any portable clock having a caſe of the uſual " dimenſions, without great trouble, and an apparatus ill " ſuited for experiments of this nature.

" In the middle of the horizontal bar that connects the " front legs is fixed a piece of ſilvered-glaſs, by means of " which the whole machine is readily adjuſted to its " proper poſition: the lower part of the pendulum-" ball hangs directly over this mirror, on which is drawn " a line from back to front; and when the image of a " ſmall pin, which is ſcrewed into the lower part of the " pendulum, is ſeen biſected by this line viewed directly in " front, the poſition of the machine is properly adjuſted.

" On the back leg of the ſtand, immediately behind the " pendulum, is a hook to hang a thermometer on, for " making frequent obſervations of the temperature of the " air. In order to prepare for an experiment, the pendulum

" is made to vibrate till 60 on the ſecond-circle comes to " the index, and is then to be held at the extremity of " its vibration by a trigger; on preſſing which with the " finger, the pendulum is diſengaged in an inſtant: hence " the vibrations muſt be of equal extent in every experi- " ment.

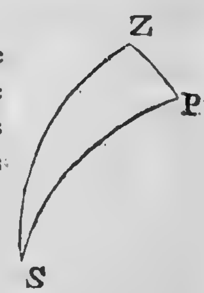
" The wooden ſtand which ſupports the pendulum is " ſo conſtructed, that it forms an oblong ſquare box, in " which the pendulum, with every part of its apparatus, " is with great facility and expedition packed; ſo ſecurely " that no part can receive damage; and the whole is ſo " portable, that it may with eaſe be carried on a man's " ſhoulder to any acceſſible place.

" This pendulum immediately before the voyage was " compared with a well-regulated eight-day clock, and in " twelve hours its beat did not differ ſenſibly from that of " the clock; Fahrenheit's thermometer being then at 60°."

July the ſixteenth the Pendulum and the Equatorial Inſtrument were landed on a ſmall rocky iſland in latitude 79° 50′ N; and the pendulum being carefully ſet up in a ſmall tent erected for that purpoſe, and its poſition truly adjuſted, a thermometer was ſuſpended on the hook behind the pendulum-rod; and the pendulum being repeatedly put in motion, it was found to ſtop, till a muſket bullet and a half was added to the weight, which was found ſufficient to keep it in motion; when it was thus found to continue its vibration, it was locked by the trigger at 60″. The equatorial inſtrument was ſet up on a baſis of ſolid rock, and being in this caſe to be uſed only as a tranſit inſtrument, no attempt was made to adjuſt it either to the latitude or meridian of the place; but the azimuth and equatorial circles being truely levelled, the teleſcope was directed towards the ſun, and ſo elevated that it ſhould paſs as near as poſſible through the middle of the field. The inſtrument being thus prepared, the Weſt limb of the ſun was obſerved to touch the Eaſt ſide of the vertical wire in the teleſcope at 5^h 19′ 28″ in the afternoon, by the watch; and at the ſame inſtant the pendulum was unlocked, and kept vibrating till after the ſun had completed its revolution, and its Weſt limb was again ſeen to touch the ſame ſide of the vertical wire.

From the vertical poſition of the wire and the time of the day, the ſun's motion had a degree of obliquity with reſpect to the wire, which muſt occaſion its diameter to take a longer time in paſſing than if it croſſed the wire at right angles: this poſition of the wire, together with the change of the ſun's declination, prolong the time of the ſun's coming again to the wire; ſo that there was an interval of twenty-four hours, forty-nine ſeconds and a half, from the time that the ſun's limb touched the wire on the ſixteenth day of July, to the time of its return to the ſame wire on the ſeventeenth day*.

During the time of this revolution of the ſun, an account was kept of the thermometer, and ſeveral compariſons made of the rate of the going of the pendulum with my ſecond-watch: in making which, I always took the time by the watch, when the pendulum ſhewed 60″: theſe compariſons were chiefly intended to prevent a miſtake of a whole minute in eſtimating the acceleration of the pendulum, which only ſhewed ſeconds, having no index for minutes:



* July the ſixteenth P. M. at 5^h 19′ 28″ by the watch: the angle S between the vertical and circle of declination was 10° 49: the ſun's altitude 20°; its declination 21° 8′: the change in the ſun's declination in 24^h, was 10′ 11″: hence the time of the ſun's coming to the ſame vertical hair of a teleſcope, will be retarded 44″,1: for (by Cotes, *Æſtimatio Errorum*, Theor. 35.)

As ſine Z P or coſine latitude, — — Comp. Ar.	0,75322
Is to tang. S. 10° 49′; — — —	9,28117
So is the change in declin. 10′ 11″ ſine, — —	7,47161
To 11′ 1″ the change in the hor. angle ſine, —	7,50600
Which turned into time, gives — —	44″,1
The change in the equation of time is — —	5,4
Therefore the interval between the two tranſits is —	24^h 0′ 49,5
It was obſerved — — —	24 (2) 4,5
The difference is the gain of the pendulum — —	(1) 15

To

minutes: and as a candid inveſtigation of a matter that had ſo much engaged the attention of the beſt philoſophers and mathematicians was the only object of my wiſh, I judged it beſt, in the firſt place, to give the obſervations juſt as they were made, regularly numbered, that they may be readily referred to from the following tables, in which the order of the original obſervations is varied, according to the periods of time between each pair of obſervations. By thus giving the foundations on which the concluſions depend, all perſons, who chuſe it, may trace and examine every ſtep towards the concluſion, and by that means be enabled to detect any error that may have crept into the operation; or draw ſuch further concluſions as their ingenuity may ſuggeſt, and the materials here given may warrant.

To find the time of the ſun's diameter paſſing a vertical hair. (Cotes, *Æſtim. Error.* Theor. 21.)

As the product of { Coſine declination	—	—	Comp. Ar. 0,03024
Coſine S.	—	—	Comp. Ar. 0,00778
Is to the product of Radius and Coſ. Altitude;	—	—	19,97298
So is the ſun's diameter in time 135″,6,	—	—	2,13226
To the time ſought	—	139″,1 = 2′ 19″,1 —	2,14326
It was obſerved	—	2′ 21″,0	
	Difference	1″,9	

Although the obſervation of the ſun's diameter paſſing the wire has no immediate connection with our concluſion; yet the agreement between the calculated and the obſerved time of its paſſing, ſerves to ſhow that the proper allowance was made for the obliquity of the direction in which it paſſed the wire.

Day of the Month.	N°	Time by the Watch.	Time by the *Pendulum.*	Thermometer.	Remarks.
		h ′ ″	″		
July 16th P. M.	1	5 19 28	60	50	Equatorial fixed.
	2	6 30 00	. .	49½	
	3	7 00 00	. .	50	
	4	8 00 00	. .	49	
	5	8 30 00	. .	49	
	6	9 00 00	. .	45	
	7	9 30 00	. .	45	
	8	10 00 00	. .	45	
	9	11 00 00	. .	45	
	10	11 30 00	. .	48½	
	11	12 00 00	. .	48½	
	12	12 30 00	. .	46	
	13	12 39 14	60	51	
17th A. M.	14	1 00 00	. .	50½	
	15	2 55 9	60	49	
	16	5 00 00	. .	45	
	17	6 00 00	. .	44	
	18	7 00 00	. .	49½	
	19	8 00 00	. .	47	
	20	9 00 00	. .	49½	
	21	11 2 23	60	58½	
	22	12 00 20	60	56	
P. M.	23	1 00 00	. .	54	
	24	2 30 00	. .	52½	
	25	3 30 00	. .	56	
	26	4 00 00	. .	55½	
	27	4 46 10½	60	52½	
	28	[5 19 24]	4½		Tranſit of the Sun's Weſt limb.
	29	. . .	25		Tranſit of the Sun's Eaſt limb.
	30	5 24 9	60	51	

It

It has already been ſaid that the watch was uſed only to prevent an error of *whole minutes*, in eſtimating the time gained by the pendulum in twenty-four hours; the exact period of twenty-four hours being determined by the revolution of the ſun.

In order to obtain the acceleration of the pendulum, the original obſervations are transferred from the foregoing table, to that which follows, for the convenience of arranging them according to the length of the intervals, beginning with thoſe of the ſhorteſt duration: ſo that the concluſion from each period becomes a check upon thoſe that follow.

In this table *the firſt column* refers to the original obſervations, from which a concluſion is here to be drawn; thus, in the firſt line, we find 27—30, by which is meant that a concluſion is to be drawn in this line from obſervations 27 and 30, that is, from the acceleration of the pendulum from four hours, forty-ſix minutes, ten ſeconds and a half, to five hours, twenty-four minutes nine ſeconds in the afternoon, July 17.

The ſecond column expreſſes the interval of time by the watch, between each pair of obſervations referred to in the firſt.

The third column ſhews how much the pendulum gained on the watch, in each period expreſſed in the ſecond.

The fourth column ſhews the mean height of the Thermometer for each period.

The

The fifth column expreſſes the difference between this mean height, and 60°, the height of the thermometer at London when the pendulum was adjuſted.

The ſixth column ſhews the contraction of the pendulum rod by the degree of cold expreſſed in the fifth column, according to Mr. Smeaton's experiments, publiſhed in N° 79 of the Philoſophical Tranſactions for the year 1754.

The ſeventh column ſhews how much this contraction would make the pendulum gain during each period of the ſecond column.

The eighth column ſhews how much the pendulum would have gained on the watch in each period, if the thermometer had remained at 60°, and therefore no contraction of the pendulum-rod had taken place.

The ninth column ſhews how much the watch ought to have loſt in each period, allowing it to have loſt uniformly at the rate of four ſeconds in twenty-four hours, as was obſerved by the tranſit.

The tenth column ſhews how much the pendulum would have gained on the watch, in each period; allowing for its loſing at the rate of four ſeconds in twenty-four hours, and ſuppoſing the thermometer to have remained conſtantly at 60°.

The eleventh column ſhews how much the pendulum would gain *per* hour according to the rate of acceleration given in the tenth column for each period.

TABLE [*A*.]

Obfervations with the *Pendulum* from the 16th to the 18th of July, 1773, in Latitude 79° 50′ N.

1 Obfervations referred to.	2 Duration in Time by the Watch.	3 Seconds gained by the *Pendulum*, on the Watch.	4 Mean Height of the Thermometer.	5 Difference between the Height of the Thermometer at the Time of adjuftment at London, and at the Time of Obfervation.	6 Contraction of the *Pendulum* rod by the cold, in parts of an Inch.	7 Time gained on the Watch by the contraction of the *Pendulum* rod.	8 Time gained by the *Pendulum* on the Watch, corrected for the Thermometer.	9 Time loft by the Watch, according to its Rate of going, as determined by the tranfit.	10 Time gained by the *Pendulum* on the Mean Time, allowing for the Thermometer, and Rate of the Watch's lofing.	11 *Ratio* of Acceleration *per* Hour.
	H ′ ″	″	°	°		″	″	″	″	″
27——30	0 37 58½	1½	52	8	,0020	0,06	1,44	0,10	1,34	2,12
21——22	0 57 57	3	57	3	,0007	0,03	2,97	0,15	2,82	2,93
13——15	2 15 55	5	49¼	10¾	,0027	0,28	4,72	0,37	4,35	1,92
22——27	4 45 50½	9½	53¾	6¼	,0015	0,35	9,15	0,78	8,37	1,75
22——30	5 23 49	11	53	7	,0017	0,44	10,56	0,90	9,66	1,79
21——27	5 43 47½	12½	54½	5½	,0014	0,37	12,13	0,95	11,18	1,95
21——30	6 21 46	14	54½	5½	,0014	0,41	13,59	1,05	12,54	1,97
1——13	7 19 46	14	47½	12½	,0031	1,06	12,94	1,21	11,73	1,60
15——21	8 7 14	46	48¾	11¼	,0028	1,05	44,95	1,34	43,61	5,37
15——22	9 5 11	49	50¾	9¼	,0023	0,98	48,02	1,51	46,51	5,12
1——15	9 35 41	19	48	12	,0030	1,33	17,67	1,60	16,07	1,67
13——21	10 23 9	51	49½	10½	,0026	1,26	49,74	1,72	48,02	4,62
13——22	11 21 6	54	50	10	,0025	1,31	52,69	1,88	50,81	4,47
15——27	13 51 1½	58½	52	8	,0020	1,28	57,22	2,30	54,92	3,96
15——30	14 29 0	60	51¾	8¼	,0021	1,38	58,62	2,41	56,21	3,88
13——27	16 6 56½	63½	54	6	,0015	1,11	62,39	2,68	59,71	3,70
13——30	16 44 55	65	53¾	6¼	,0016	1,22	63,78	2,78	61,00	3,64
1——21	17 42 55	65	48¾	11¼	,0028	2,30	62,70	2,94	59,76	3,37
1——22	18 40 52	68	49¼	10¾	,0027	2,33	65,67	3,11	62,56	3,34
1——27	23 26 42½	77½	50½	9½	,0024	2,58	74,92	3,90	71,02	3,02
1——30	24 4 41	79	50¼	9¾	,0024	2,72	76,28	4,01	72,27	3,00

It

It appears by the original obſervations that the pendulum began its vibrations at 60″, the inſtant in which the firſt limb of the ſun was obſerved to touch the ſide of the vertical wire in the teleſcope of the Equatorial, that is, at five hours, nineteen minutes, twenty-eight ſeconds in the afternoon by the watch, on the 16th of July; and by every compariſon of the pendulum with the watch, that the pendulum was conſtantly gaining on the watch, and in a period of twenty-four hours, four minutes, forty-one ſeconds, had gained on the watch ſeventy-nine ſeconds; and when the revolution of the ſun was completed, it appeared, that the watch had loſt four ſeconds in the exact period of twenty-four hours; therefore, if four ſeconds loſt by the watch, be ſubtracted from ſeventy-nine, the time gained by the pendulum on the watch, it will leave ſeventy-five ſeconds for the time gained by the pendulum on the *mean*, or true time, no deduction being here made for the contraction of the pendulum-rod by the cold.

The odd fifteen ſeconds are determined by obſerving, that the pendulum ſhewed four ſeconds and a half exactly when the ſun had again returned to the vertical wire; ſo that this period is determined wholly by the ſun, and totally independent of the watch; but as the watch is found by the ſame obſervation to have loſt only four ſeconds, recourſe is had to the intermediate compariſons of it with the pendulum, which clearly ſhow that the pendulum had gained *one whole minute*, together with the fifteen seconds determined by the pendulum and the revolution of the sun: and although it appears by the eleventh column of the foregoing table that the watch did not lose uniformly at the rate of four seconds in twenty-four hours, yet its mean rate leaves as little doubt with regard to the *whole minute* gained by the pendulum, as if its going had been perfectly uniform during the whole time. For, if from the sum of all the periods in the second column, and of all the accelerations in the tenth, a mean rate be taken, it makes the acceleration of the pendulum on the watch to be 80″,79 in twenty-four hours, which differs from the acceleration observed by the revolution of the sun only 5″,75; and from the rate of going of the watch, determined by the revolution of the sun, only 1″,79: hence there can be no possible room to suppose an error of a whole minute.

Although the period of twenty-four hours, and the rate of going of the watch for that time, are very accurately determined by the revolution of the sun; it may not be improper here to take notice, that from a mean of six altitudes of the sun, taken by a very good astronomical quadrant of eighteen inches radius, the watch was computed to have lost 5″$\frac{1}{2}$, in twenty-four hours, which differs from the rate given by the revolution of the sun only 1″$\frac{1}{2}$; this may serve to shew how far the mean of a great number of observations by the same observer and inſtrument may be relied on, when there is no other obſervation to check or corroborate.

It may alſo be proper here to mention, that the time by the watch was not obſerved at the inſtant that the ſun had returned to the vertical wire, and at which the pendulum was obſerved to ſhow $4\frac{1}{2}$ ſeconds, my attention being wholly engaged in obſerving the pendulum. The watch was found to have loſt $77''\frac{1}{2}$ by the pendulum, in twenty-three hours, twenty-ſix minutes, forty-two ſeconds and a half. An allowance according to this rate for $34'\ 4''$ (the ſupplement of the laſt obſervation by the watch to the time of the ſun's paſſage when the pendulum ſhewed $4''\frac{1}{2}$) amounts to $1''\frac{1}{2}$.

From whence it follows, that the Weſt limb of the ſun touched the Eaſt ſide of the vertical hair at five hours, twenty minutes, thirteen ſeconds and a half, by the watch; which had therefore loſt four ſeconds in twenty-four hours.

As the compariſon of the watch and the pendulum in this one inſtance is not from actual obſervation, *at the inſtant*, but ſuppoſes that the watch had kept for thirty-four minutes to the ſame rate of loſing at which it had been obſerved to loſe for nearly twenty-four hours immediately preceding; the time by the watch *thus found* is inſerted in the table of obſervations within hooks to diſtinguiſh it, that every perſon may have an opportunity of judging how far it ought to be admitted. Upon the whole it appears, that by the revolution of the ſun, corrected for the oblique direction in which it paſſed the vertical wire in the teleſcope, the change of declination and the equation from the time of its Weſt limb touching the wire on the 16th, to the time of its touching the ſame wire on the 17th of July, that the pendulum gained ſeventy-five ſeconds in twenty-four hours. But as the mean height of the thermometer for the time of this experiment was $9^{\circ}\frac{3}{4}$ lower than 60°, the height at which it was at London when the pendulum was compared with the clock; the pendulum ought on this account, according to Mr. Smeaton's experiments, to have been contracted $\frac{24}{10000}$ of an inch, and to have gained on that account 2,″72; ſo that the acceleration of the pendulum ariſing only from the difference between the latitude of London and 79° 50′ N, is 72″,28.

The pendulum was continued in motion, and the comparisons between it and the watch made as before, with intention to take a ſecond revolution of the ſun: but at eleven o'clock next morning, the wind being fair, and the weather cloudy ſo as to afford no proſpect of ſeeing the ſun in the afternoon, the inſtruments were taken on board, and the ſhips ſailed immediately.

August

Auguſt the fourteenth, we landed the Pendulum, Equatorial Inſtrument, and aſtronomical Quadrant on Smeerenberg Point, latitude 79° 44′ N; and ſet up the pendulum in every reſpect as formerly deſcribed. The equatorial and quadrant were alſo ſet up, and prepared for obſervation.

The pendulum was ſet a going when it was exactly $6^h\ 0'\ 0''$ P. M. by my watch, from which time it was frequently compared with the watch, till $5^h\ 50'$ A. M. the 15th; when the pendulum ſtopped. It was again ſet a going with the additional weight which had formerly been uſed, when the watch was exactly $6^h\ 00'\ 00''$, and continued going from that time till after five in the morning of the 18th, in which time the thermometer was obſerved, and the watch and pendulum compared, as in the following table: many altitudes of the ſun were taken with the quadrant, on the 15th A. M. but without any further opportunity till the 18th A. M. when they were repeated to aſcertain the rate of the watch's loſing.

Day

Day of the Month.	N°	Time by the Watch.	Time by the *Pendulum.*	Thermometer.	Remarks.
		h ′ ″	″	°	
Aug. 14th, P. M.	1	6 00 00	60	44	
	2	7 29 53½	60	43	
	3	12 13 30½	60	40	
15th, A. M.	4	5 00 09	60	36	The *Pendulum* ſet agoing with the additional Weight.
	5	6 00 00	60	35	
P. M.	6	2 09 22½	60	{36 36	
	7	8 59 49	60	37	
16th, A. M.	8	2 00 00	.	{36 36½	
	9	3 00 00	.	37	
	10	4 00 00	.	36	
	11	5 00 00	.	37	
	12	6 00 00	.	36½	
	13	7 00 00	.	37	
	14	8 00 00	.	37	
	15	9 00 00	.	37	
	16	10 00 00	.	37	
	17	11 00 00	.	37	
Noon	18	12 00 00	.	37	
P. M.	19	1 00 00	.	37	
	20	2 01 39½	60	37	
	21	3 01 34½	60	37	

Day

Day of the Month.	N°	Time by the Watch.	Time by the *Pendulum.*	Thermometer.	Remarks.
		h ′ ″	″	°	
	22	7 13 16	60	38	
	23	9 00 00	.	38	
	24	10 00 00	.	37½	
	25	11 00 57	60	37	
Midnight,	26	12 00 00	.	38	
Aug. 17th, A. M.	27	1 00 00	.	38	
	28	2 00 00	.	38	
	29	3 00 00	.	38	
	30	4 00 00	.	37½	
	31	5 00 00	.	37½	
	32	6 00 00	.	38	
	33	7 00 00	.	37½	
	34	8 00 00	.	37½	
Noon	35	9 00 00	.	37½	
P. M.	36	10 00 00	.	38½	
	37	11 00 00	.	37	
	38	12 00 00	.	39½	
	39	1 00 00	.	40	
	40	2 02 58	60	41	
	41	4 23 45½	60	40	
	42	10 00 19½	60	39	

Between five and ſix in the morning of the eighteenth, it blew hard, and the *Pendulum* ſtopped.

The

The following table is conſtructed in every reſpect the ſame as that deſcribed page 163, and differs from it only in having an *additional column*, in which is given the rate of acceleration of the Pendulum in twenty-four hours, according to the time by the watch, corrected by a mean of ſixteen altitudes of the ſun taken on the 15th, and a mean of thirty-nine altitudes on the 18th of Auguſt, from which the watch appears to have loſt, during the interval of the three days, at the rate of 23″,7 per day. The rate of acceleration of the pendulum in twenty-four hours being thus determined, agreeable to the acceleration obſerved in each of the laſt eight periods, being thoſe of the longeſt duration; and theſe obſervations being already corrected for the thermometer; a mean is taken from the whole as the true rate of acceleration of the pendulum on mean time in twenty-four hours.

TABLE

TABLE [B.]

Obfervations with the Pendulum from the 14th to the 16th of Auguft, 1773, in Latitude 79° 44′ N.

1 Obfervations referred to	2 Duration in Time by the Watch.	3 Seconds gained by the *Pendulum* on the Watch.	4 Mean Height of the Thermometer.	5 Difference of the Thermometer at the Time of adjuftment in London, and at the Time of Obfervation.	6 Contraction of the *Pendulum* rod by the cold, in parts of an Inch.	7 Time gained on the Watch by the contraction of the *Pendulum* rod.	8 Time gained by the *Pendulum* on the Watch, corrected for the Thermometer.	9 Time loft by the Watch according to its Rate of going, as determined by the Altitudes of the Sun.	10 Time gained by the *Pendulum* on the Mean Time, allowing for the Thermometer and rate of the Watch's lofing.	11 Ratio of Acceleration *per* Hour.	12 Ratio of acceleration of the *Pendulum* on the Mean Time in Twenty-Four Hours.
	h ′ ″	″	°	°		″	″	″	″	″	
20—21	0 59 55	5	37	23	,0057	0,26	4,74	0,99	3,75	3,75	
1—2	1 30 00	6½	43⅓	16⅔	,0042	0,25	6,25	1,47	4,78	3,19	
40—41	2 20 47½	12½	40	20	,0050	0,54	11,96	2,31	9,65	4,11	
41—42	5 36 34	26	40	20	,0050	1,25	24,75	5,63	19,12	3,41	
1—3	6 13 30	29½	40¾	19¼	,0049	1,41	28,09	6,14	21,95	3,52	
5—6	8 9 22½	37½	36	24	,0060	2,26	35,24	8,04	27,20	3,34	
1—4	11 0 9	51	38¾	21¼	,0054	2,70	48,30	10,86	37,44	3,41	
5—7	14 59 49	60	36	24	,0060	4,17	55,83	14,79	41,04	2,73	″
25—42	22 59 22½	97½	38½	21½	,0054	5,75	91,75	22,71	69,04	3,00	. . 72,07
21—40	23 01 23	96½	38	22	,0055	5,86	90,64	22,73	67,91	2,95	. . 70,79
6—20	23 52 17	103	36	24	,0060	6,60	96,40	23,55	72,85	3,05	. . 73,24
20—40	24 01 18	101½	38¼	21¾	,0054	6,00	95,50	23,72	71,78	2,99	. . 71,71
6—21	24 52 12	108	36⅔	23⅓	,0057	6,75	101,25	24,59	76,66	3,08	. . 73,98
21—41	25 22 11	109	38	22	,0055	6,49	102,51	24,43	78,08	3,07	. . 73,86
6—40	47 53 35½	204½	38	22	,0055	12,20	192,30	45,49	146,81	3,06	. . 73,57
5—42	64 00 19½	280½	37½	22½	,0056	16,67	263,83	63,20	200,63	3,13	. . 75,23
											Mean 73,06
											Which gives the Acceleration of the Pendulum on true Time from the change of Latitude.

From

From the refult of this table, the time gained by the pendulum in twenty-four hours of mean time, after deducting the acceleration on account of the contraction of its rod by the cold, is feventy-three feconds, and fix hundredths of a fecond; which is one fecond, and two hundredths of a fecond more than by the refult of the obfervations of the 16th and 17th of July. But although the rate of going of the watch from the 15th to the 18th days of Auguft, was afcertained by a mean of fifty-five altitudes of the fun, I am inclined to give the preference to the obfervations of July, where the exact period of twenty-four hours was determined by a revolution of the fun, obferved with a telefcope whofe magnifying power was fixty. And notwithftanding that the height of the thermometer during the time of obfervation in Auguft was remarkably uniform, and that the watch was found by the comparifons with the pendulum to have loft during the whole time as uniformly as could reafonably be expected; yet a fmall irregularity in its rate of going near the beginning or end of the obfervation, might occafion the difference of this refult from the former.

As the time corrected by the mean of fix altitudes of the fun taken on the 16th and 17th July, differed only one fecond and a half from that obferved by the revolution of the ſun, there is reaſon to believe that the period of three days, determined by a mean of fifty-five altitudes, taken on the 15th and 18th of Auguſt, might be relied on to one ſecond at moſt: and that, although the concluſion from the obſervations of Auguſt are not ſo deciſive, on account of its depending in ſome ſmall degree on the regularity of the watch, it ſtrongly corroborates the concluſion from the obſervations in July, as it proves that the acceleration of the pendulum proceeded from an uniform cauſe, which produced equal effects in each caſe. This is yet further proved, by comparing the pendulum when it returned to London with the ſame clock with which it had been compared before the voyage, the thermometer being at this time alſo at 60°, and the additional weight of a muſket bullet and a half being applied to the weight which kept it going; the pendulum and the clock were found to agree ſo well, that no ſenſible difference could be diſtinguiſhed in their beats for the ſpace of twelve hours.

From all which circumſtances it may fairly be concluded, that a pendulum which vibrates ſeconds at London, will gain from ſeventy-two to ſeventy-three ſeconds in twenty-four hours, in latitude 79° 50′; allowing the temperature of the air to be the ſame at both places.

These observations give a figure of the earth nearer to Sir Isaac Newton's computation than any others which have hitherto been made.

According to Sir Isaac Newton the Pendulum gains in latitude 79° 50′,	66″,9;	
In which case the equatorial diameter would be to the polar as - -		230 to 229:
According to Mr. Bradley's computation, from Mr. Campbell's observations,	76,6;	
Equatorial diameter to the polar as -		201 to 200:
According to Maupertuis, - -	86,5;	
Equatorial diameter to the polar as -		178 to 179:
According to my observations, -	72,28 73,06;	
Equatorial diameter to the polar as -		212,9 to 211,9 210,7 to 209,7:
The mean of which is very nearly as -		212 to 211.

REFERENCE TO PLATE XI.

Fig. 1. Is a general view of the apparatus when fitted up; the pendulum being locked by the trigger, and ready for an experiment.

Fig. 2. The upper part of fig. 1, on a larger ſcale, in order to ſhew the ſeveral parts more diſtinctly.

Fig. 3. Repreſents the whole frame and apparatus when packed for carriage.

Fig. 4. Is the cap which covers the wheels and pallets, detached from fig. 3.

A.	Fig. 1.	The pendulum-ball.
B. B.		The pendulum-rod.
C. C.	Fig. 2.	The axis of the pendulum.
D.	-	An oblong hole in the axis, into which the end of the pendulum-rod is fitted, and ſecured by means of the ſteel pin *d*.
E. E.	-	The upper part of the wooden frame; to which the three legs are ſtrongly fixed by hinges and table-joints, and on which is ſcrewed
F. F. F. F.		A ſtrong braſs frame which ſupports the pendulum and wheels.

G. G.

G. G. Fig. 1. A flat board that forms one of the ſides of the box, fig. 3, and has two ſmall mortiſes near its ends, which receive the points of the fore-legs of the ſtand; two ſmall ſteel rods, which are jointed near the lower end of the back-leg hook into the ends of this board, ſo as to preſerve the relative poſition of the three legs unalterable: and near the middle of it is fitted

H. - A piece of ſilvered glaſs, with a diamond line on it from back to front, for adjuſting the poſition of the ſtand: and

I. - The trigger for locking the pendulum.

K. - A wooden wedge which is occaſionally put under either end of the board G. G. to adjuſt the ſtand to its proper poſition; and when packed, is put in its place, as repreſented in the figure.

L. L. L. Pieces of wood ſcrewed to the legs, having cavities in them which embrace the pendulum-ball when the legs of the ſtand are brought together in order to be packed, as in fig. 3.

M. - A flat piece of wood, under the ends of which are confined the ſteel rods that connect the back leg of the ſtands to the board G. G. when the ſtand is packed.

N. A turn-

N.	-	A turn-button, under which the line which carries the weights is put when packed for carriage.
O.	-	A pin on which the weights are put when packed.
P.	-	The pulley and ratchet by means of which the machine is kept going whilſt it is winding up.
Q.	-	The weight that keeps the pendulum in motion.
R.	-	The counter-weight.
S.	-	The index which ſhows the ſeconds on a divided circle fixed on the axis of the ſwing-wheel.
T.	-	The thermometer ſuſpended on a hook immediately behind the pendulum wire.
W. W.		Two leather ſtraps that ſecure the whole when packed, as in fig. 3.

Fig. 2.

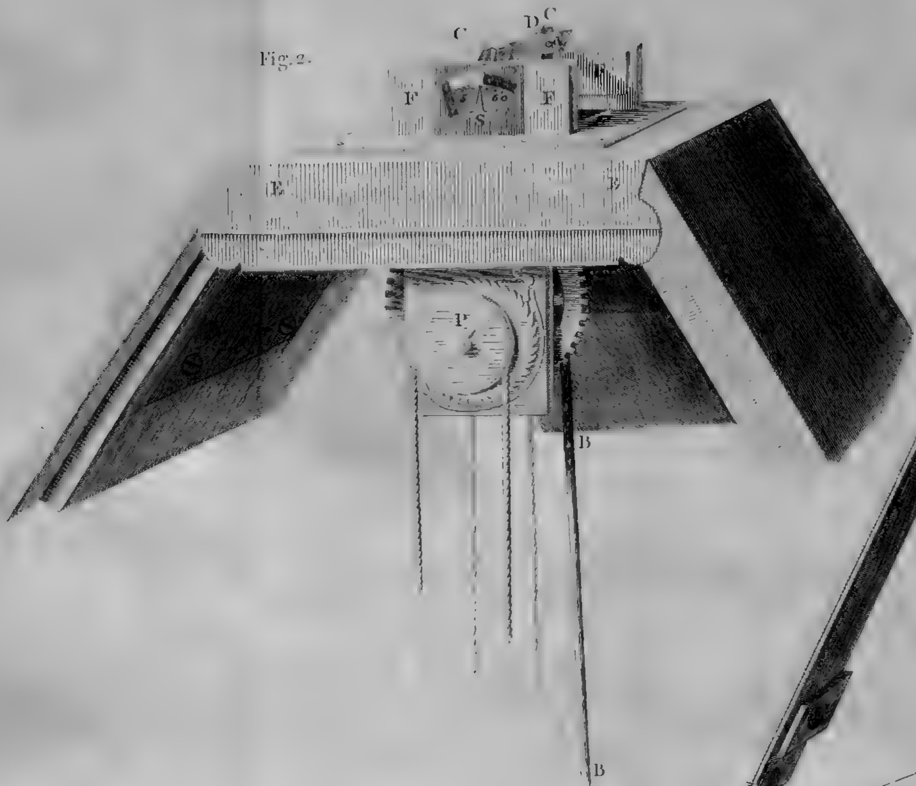


Fig. 1

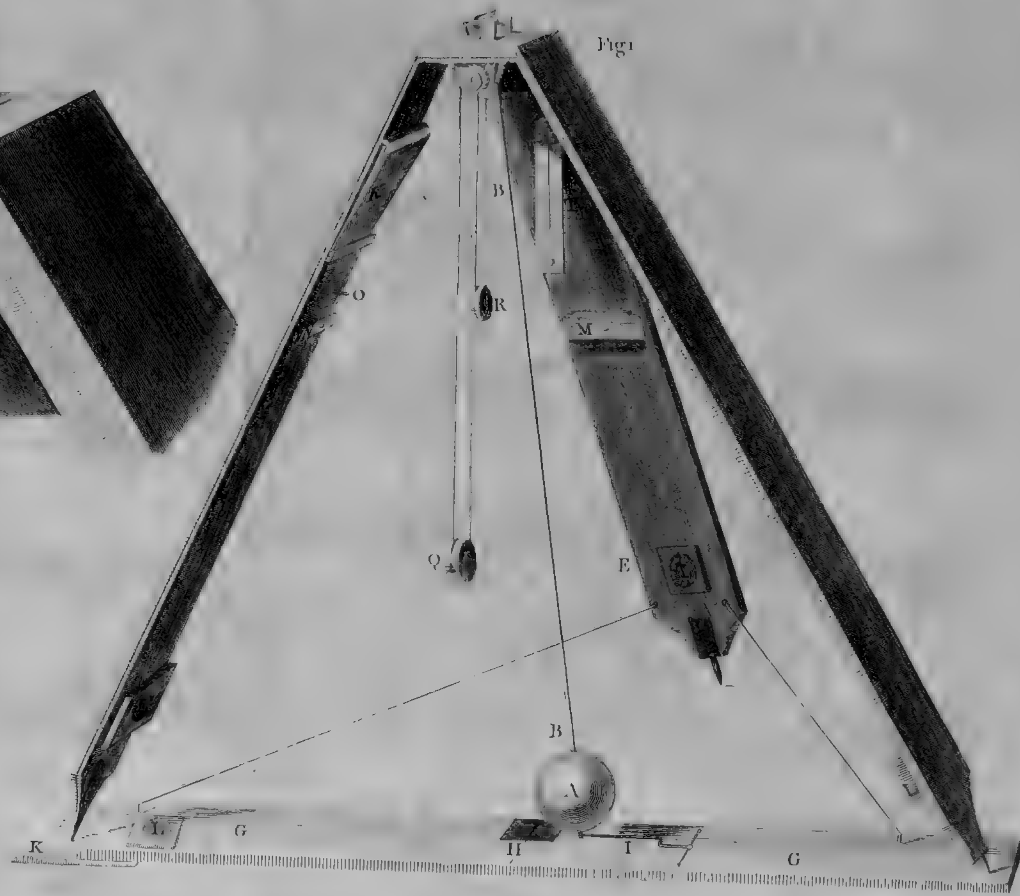


Fig. 3.

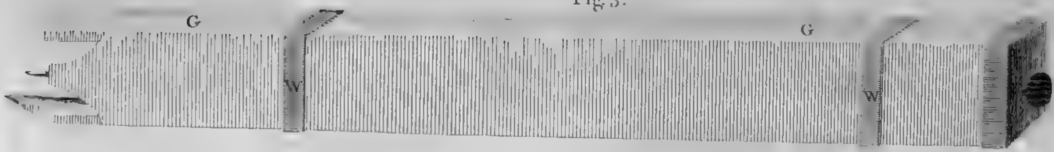
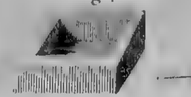


Fig. 4.



11

NATURAL HISTORY.

THOUGH the ſhortneſs of my ſtay at Spitſbergen, and the multiplicity of occupations, in which I was neceſſarily employed, during the greateſt part of that time, rendered it impoſſible for me to make many obſervations on its natural productions; yet as there are among thoſe few ſome which have not before been made public, I am in hopes that this article will not be found wholly unprofitable. The following catalogue, imperfect as it is, may ſerve to give a general idea of the ſparing productions of that inhoſpitable climate.

As modern naturaliſts have formed the technical terms of their ſcience out of the Latin, it becomes neceſſary to make ſome uſe of that language, in order to render the deſcriptions of ſuch things, as are new, intelligible to thoſe for whoſe uſe they are intended: I ſhall always, however, annex Engliſh names to the ſcientifick ones, when ſuch are to be found.

MAMMALIA.

MAMMALIA.

TRICHECHUS *Rosmarus*, *Linn. Syst. Nat.* 49. 1.
Arctick Walrus. *Penn. Syn. Quadr.* p. 335.

This animal, which is called by the Russians Morse, from thence by our seamen corruptly Sea Horse, and in the Gulph of St. Lawrence Sea Cow, is found every where about the coast of Spitsbergen, and generally where-ever there is ice, though at a distance from the land. It is a gregarious animal, not inclined to attack, but dangerous if attacked, as the whole herd join their forces to revenge any injury received by an individual.

PHOCA *Vitulina. Linn. Syst. Nat.* 56. 3.
Common Seal. *Penn. Syn. Quadr.* p. 339.
Found on the coast of Spitsbergen.

CANIS *Lagopus. Linn. Syst. Nat.* 95. 63.
Arctick Fox. *Penn. Syn. Quadr.* p. 155.
Found on the main land of Spitsbergen and islands adjacent, though not in any abundance. It differs from our Fox, besides its colour, in having its ears much more rounded. It smells very little. We ate of the flesh of one, and found it good meat.

Ursus *Maritimus. Linn. Syst. Nat.* 70. 1.

Polar Bear. *Penn. Syn. Quadr.* p. 192. T. 20. F. 1.

Found in great numbers on the main land of Spitsbergen; as also on the islands and ice fields adjacent. We killed several with our musquets, and the seamen ate of their flesh, though exceeding coarse. This animal is much larger than the black bear; the dimensions of one were as follows:

	Feet.	Inches.
Length from the snout to the tail, -	7	1
Length from the snout to the shoulder-bone,	2	3
Height at the shoulder, - - -	4	3
Circumference near the fore legs, - -	7	0
Circumference of the neck close to the ear,	2	1
Breadth of the fore paw, - - -	0	7
Weight of the carcass without head, skin or entrails, - - -	610 lb.	

Cervus *Tarandus. Linn. Syst. Nat.* 93. 4.

Rein Deer. *Penn. Syn. Quadr.* p. 46. T. 8. F. 1.

Found every where on Spitsbergen.

We ate the flesh of one which we killed, and found it excellent venison.

Balaena *Mysticetus. Linn. Syst. Nat.* 105. 1.

Common Whale. *Penn. Brit. Zool.* p. 85.

 This

This ſpecies, which is ſought after by the fiſhermen in preference to all other whales, is found generally near the ice. We ſaw but few of them during our ſtay.

BALAENA *Phyſalus. Linn. Syſt. Nat.* 106. 2.
Fin Fiſh. *Penn. Brit. Zool.* p. 41.
Found in the ocean near Spitſbergen.

A V E S.

ANAS *molliſſima. Linn. Syſt. Nat.* 198. 15.
Eider Duck. *Penn. Brit. Zool.* p. 454.
Found on the coaſt of Spitſbergen.

ALCA *arctica. Linn. Syſt. Nat.* 211. 4.
The Puffin. *Penn. Brit. Zool.* p. 405.
Found on the coaſt of Spitſbergen.

ALCA *Alle. Linn. Syſt. Nat.* 211. 5.
Found on the coaſt of Spitſbergen in great abundance.

PROCELLARIA *glacialis. Linn. Syſt. Nat.* 213. 3.
The Fulmar. *Penn. Brit. Zool.* p. 431.
Found on the coaſt of Spitſbergen.

COLYMBUS *Grylle. Linn. Syſt. Nat.* 220. 1.
Found on the coaſt of Spitſbergen.

Colymbus *Troile. Linn. Syst. Nat.* 220. 2.
Found on the coast of Spitsbergen.

Colymbus *glacialis. Linn. Syst. Nat.* 221. 5.
The great Northern Diver. *Penn. Brit. Zool.* p. 413.
Found on the coast of Spitsbergen.

Larus *Rissa. Linn. Syst. Nat.* 224. 1.
Found on the coast of Spitsbergen.

Larus *Parasiticus. Linn. Syst. Nat.* 226. 10.
The Arctick Gull. *Penn. Brit. Zool.* p. 420.
Found on the coast of Spitsbergen.

Larus *Eburneus*, niveus, immaculatus, pedibus plumbeo-cinereis.
Found on the coast of Spitsbergen.

This beautiful bird is not described by Linnæus, nor, I believe, by any other author; it is nearly related indeed to the Rathsher, described by Marten in his voyage to Spitsbergen, (See page 77 of the English translation) but, unless that author is much mistaken in his description, differs essentially from it. Its place in the *Systema Naturæ* seems to be next after the *Larus nævius*, where the specifick difference given above, which will distinguish

 it

it from all the ſpecies deſcribed by Linnæus, may be inſerted.

DESCRIPTION.

Tota avis (quoad pennas) nivea, immaculata.
Roſtrum plumbeum.
Orbitæ oculorum croceæ.
Pedes cinereo-plumbei. *Ungues* nigri.
Digitus Poſticus articulatus, unguiculatus.
Alæ cauda longiores.
Cauda æqualis, pedibus longior.

Longitudo totius avis, ab apice roſtri ad finem caudæ,	Uncias	16
Longitudo inter apices alarum expanſarum,	-	37
———— Roſtri, - - -	-	2

STERNA *Hirundo. Linn. Syſt. Nat.* 227. 2.
The greater Tern. *Penn. Brit. Zool.* p. 428.

Found on the coaſt of Spitſbergen.

EMBERIZA *nivalis. Linn. Syſt. Nat.* 308. 1.
The greater Brambling. *Penn. Brit. Zool.* 321.

Found not only on the land of Spitſbergen, but alſo upon the ice adjacent to it, in large flocks: what its food can be is difficult to determine; to all appearance it is a granivorous

granivorous bird, and the only one of that kind found in these climates, but how that one can procure food in a country which produces so few vegetables, is not easy to guess.

AMPHIBIA.

CYCLOPTERUS *Liparis*. *Linn. Syst. Nat.* 414. 3.
Sea Snail. *Penn. Brit. Zool.* III. p. 105.

Two only of these were taken in a trawl near Seven Island Bay.

PISCES.

GADUS *carbonarius*. *Linn. Syst. Nat.* 438. 9.
The Coal Fish. *Penn. Brit. Zool.* III. p. 152.

Though we trawled several times on the North side of Spitsbergen, and the seamen frequently tried their hooks and lines, yet nothing was taken except a few individuals of this and the foregoing species.

INSECTA.

CANCER *Squilla*. *Linn. Syst. Nat.* 1051. 66.
The Prawn. *Merr. Pin.* 192.

Found

Found in the ſtomach of a ſeal, caught near the coaſt of Spitſbergen.

Cancer *Boreas*, macrourus, thorace carinato aculeato, manibus lævibus, pollice ſubulato incurvo.

Tab. XII. Fig. 1.

This ſingular ſpecies of Crab, which has not before been deſcribed, was found with the former in the ſtomach of a Seal; its place in the *Syſtema Naturæ* ſeems to be next after *Cancer Norwegicus*.

Description.

Thorax ovatus, tricarinatus: *Carinæ laterales* tuberculoſæ, antice ſpina acuta terminatæ; *Carina dorſalis* ſpinis tribus vel quatuor validis armata; antice producta in roſtrum porrectum, acutum, breve, Thorace quintuplo brevius; præter ſpinas carinarum, anguli laterales thoracis antice in ſpinas terminantur.

Antennæ duæ, thorace fere triplo breviores, bifidæ: *Ramulus ſuperior* craſſiuſculus, filiformis, obtuſus; *Inferior* gracilis, ſubulatus.

Palpi duo, duplicati; *Ramus ſuperior* foliatus, ſeu explanatus in *laminam* ovalem, obtuſam, longitudine antennarum, intus et antice villis ciliatam; *Ramus interior* antenniformis, ſubulatus, multiarticulatus, antennis triplo longior.

Paraſtatides

Paraſtatides decem, anteriores parvi; poſtremi magni, pediformes articulo ultimo explanato in laminam ovali-oblongam.

Pedes decem, duo primores cheliferi, carpis incraſſatis, reliqui ſimplices; pares ſecundi et tertii filiformes, graciles; quarti et quinti craſſiuſculi.

Cauda thorace longior, ſexarticulata; articulis quinque anterioribus carinatis, carinis ſpina antrorſum vergente armatis; articulus ſextus ſupra bicarinatus, muticus, terminatus *foliolis* quinque, articulis caudæ longioribus; intermedio lanceolato, acuto, porrecto, craſſo, ſupra planiuſculo, quadricarinato carinis interioribus obſoletis, ſubtus concavo; lateralibus ovali-oblongis, obtuſis.

Neuſteri decem (nulli ſub articulo ultimo) duplicati: Foliolis lanceolatis, ciliatis.

Obſ. Specimina magnitudine variant, alia triuncialia, alia ſeptem uncias longa.

CANCER *Ampulla*, macrourus, articularis, corpore ovali, pedibus quatuordecim ſimplicibus, laminis femorum poſtici paris ovato-ſubrotundis.

Tab. XII. Fig. 3.

This ſingular animal was alſo taken out of the ſtomach of the ſame ſeal in which the two former were found. Its place in the *Syſtema Naturæ* is next to *Cancer Pulex*.

DESCRIPTION.

DESCRIPTION.

Insectum ex ovali-oblongum, glabrum, punctulatum, articulis quatuordecim compositum, quorum primus capitis est, septem thoracem mentiuntur, et sex caudam tegunt.

Capitis clypeus antice inter antennas in processum conicum, acutum descendit.

Antennæ quatuor, subulatæ, articulatæ, simplices, corpore decuplo breviores.

Pedes quatuordecim, simplices, unguiculati; *femora* postremi paris postice acuta, lamina dimidiato-subrotunda, integra, magna, quatuor lineas longa.

Cauda foliata, foliolo unico brevi bifido: *Laciniæ* lanceolatæ, acutæ.

Neusteri duodecim, duplicati, subulati, pilis longis ciliati, posteriores retrorsum porrecti.

Obs. Specimina magnitudine variant, uncialia et biuncialia erant.

CANCER *nugax*, macrourus, articularis, pedibus quatuordecim simplicibus, laminis femorum sex posteriorum dilatatis subrotundo-cordatis.

Tab. XII. Fig. 2.

This animal, which has not before been described, should be inserted in the *Systema Naturæ* near *Cancer Pulex*; it was taken in the trawl near Moffen Island.

DESCRIPTION.

Insectum oblongum, compressum, dorso rotundatum, glabrum, sesquiunciale, articulis quatuordecim compositum, quorum primus capitis est, septem thoracem mentiuntur, et sex caudam efficiunt.

Capitis Clypeus sinu obtuso antice pro antennis emarginatus.

Antennæ quatuor, subulatæ, multiarticulatæ; *superiores* corpore sextuplo breviores, bifidæ: articulo baseos communi, magno; *Ramulus* interior exteriori duplo brevior.

Inferiores simplices, superioribus duplo longiores.

Pedes quatuordecim, simplices, unguiculati, unguibus parum incurvis. *Femora* sex posteriora postice aucta.

Lamina foliacea, subrotundo-cordata, dimidiata, margine integra, magna, (tres lineas longa.)

Cauda apice foliata. *Foliolis* duobus, oblongis, obtusis, parvis.

Neusteri duodecim, duplicati, lineari-lanceolati, posteriores retrorsum porrecti, ut facile pro appendicibus caudæ sumantur.

CANCER *Pulex. Linn. Syst. Nat.* p. 1055. 81.

Taken up in the trawl along with the former.

VERMES.

SIPUNCULUS *Lendix*, corpore nudo cylindraceo, apertura ſubterminali. Tab. XIII. Fig. 1.

Found adhering, by its ſmall ſnout, to the inſide of the inteſtines of an Eider Duck. Mr. Hunter, who at my requeſt diſſected it, informed me that he had ſeen the ſame ſpecies of animal adhering to the inteſtines of whales.

DESCRIPTION.

Corpus croceum, ſubcylindraceum, tres lineas longum, craſſitie pennæ paſſerinæ, utraque extremitate parum attenuatum, apice terminatum in *Roſtrum* anguſtum corpore quintuplo brevius, quo tunicis internis inteſtinorum ſeſe affigit; prope alteram extremitatem *Apertura* ſimplex, pro lubitu extenſibilis.

A. A piece of the inteſtine, with the animals adhering thereto.

B. One of the animals magnified.

C. The ſame cut open.

ASCIDIA *gelatinoſa*. *Linn. Syſt. Nat.* 1087. 2.

Taken

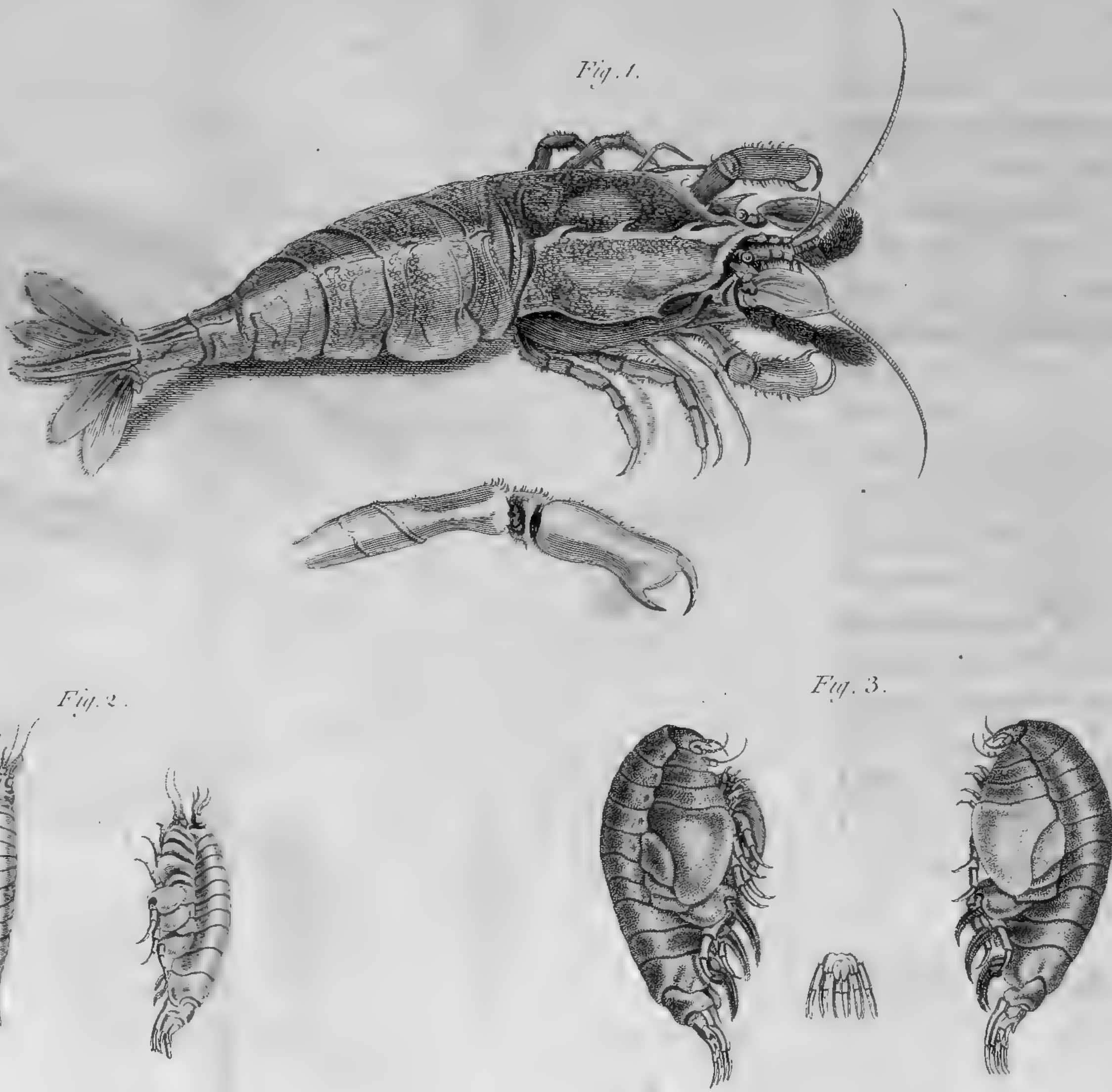


Fig. 1. Cancer (Boreas). 2. Cancer nugax. 3. Cancer Ampulla.

Barnes delin J Caldwell Sculp

Taken up in the trawl, on the North ſide of Spitſbergen.

ASCIDIA *ruſtica. Linn. Syſt. Nat.* 1087. 5.

Taken up likewiſe in the trawl, on the North ſide of Spitſbergen.

LERNEA *branchialis. Linn. Syſt. Nat.* 1092. 1.

Found in the gills of the Sea ſnail mentioned before.

CLIO *helicina* nuda corpore ſpirali.

Marten's Spitſbergen Engliſh, p. 141. t. Q. fig. *e*. Snail ſlime fiſh.

Found in innumerable quantities throughout the Arctick ſeas.

DESCRIPTION.

Corpus magnitudine piſi, in ſpiram ad inſtar helicis involutum.

Alæ ovatæ, obtuſæ, expanſæ, corpore majores.

CLIO *limacina* nuda, corpore obconico.

The Sea May Fly. *Marten's Spitſbergen Engliſh*, p. 169. Tab. P. f. 5.

 This

This little animal is found where the laſt is, in equal abundance, peopling as it were this almoſt uninhabited ocean. Marten ſays that they are the chief food of the whale-bone whale; and our fiſhermen, who call them by the name of whale food, are of the ſame opinion.

MEDUSA *capillata. Linn. Syſt. Nat.* 1097. 6.
Sea Blubber.

Taken up on the paſſage home, about the latitude 65°.

ASTERIAS *papposa. Linn. Syſt. Nat.* 1098. 2.

Taken up on the North ſide of Spitſbergen.

ASTERIAS *rubens. Linn. Syſt. Nat.* 1099. 3.
Sea Star.

Alſo taken up in the trawl on the North ſide of Spitſbergen.

ASTERIAS *Ophiura. Linn. Syſt. Nat.* 1100. 11.

We likewiſe took this up in the trawl, on the North ſide of Spitſbergen.

ASTERIAS *pectinata. Linn. Syſt. Nat.* 1101. 14.

This, as well as all the reſt of this genus, was taken up in the trawl on the North ſide of Spitſbergen.

CHITON

CHITON *ruber. Linn. Syst. Nat.* 1107. 7.
Coat of Mail Shell.

Taken in the trawl, on the North side of Spitsbergen.

LEPAS *Tintinnabulum. Linn. Syst. Nat.* 1168. 12.
Acorn Shell.

Was picked up on the beach of Smeerenberg harbour; but as it is much worn and broken, it is impossible to be certain, whether it is a native of those seas, or has been brought there by accident.

MYA *truncata. Linn. Syst. Nat.* 1112. 26.

Likewise found on the beach in Smeerenberg harbour.

MYTILUS *rugosus. Linn. Syst. Nat.* 1156. 249.

Was found with the former on the beach at Smeerenberg.

BUCCINUM *carinatum*, testa oblongo-conica transversim striata; anfractibus superioribus oblique obtuseque multangulis; inferioribus unicarinatis.

Tab. XIII. Fig. 2.

Found on the beach at Smeerenberg harbour.

N. B. The shell has been reversed by a mistake of the engraver.

TURBO

Turbo *helicinus*, testa umbilicata convexa obtusa: anfractibus quatuor lævibus.

Taken up in the trawl, on the North side of Spitsbergen.

Serpula *spirorbis*. *Syst. Nat.* 1265. 794.

Found in plenty sticking to the stones and dead shells in Smeerenberg harbour.

Serpula *triquetra*. *Linn. Syst. Nat.* 1265. 795.

Found with the last adhering to dead shells.

Sabella *frustulosa*, testa solitaria libera simplici curvata: fragmentis conchaceis sabulosisque.

Taken up in the trawl on the North side of Spitsbergen.

Description.

Vagina spithamea vel longior, crassitie pennæ anserinæ, undique tecta *fragmentis conchaceis* sæpe magnitudine unguis, et sabulis magnitudine seminum cannabis.

Millepora *polymorpha*. *Linn. Syst. Nat.* 1285. 53.
Varietas rubra.

Found thrown up on the beach at Smeerenberg harbour.

Cellepora

CELLEPORA *pumicofa. Linn. Syft. Nat.* 1286. 56.
Found on the beach at Smeerenberg.

SYNOICUM *turgens.* Tab. XIII. Fig. 3.

Taken up in the trawl, on the North fide of Spitfbergen.

This animal is quite new to the Natural Hiftorians, and fo different from the Zoophytes which have been hitherto defcribed, that it may be confidered as a diftinct genus, whofe characters are the following:

Animalia nonnulla, ex apice finguli ftirpis fefe aperientia.

Stirpes plures, radicatæ, carnofo-ftupofæ, e bafi communi erectæ, cylindraceæ, apice regulariter pro animalibus pertufæ.

It fhould be inferted next to the Alcyonium, with which it in fome particulars agrees, but differs from it materially in having the openings for the animals only at the top, and the animals themfelves not exferted like polypes (Hydra) which is the cafe in the Alcyonium.

DESCRIPTION.

Stirpes plures, radicatæ, carnofo-ftupofæ, digitiformes, cylindraceæ, fuperne paulo craffiores, obtufæ, magnitudine digiti infantis, fuberectæ, apice orificiis nonnullis perforatæ, inferne dilatatæ feu explanatæ in bafin communem lapidibus adhærentem.

Orificia

Orificia ſex ad novem, ordine circulari plerumque diſpoſita; ſub ſingulo orificio cavitas longitudinalis, forſitan ſingulo animali propria, in qua

1^mo^ Faux anguſta, brevis.

2^do^ *Inteſtinum* inſtar ſtomachi dilatatum, oblongo-ovatum, inferne *foraminibus* duobus pertuſum; inter illa foramina aliud deſcendit inteſtinum, valde anguſtum, filiforme, arcum brevem formans.

Cavitas, quæ per totam ſtirpem longitudinaliter pro ſingulo animali deorſum tendit, ſuperne ab inteſtinis vix diſtincta, infra illa autem cylindrum exhibet granulis parvis (forſitan ovulis) repletam.

A. Shews the animals adhering to a ſtone.
B. One of the animals ſeparate, a little magnified.
C. The ſame cut open lengthways.
D. The ſame cut open acroſs.

FLUSTRA *piloſa*. *Linn. Syſt. Nat.* 1301. 3.
Found adhering to ſtones in Smeerenberg harbour.

FLUSTRA *membranacea*. *Linn. Syſt. Nat.* 1301. 5.
Found with the laſt mentioned ſpecies.

PLANTÆ.

AGROSTIS *algida* panicula mutica contracta, calycibus breviſſimis inæqualibus.

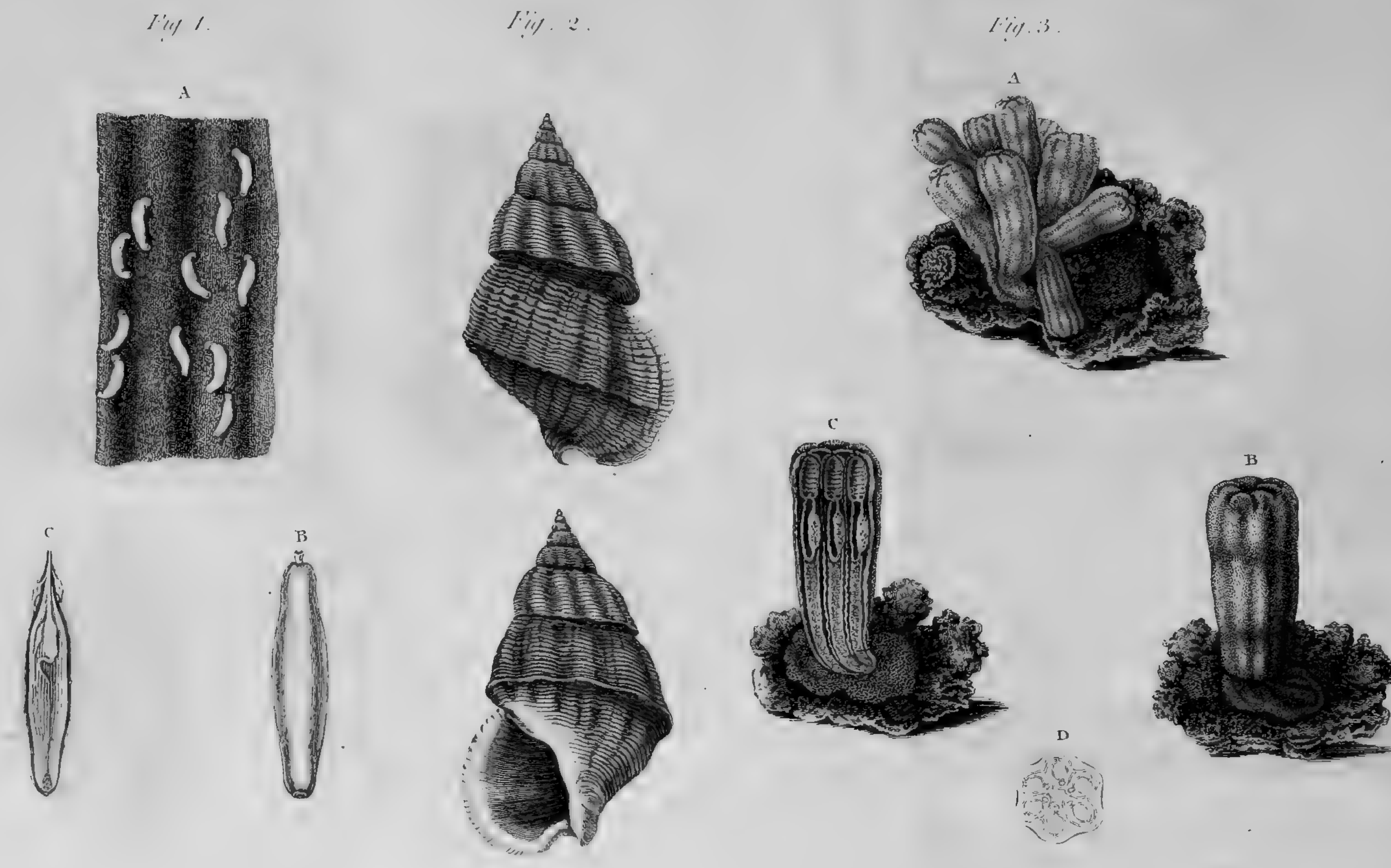


Fig. 1. Sipunculus Lendix. 2. Buccinum carinatum. 3. Synoicum turgens.

Barnes delin

This ſmall graſs, which has not before been known to botaniſts, may be inſerted among the ſpecies of *Agroſtis* next to the *minima*.

Description.

Gramen in cæſpitibus naſcens.

Radix fibroſa, perennis.

Folia plurima radicalia, pauciſſima caulina, glabra, latiuſcula, longitudine culmi, patula, baſi dilatata in vaginas laxas.

Culmi adſcendentes, glabri, ſeſquiunciales.

Panicula lineari-oblonga, contracta, ſtricta, multiflora.

Calycis Glumæ membranaceæ, albidæ, glabræ, muticæ, inæquales: *exterior* minutiſſima, ovata, obtuſa; *interior* oblonga, acuta, corolla quintuplo brevior.

Corollæ Glumæ oblongæ, acutæ, carinatæ, muticæ, glabræ, ſemilineares: exterior paulo longior.

Stamina tria.

Stigmata duo.

Semen unicum, oblongum, utrinque acuminatum, a corolla liberum.

Tillæa *aquatica. Linn. Spec. Plant.* 186. 2.

Juncus *campeſtris. Linn. Spec. Plant.* 468. 17.

SAXIFRAGA *oppositifolia*. *Linn. Spec. Plant.* 575. 18.

SAXIFRAGA *cernua*. *Linn. Spec. Plant.* 577. 26.

SAXIFRAGA *rivularis*. *Linn. Spec. Plant.* 577. 28.

SAXIFRAGA *cæspitosa*. *Linn. Spec. Plant.* 578. 34.

CERASTIUM *alpinum*. *Linn. Spec. Plant.* 628. 8.

RANUNCULUS *sulphureus*, calycibus hirsutis, caule subbifloro, petalis rotundatis, integerrimis, foliis inferioribus sublobatis, supremis multipartitis.

Ranunculus quartus. *Mart. Spitz. Engl.* p. 58. T. T. F. *d.*

Obs. Primo intuitu *Ranunculo glaciali* simillimus, differt autem, quod *Petala* rotundata, integerrima, intense lutea, fulgida; et *Folia* minus subdivisa; *superiora* fissa, laciniis oblongo-lanceolatis integerrimis; *inferiora caulina* lata, plana, leviter triloba vel quadriloba.

This new plant should be inserted next to *Ranunculus glacialis.*

COCHLEARIA *Danica*. *Linn. Spec. Plant.* 903. 3.

COCHLEARIA *Groenlandica*. *Linn. Spec. Plant.* 904. 4.

SALIX *herbacea*. *Linn. Spec. Plant.* 1445. 16.

POLYTRICHUM *commune*. *Linn. Spec. Plant.* 1573. 1.

BRYUM

BRYUM *Hypnoïdes. Linn. Spec. Plant.* 1584. 21.

Besides these, there were two other kinds of Bryum, the species of which could not be determined, for want of the fructification; the one resembled Bryum trichoides læte virens, &c. *Dill. Musc.* 391, t. 50, f. 61; and the other Bryum hypnoïdes pendulum, *Dill. Musc.* 394, t. 50, F. 64, C.

HYPNUM *aduncum. Linn. Spec. Plant.* 1592. 23.

JUNGERMANNIA *julacea. Linn. Spec. Plant.* 1601. 20. Another species of Jungermannia was also found, but without fructification; it is not much unlike Lichenastrum ramosius foliis trifidis. *Dill. Musc.* 489, t. 70, f. 15.

LICHEN *ericetorum. Linn. Spec. Plant.* 1608. 12.

LICHEN *Islandicus. Linn. Spec. Plant.* 1611. 29.

LICHEN *nivalis. Linn. Spec. Plant.* 1612. 30.

LICHEN *caninus. Linn. Spec. Plant.* 1616. 48.

LICHEN *polyrrhizos. Linn. Spec. Plant.* 1618. 57.

LICHEN *pyxidatus. Linn. Spec. Plant.* 1619. 60.

LICHEN *cornutus. Linn. Spec. Plant.* 1620. 64.

LICHEN *rangiferinus*. *Linn. Spec. Plant.* 1620. 66.

LICHEN *globiferus*. *Linn. Mant.* 133.

LICHEN *paschalis*. *Linn. Spec. Plant.* 1621. 69.

LICHEN *chalybeiformis*. *Linn. Spec. Plant.* 1623. 77.

ACCOUNT

ACCOUNT of Doctor IRVING's Method of obtaining fresh Water from the Sea by Distillation.

AS the method of rendering salt water fresh, by distillation, introduced by Doctor Irving into the Royal Navy in the year 1770, and practised in this voyage, is an object of the highest importance to all navigators, and has not hitherto been generally known, I have added the following very full account of its principles, apparatus, and advantages, with which I was favoured by Doctor Irving himself.

"PREVIOUS to an account of this method of rendering "sea water fresh by distillation, it may not be improper "to give a short detail of the experiments which have "been formerly made by others on this subject; pointing "out at the same time the several disadvantages attending "their processes, and the general causes which obstructed "the desired success.

"Without entering into an account of the earlier expe-"riments, it will be sufficient to take a view of such as "have been prosecuted with most attention, for the "last forty years.

"The

" The firſt of theſe was the proceſs of Mr. Appleby, " publiſhed by order of the Lords of the Admiralty, in the " Gazette of June 22d, 1734. By the account of that " proceſs it appears, that Mr. Appleby mixed with the " ſea water to be diſtilled, a conſiderable quantity of the " *Lapis Infernalis* and calcined bones. The highly un- " palatable taſte of the water, however, excluſive of the " extreme difficulty, if not impoſſibility, of reducing the " proceſs into practice, prevented the further proſecution " of this method.

" Another proceſs for procuring freſh water at ſea, " was afterwards publiſhed by Doctor Butler. Inſtead of " the *Lapis Infernalis* and calcined bones, he propoſed the " uſe of ſoap leys; but though the ingredients were ſome- " what varied, the water was liable to the ſame objections " as in the preceding experiment. Doctor Stephen " Hales uſed powdered chalk; and introduced ventila- " tion, by blowing ſhowers of air up through the diſtil- " ling water, by means of a double pair of bellows. It " was found by this method, that the quantity of freſh " water obtained in a given time, was ſomewhat greater " than what had been procured by the proceſs of Mr. " Appleby. This invention, however, was ſubject to " ſeveral diſadvantages. The air box which lay on the " bottom of the ſtill, as well as the chalk, much ob- " ſtructed the action of the fire upon the water, at the " ſame time that the boiling heat of the latter was

" diminiſhed

" diminiſhed by the ventilation: ſo that more than double
" the uſual quantity of fuel was neceſſary to produce the
" ſame effect. Beſides this method by no means improved
" the taſte of the water.

" The next who attempted any improvement was the
" learned Doctor Lind, of Portſmouth. He diſtilled ſea
" water without the addition of any ingredients; but as
" the experiment he made was performed in a veſſel con-
" taining only two quarts, with a glaſs receiver, in his
" ſtudy, nothing concluſive can be drawn from it for
" the uſe of ſhipping. Indeed experiments of the like
" kind had been made by the chemiſts in their labora-
" tories, for at leaſt a century before.

" In the year 1765, Mr. Hoffman introduced a Still of a
" new conſtruction, with a *ſecret ingredient*; but the large
" ſpace which this machine occupied, being ſeven feet
" five inches by five feet eight inches, and, with its ap-
" paratus, ſix feet ſeven inches high, made it extremely
" inconvenient: at the ſame time that, on account of its
" ſhallow form, the uſe of it was impracticable during
" any conſiderable motion of the ſhip. The water ob-
" tained, likewiſe, poſſeſſed all the diſadvantages common
" to the preceding methods.

"About the ſame time experiments were made with a "ſtill of the common conſtruction, and Mr. Dove's *in-* "*gredient*. This method was attended with no advan- "tage over any that had been formerly uſed; the diſtilled "water was moſt unpalatable; and the enormous ſize of "the apparatus, which occupied a ſpace of thirteen feet "ſeven inches by ſix feet one inch, and ſix feet five inches "in height, rendered it impracticable on board ſhips. "An experiment was immediately afterwards made with "the ſame ſtill without any ingredient; the reſult, how- "ever, was uniformly a moſt unpalatable taſte of the "water.

"About this period, alſo, M. Poiſſonnier of Paris intro- "duced into the French marine a ſtill, three feet ſix "inches long, two feet wide, and eighteen inches deep. "A portion of the chimney paſſed through the upper "part of the ſtill, much in the ſame manner as that of "Mr. Hoffman: theſe gentlemen ſuppoſed that by this "means they ſhould ſave fuel. The mouth of M. "Poiſſonnier's ſtill was thirteen inches wide, on which he "placed a tin plate, pierced like a cullender, with thirty- "ſeven holes of ſix lines diameter each; to theſe were "fixed tin pipes, of the ſame bore and ſeven inches long, "terminating within the ſtill-head. The intention of "this contrivance is to prevent any of the water in the "ſtill from paſſing over into the worm, while the ſhip "is in conſiderable motion.

"In every other respect M. Poissonnier employs "a still-head, worm-pipe, and worm-tub, with all its "usual apparatus; and he directs six ounces of *fossil* "*alcali* to be mixed with the sea water at each distilla-"tion, to prevent the acid of the Magnesia salt from "rising with the vapour, when salt begins to form on the "bottom of the still. It is probable that in M. "Poissonnier's still, which was even more shallow in its "form than Mr. Hoffman's, some of the water might be "thrown up toward the worm; in which case the pierced "plate with pipes might be of some service in breaking the "direction of the water. But by Doctor Irving's tube "this inconvenience is entirely prevented, as experience "fully evinces, viz. in a voyage to Falkland's Islands, "where it has been used in distillation every day; in "several voyages to the East Indies; and in this voyage, as "is mentioned in the Journal.

"M. Poissonnier, in correcting this error in the "construction of his still, has introduced another of the "most capital nature in distillation. For by means of "the pipe-cullender, the vapour will meet with the "greatest resistance to its ascent, which will retard the "progress of distillation in a very high degree, and "increase the *Empyreuma*.

"From all the experiments abovementioned, it "is evident, that no method had hitherto been "invented of making sea-water fresh, which was

" not attended with ſuch inconveniences as rendered " the ſeveral proceſſes of ſcarce any utility. The defects " of the various methods above enumerated, may be re- " duced to the following heads:

" 1. The ſmall quantity of water produced by the " ordinary methods of diſtillation with a ſtill-head, and " worm, could never be adequate to the purpoſes of " ſhipping, though the apparatus ſhould be kept in con- " ſtant uſe; and at the ſame time, this mode of diſtilla- " tion required a quantity of fuel, which would occupy " greater ſpace than might be ſufficient for the ſtowage " of water.

" 2. A *ſtill-burnt* taſte, which always accompanies this " method of diſtillation, and renders the water extremely " unpalatable, exciting heat and thirſt, if drank when " recently diſtilled.

" 3. A total ignorance with reſpect to the proper time " of ſtopping the diſtillation, whereby ſalt was permitted " to form on the bottom of the boiler; which burning, " and corroding the copper, decompoſed the ſelenitic and " magneſia ſalts, cauſing their acids to aſcend with the " vapour, and act on the ſtill-head and worm pipe, im- " pregnating the water with metallic ſalts of the moſt per- " nicious quality.

" 4. The ſpace occupied by the ſtill, ſtill-head, and " worm-tub, renders the uſe of them in moſt caſes totally " impracticable on board ſhips. Add to this, their wearing " out ſo faſt on account of the cauſes above mentioned,

" the

" the great expence of the apparatus, with the hazard of " the ſtill-head being blown off, and the inconveniences " thence ariſing.

" 5. The uſe of ingredients, which though omitted in " ſome experiments in ſmall, were nevertheleſs erro- " neouſly conſidered as eſſential to the making ſea-water " ſweet and palatable by diſtillation.

" 6. The inconvenience of a cumberſome apparatus, " calculated only to be eventually uſeful in unexpected " diſtreſs for water, but conſtantly occupying a great deal " of room in a ſhip, too neceſſary for the ordinary pur- " poſes to be ſpared for that object.

" Having ſpecified the principal defects of the ſeveral " methods hitherto propoſed for making ſea water freſh, " it will be proper before ſtating the advantages of Doctor " Irving's method, to conſider briefly the principles of " diſtillation in general, and the chemical analyſis of " ſea water.

" Water, in an exhauſted receiver, riſes in vapour more " copiouſly at 180° of Fahrenheit's thermometer, than in " the open air at 212°, which may be conſidered as its " boiling point.

" It therefore follows, that any compreſſion upon the " boiling fluid checks the vapour in riſing, and conſe- " quently diminiſhes the quantity of water obtained. This " is clearly examplified in the ſteam-engine, where the

 " conſumption

" consumption of water in the boiler is very inconsider-
" able, in comparison to what would happen if the
" compression arising from the throat-pipe and valve of
" that machine was taken off, and the pressure of the
" atmosphere only admitted. But by the restraint of that
" valve, the vapour becomes hotter, and increases in
" rarity and elasticity; qualities essential to the purposes
" of the engine, although the reverse of those which
" ought to take place in common distillation. For the
" columns of vapour should be removed from the boiling
" fluid as fast as they ascend, without suffering any other
" resistance than that of the atmosphere, which, in the
" ordinary business of distillation, cannot be prevented.

" The impropriety of the common process of distillation,
" will appear evident by comparing it with the above
" principles and facts.

" In the common method of distillation, the whole
" column of vapour from a still of whatever size, after
" ascending to the still-head, must not only find its passage
" through a pipe of scarce an inch and half diameter; but
" descend contrary to its specific gravity through air
" which is fifteen times its weight, in spiral convolutions:
" a course so extremely ill adapted to the progress of an
" elastic vapour, that frequently the still-head is blown off
" with incredible violence, owing to the increased heat

" and elaſticity of the vapour confined by this conſtruction.
" In the mean time, the external ſurface of the pipe
" communicates heat to the water in contact with it,
" which, inſtead of being entirely carried off, mixes with
" the ſurrounding fluid, and heats the whole, rendering
" it unfit for condenſing the vapour within; eſpecially
" when it is conſidered that the ſubſtance of the pipe is at
" leaſt a quarter of an inch thick.

" From what has been ſaid, it is plain, that the quan-
" tity of diſtilled water will be leſſened in proportion to
" the reſiſtance made to the aſcent of the vapour, while
" the difficulty of condenſation will be greatly augmented,
" in conſequence of the increaſed heat and elaſticity of
" the vapour. But theſe diſadvantages, however great,
" reſpecting the mode of diſtillation, give riſe to another
" evil of a ſtill more important nature, as affecting the
" diſtilled fluid with a noxious *burnt taſte* or *empyreuma*;
" occaſioned by the vapour, highly heated, paſſing over
" ſo much ſurface of metal, viz. the ſtill-head, crane-neck,
" and a pipe of ſix or ſeven feet in length, before it reaches
" the water in the worm tub.

" Having diſcuſſed the ſubject of diſtillation, we come
" now to treat of the chemical analyſis of ſea water.

" Sea-water,

" Sea-water contains chiefly a neutral ſalt, compoſed of " foſſil alcali and marine acid. It likewiſe contains a ſalt " which has magneſia for its baſis, and the ſame acid. " Theſe two ſalts are blended together in our common " ſalt in England, which is prepared by quick boiling " down ſea water. But when the proceſs is carried on by " the ſun, or a ſlow heat, they may be collected ſepa- " rately; that which has the foſſil alcali for its baſis " cryſtallizing firſt; and this is of a vaſtly ſuperior quality " for preſerving meat, and for the other culinary pur- " poſes. The mother liquor now remaining, being " evaporated, affords a vitriolic magneſia ſalt, which in " England is manufactured in large quantities, under the " name of Epſom ſalt.

" Beſides theſe ſalts, which are objects of trade, ſea- " water contains a ſelenitic ſalt, a little true Glauber's ſalt, " often a little nitre, and always a quantity of gypſeous " earth ſuſpended by means of fixed air.

" The ſpecific gravity of ſea-water to that of pure diſ- " tilled water, is at the Nore as 1000 to 1024,6; in the " North ſea as 1000 to 1028,02.

" The quantity of ſalt obtained by boiling ſea-water in " different latitudes, from 51° 30′ to 80°,43 N. L. is in- " ſerted in a table in the former part of this Appendix.

" Sea-water,

" Sea-water, when boiled down to a ſtrong brine, admits " with difficulty the ſeparation of freſh water from it; the " diſtillation becoming ſlower as the ſtrength of the brine " increaſes, ſo that a greater quantity of fuel is conſumed " in procuring a ſmaller portion of water, and this like- " wiſe of a bad quality. From this eſſential circumſtance " ariſes the neceſſity of letting out the brine by the cock " of the boiler, when the diſtillation is advanced to a " certain degree; and of adding more ſea-water to con- " tinue the proceſs if required.

" The defects of the ſeveral ſchemes formerly propoſed for " rendering ſea-water freſh being pointed out, the general " principles of diſtillation explained, and the component " parts of ſea-water analytically examined; the advan- " tages of the method invented by Doctor Irving remain " to be ſtated, which may be reduced to the following:

" 1. The aboliſhing all ſtills, ſtill heads, worm pipes, " and their tubs, which occupy ſo much ſpace as to " render them totally incompatible with the neceſſary " buſineſs of the ſhip; and uſing in the room of theſe, " the ſhip's kettle or boiler, to the top whereof may oc- " caſionally be applied a ſimple tube, which can be eaſily " made on board a veſſel at ſea, of iron plate, ſtove " funnel, or tin ſheet; ſo that no ſituation can prevent a " ſhip from being completely ſupplied with the means of " diſtilling ſea-water.

" 2. In consequence of the principles of distillation " being fully ascertained, the contrivance of the simplest " means of obtaining the greatest quantity of distilled " water, by making the tube sufficiently large, to receive " the whole column of vapour; and placing it nearly in a " horozontal direction to prevent any compression of the " fluid, which takes place so much with the common " worm.

" 3. The adopting the simplest and most efficacious " means of condensing vapour; for nothing more is re- " quired in the distillation but keeping the surface of the " tube always wet; which is done by having some sea- " water at hand, and a person to dip a mop or swab into " this water, and pass it along the upper surface of the " tube. By this operation the vapour contained in the " tube will be entirely condensed with the greatest rapi- " dity imaginable; for by the application of the wet mop " thin sheets of water are uniformly spread, and mechani- " cally pressed upon the surface of the hot tube; which " being converted into vapour, make way for a succession " of fresh sheets; and thus both by the evaporation and " close contact of the cold water constantly repeated, the " heat is carried off more effectually than by any other " method yet known.

" 4. The carrying on the distillation without any addi- " tion, a correct chemical analysis of sea water having " evinced the futility of mixing ingredients with it, either " to prevent an acid from rising with the vapour, or to " destroy

" deſtroy any bituminous oil ſuppoſed to exiſt in ſea
" water, and to contaminate the diſtilled water, giving it
" that fiery unpalatable taſte inſeparable from the former
" proceſſes.

" 5. The aſcertaining the proper quantity of ſea water
" that ought to be diſtilled, whereby the freſh water is
" prevented from contracting a noxious impregnation of
" metallic ſalts, and the veſſel from being corroded and
" otherwiſe damaged by the ſalts caking on the bottom
" of it.

" 6. The producing a quantity of ſweet and wholeſome
" water, perfectly agreeable to the taſte, and ſufficient
" for all the purpoſes of ſhipping.

" 7. The taking advantage of the dreſſing the ſhip's
" proviſions, ſo as to diſtil a very conſiderable quantity
" of water from the vapour which would otherwiſe be
" loſt, without any addition of fuel.

" To ſum up the merits of this method in a few
" words:

" The uſe of a ſimple tube, of the moſt eaſy con-
" ſtruction, applicable to any ſhip's kettle. The rejecting
" all ingredients. Aſcertaining the proportion of water to
" be diſtilled, with every advantage of quality, ſaving of
" fuel, and preſervation of boilers. The obtaining freſh
" water, wholeſome, palatable, and in ſufficient quantities.

" Taking advantage of the vapour which aſcends in the
" kettle while the ſhips proviſions are boiling.

" All theſe advantages are obtained by the abovementioned ſimple addition to the common ſhip's kettles. But Doctor Irving propoſes to introduce two further improvements.

" The firſt is a hearth, or ſtove, ſo conſtructed, that the fire which is kept up the whole day for the common buſineſs of the ſhip, ſerves likewiſe for diſtillation; whereby a ſufficient quantity of water for all the œconomical purpoſes of the ſhip may be obtained, with a very inconſiderable addition to the expence of fuel.

" The other improvement is that of ſubſtituting, even in the largeſt ſhips, caſt-iron boilers, of a new conſtruction, in the place of coppers."

DIRECTIONS for DISTILLING SEA-WATER.

" As ſoon as ſea-water is put into the boiler, the tube is to be fitted either into the top or lid, round which, if neceſſary, a bit of wet linen may be applied, to make it ſit cloſe to the mouth of the veſſel; there will

" be

" be no occafion for luting, as the tube acts like a funnel
" in carrying off the vapour.

" When the water begins to boil, the vapour fhould
" be allowed to pafs freely for a minute, which will
" effectually clean the tube and upper part of the boiler.
" The tube is afterwards to be kept conftantly wet, by
" paffing a mop or fwab, dipped in fea-water, along its
" upper furface. The wafte water running from the mop,
" may be carried off by means of a board, made like a
" fpout, and placed beneath the tube.

" The diftillation may be continued till three fourths of
" the water be drawn off, and no further. This may be
" afcertained either by a gauge-rod put into the boiler,
" or by meafuring the water diftilled. The brine is then
" to be let out.

" Water may be diftilled in the fame manner while the
" provifions are boiling.

" When the tube is made on fhore, the beft fubftance
" for the purpofe is thin copper well tinned, this being
" more durable in long voyages than tin plates.

" Inftead of mopping, the tube, if required, may have
" a cafe made alfo of copper, fo much larger in diameter
" as to admit a thin fheet of water to circulate between

" them, by means of a ſpiral copper thread, with a pipe " of an inch diameter at each end of the caſe; the " lower for receiving cold water, and the upper for " carrying it off when heated.

" When only a very ſmall portion of room can be " conveniently allowed for diſtillation, the machine " (N° 2. in the Plate), which is only twenty-ſeven inches " long, may be ſubſtituted, as was done in this voyage. " The principal intention of this machine, however, is to " diſtil rum and other liquors; for which purpoſe it has " been employed with extraordinary ſucceſs, in preventing " an *empyreuma*, or *fiery* taſte."

Explanation of Plate XIV.

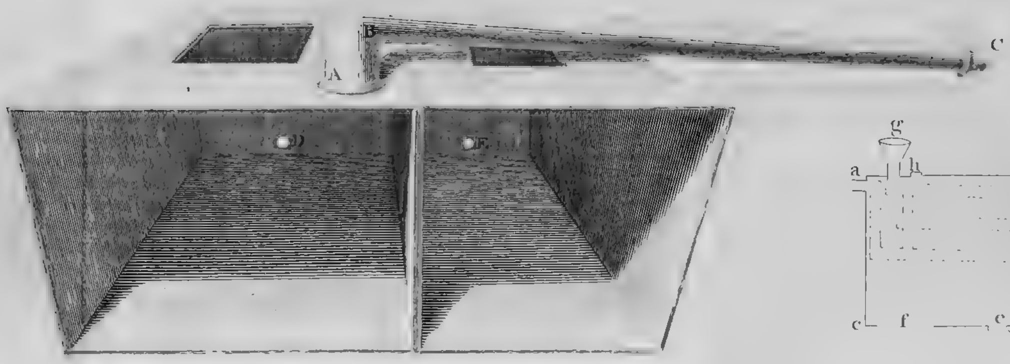
" Figure 1, repreſents in perſpective a ſection of the " two boilers taken out of the frame. In the back " part at D, E, are ſeen openings for the cocks. On " the top is a diſtilling tube A, B, C, five inches dia- " meter at A, and decreaſing in ſize to three inches at C; " the length from B to C is five feet. Near C is a ring " to prevent the water which is applied to the ſurface " from mixing with the diſtilled water. In the inſide of " the tube, below B, is a ſmall lip or ledging, to hinder " the diſtilled water from returning into the boiler by the " rolling of the ſhip.

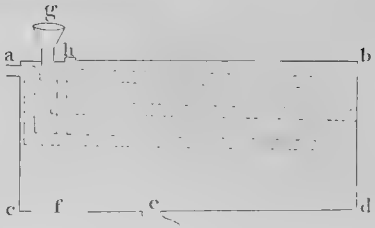
"In figure 2, A, B, C, D, repreſent a vertical ſection "of a copper box, twenty-ſeven inches long, ſeven inches "wide, and eleven in height, tinned on the inſide. In "the bottom F, is an aperture about ſix inches in diameter, "having a ring to fit on the ſtill or boiler. The dotted "lines which run nearly horizontal, are veſſels of thin "copper, tinned on the outſide, two feet long, ſeven "inches wide, and three quarters of an inch deep. At "G is a funnel to receive cold water, which is conveyed "into the veſſels by communicating pipes, contrived in "ſuch a manner as to form a complete and quick circu- "lation of the water through their whole extent. When "the water is become hot by the action of the ſteam, it "is diſcharged by the horizontal pipe at A. E is a pipe "from which the diſtilled water or ſpirits run, and is bent "in ſuch a form, that the liquor, running from it, acts "as a valve, and hinders any ſteam from eſcaping that "way. On the top of the box, at H, is a ſafety-valve, "which prevents any danger from a great accumulation "of vapour, not condenſed for want of a proper ſupply "of cold water."

Account of the Astronomical Observations and Time-Keepers, by Mr. Lyons.

" THE obſervations for finding the time at ſea, were " taken with a braſs Hadley's Sextant of eighteen " inches radius, made by Dollond; and ſometimes by " Captain Phipps, with a ſmaller of four inches radius, " made by Ramſden, which commonly agreed with the " other within a minute. The error of the ſextant " was generally found by obſerving the diameter of the " Sun; which if the ſame as double the ſemidiameter " ſet down in the Nautical Almanac, ſhewed that the " inſtrument was perfectly adjuſted; if it differed, the " difference was the error of the ſextant. It was neceſ- " ſary to know this error of adjuſtment very exactly, " and therefore I generally repeated the obſervation of " the Sun's diameter ſeveral times, and from the mean " of the reſult found the error of the ſextant. This error " will equally affect all the obſervations taken near " the ſame time, and therefore cannot be diſcovered " from the compariſon of ſeveral obſervations. Under " the equator, an error of one minute in altitude, near " the prime vertical, will only produce an error of " four ſeconds in the apparent time; but in the latitude of

14





" of eighty degrees it will cauſe an error of twenty-three " ſeconds. As we generally took ſeveral ſucceſſive ob- " ſervations, any error in the obſervation itſelf will be " generally independent of the reſt; and as I have calcu- " lated each ſeparately, the concluſions will ſhew which " are erroneous, by their differing much from the mean " of all, which cannot but be very near the truth.

" In calculating theſe obſervations, I found by the " logboard how much we had altered our latitude ſince " the laſt obſervation; and ſometimes, when we had " an obſervation the noon following the obſervation " for the time, the latitude of the ſhip at the time " the altitudes were taken was inferred from it. As moſt " of our altitudes were obſerved when the ſun was near " the prime vertical, a ſmall error in the latitude will " not produce any conſiderable change in the time; " indeed, if it is exactly in the prime vertical, it will not " make any change at all.

" To find the Longitude from theſe obſervations: to " the apparent time found by calculation, apply the " equation of time according to its ſign, which will " give the mean time; the difference between which and " that marked by the watch, will ſhew how much it is " too ſlow or too faſt for mean time.

" Captain

"Captain Phipps's pocket watch, made by Mr. "Arnold, when compared with the regulator at Greenwich, May 26th, was twenty-four ſeconds too ſlow; "it was there found to loſe twelve ſeconds and a quarter "a day on mean time. From this it is eaſy to find "what time it is at Greenwich at any moment ſhewn by "the watch.

"The watch was compared every day about noon "with the two time-keepers made by Meſſ. Arnold and "Kendal; and from this compariſon, and their rates of "going previouſly ſettled at Greenwich, together with "knowing how much they differed from mean time at "Greenwich before we ſet out, was calculated the table "which ſhews what the mean time is at Greenwich "according to each time-keeper, when the watch is at "twelve hours.

"By the help of this table, we may eaſily find the "longitude of the ſhip, as deduced from the going "of each time-keeper. Having found how much the "watch is too faſt or too ſlow for mean time at the "ſhip, we know what the mean time is at the ſhip "when the watch is at twelve hours; and by the table "we can find what is the mean time at Greenwich at "the ſame time, ſuppoſing each time-keeper had kept "the ſame rate of going as it had before our departure:

4 the

" the difference of these mean times will give the longi-
" tude of the ship.

" For example, June 19th, in the afternoon, the " watch was 1′ 24″ too slow for mean time at the place " where we observed; therefore, when the watch shews " twelve hours, the mean time at this place was 12^h 1′ 24″. " At this time I find by the table, that according to " Kendal's time-keeper, the mean time at Greenwich was " 12^h 2′ 7″: from this subtracting 12^h 1′ 24″, the mean " time at the ship, the remainder, 0′ 43″ is the difference " of meridians; which, converted into parts of a degree, " gives 0° 10′ 45″ for the longitude of the ship according " to Kendal, which is to the Westward, because the mean " time at the ship is less than that at Greenwich.

" When we were on shore, the observations were " made with an Astronomical Quadrant, divided by Mr. " Ramsden, of eighteen inches radius, which was " placed on a solid rock of marble; the error of the line " of collimation was found by inverting the quadrant, " which was adjusted by a spirit level. The weather did " not permit us to take corresponding altitudes of the " Sun, so that we determined the apparent time by com- " putation from altitudes of the Sun's limb; having before " settled the latitude of the place of observation, from " meridian altitudes of the Sun's limbs taken with " the same instrument.

" The Latitudes of the ſhip were determined moſt com-
" monly by the meridian altitude of the Sun's lower limb;
" in a few inſtances, by that of his upper limb, when the
" lower was not ſo diſtinct, or was hid by clouds. The
" height of the eye above the level of the ſea, in all theſe
" obſervations, was ſixteen feet. When we could not get
" a meridian obſervation, we made uſe of the method
" deſcribed in the Nautical Almanac for 1771, from two
" altitudes taken about noon, and at a little diſtance from it.

" It ſometimes happens that we can only take ſome
" altitudes very near the time of noon. If we have
" obſerved any altitudes of the Sun near the prime vertical,
" we may thence determine how much the watch is too
" faſt or too ſlow for apparent time; and conſequently,
" how much the time when the altitudes were taken, is
" diſtant from noon; it therefore remains to find how
" much theſe altitudes are different from the meridian
" altitude. This may eaſily be found by the following
" Rule:

" To the logarithm of the riſing, taken out of the
" tables in the Nautical Almanac for 1771, add the com-
" plement arithmetical of the logarithmic coſine of the
" ſuppoſed meridian altitude; from the ſum (the index
" being increaſed by five) ſubtract the logarithm ratio
" (found by the rules in the abovementioned Ephemeris)
" the remainder is the logarithmic ſine of the change in
" altitude.

" EXAMPLE.

"EXAMPLE. I.

" June the twenty-firſt, the altitude of the Sun's center " was obſerved to be 46° 6′ at 16′ 45″ after apparent noon; " the latitude by account was 67° 17′; the Sun's declination " being then 23° 28′ N, the ſuppoſed meridian altitude " 46° 11′.

				5.
" Suppoſed Latitude 67° 17′	Co. Ar. Coſ. 0,41322.	Riſing 16′ 45″	. .	2,42643
" Sun's declination 23 28	Co. Ar. Coſ. 0,03749.	Suppoſed Mer. Alt. Ar. Co. Coſ.		0,15967
				7,58610
	" Log. Ratio 0,45071	- -	-	0,45071
	" The change in Altitude is +0° 5′	- -	Sine	7,13539
	" Obſerved Altitude 46 6			
	" Meridian Altitude 46 11			
	" Declination 23 28			
	" Altitude of the Equator 22 43			
	" Latitude 67 17 N			

" As the altitudes for determining how much the watch " differs from apparent time were taken near the prime " vertical, a great error in the ſuppoſed latitude will make " a very inſenſible change in the apparent time; nor will " it create any great difference in the variation of altitude " near noon in a given time, as will appear by the following " computation:

" Suppose the latitude by account was 68° 17′, a degree " greater than before.

				5.
" Supposed Latitude 68° 17′	Cos. Co. Ar. 0,43178	Rising 16′ 45″	- -	2,42643
" Declination 23 28	——— 0,03749	Supposed Mer. Alt. 45. 11. Cos.Co.Ar.		0,15191
				7,57834
" Log. Ratio 0,46927			- -	0,46927
" The change in the Sun's Altitude is 0° 4′ 25″			- - Sine	7,10907
" Observed Altitude 46 6				
" Meridian Altitude 46 10 25				
" Declination 23 28				
" Altitude of the Equator 22 42 25				
" Latitude 67 17 35	which only differs thirty-five seconds			

" from the true latitude we found before.

" EXAMPLE II.

" June the twentieth, the altitude of the Sun's center " was observed 0^h 28′ 38″ after midnight, to be 1° 13′, the " latitude by account being 67° 40′ N.

				5.
" Supposed Latitude 67° 40′	Cos. Co. Ar. 0,42022	Rising 28′ 38″	-	2,89380
" Declination 23 28	——— 0,03749	Supposed Mer. Alt. 1° 8′ Cos.Co.Ar.		0,00001
				7,89381
" Log. Ratio 0,45771			- - -	0,45771
" Change in the Altitude — 0° 9′			- - - Sine	7,43610
" Observed Altitude 1 13				
" Meridian Altitude 1 4				
" Co-Declination 66 32				
" Latitude 67 36 N				

" There

" There were two time-keepers ſent out for trial by the " Board of Longitude; one made by Mr. Kendal after Mr. " Harriſon's principles; the other, by Mr. Arnold: this " laſt was ſuſpended in gimmals, but Mr. Kendal's was " laid between two cuſhions which quite filled up the box. " They were both kept in boxes ſcrewed down to the " ſhelves of the cabin, and had each three locks; the key " of one of which was kept by the captain, of another by " the firſt lieutenant, and of the third by myſelf; they " were wound up each day ſoon after noon, and compared " with each other and with Captain Phipps's watch. They " ſtopped twice in the voyage, owing to their being run " down; they were ſet a-going again, and as they had been " daily compared together, it was eaſy to know how " long each had ſtopped, from the others that were ſtill " going; this time is allowed for in the table of the mean " time at Greenwich by each time-keeper.

" When we were on ſhore at the iſland where we ob- " ſerved July 15th, we found how much the watch was too " ſlow for mean time. When we returned from the ice to " Smeerenberg, and again compared the watch with the " mean time, allowing the ſmall difference of longitude " between the iſland and Smeerenberg, we found that it " went very nearly at the ſame rate, as it did when tried " at Greenwich: ſo that its rate of going was nearly the " ſame in our run from England to the iſland, from thence " to the ice and back again to Smeerenberg, and in our "voyage from thence to England, as we found on our "return. By this means we were induced to give the "preference to the watch, and to conclude that the "longitude found by it was not very different from the "truth.

"The principles on which this watch is constructed, as "I am informed by the maker, Mr. Arnold, are these: the "balance is unconnected with the wheel-work, except at "the time it receives the impulse to make it continue its "motion, which is only while it vibrates 10° out of 380°, "which is the whole vibration; and during this small "interval it has little or no friction, but what is on the "pivots, which work in ruby holes on diamonds: it has "but one pallet, which is a plane surface formed out of "a ruby, and has no oil on it.

"Watches of this construction go whilst they are wound "up; they keep the same rate of going in every position, "and are not affected by the different forces of the spring: "the compensation for heat and cold is absolutely ad-"justable.

"Time-keepers of this size are more convenient than "larger, on several accounts; they are equally portable "with a pocket watch, and by being kept nearly in the "same degree of heat, suffer very little or no change from "the vicissitudes of the weather.

"This

" This watch was exceedingly uſeful to us in our obſer-
" vations on land, as the other time-keepers could not
" ſafely be moved: and indeed, in the preſent voyage,
" where they were on trial, it was contrary to the intent
" for which they were put on board, and might have been
" attended with accidents by which the rate of their going
" might have been greatly affected.

" The longitudes by Mr. Arnold's larger time-keeper
" are very different from thoſe by the watch in our voyage
" back from Spitſbergen to England; owing, probably, to
" the balance-ſpring being ruſted, as we found when it
" was opened at the Royal Obſervatory at Greenwich,
" on our return.

" The longitudes found by the Moon are deduced from
" diſtances of the Moon from the Sun's limbs, or from
" Stars, taken with the ſextant; whilſt the altitudes of
" the Moon and Sun, or Star, were taken by two other
" obſervers.

" In one inſtance (June 26th) the obſervations were all
" made by Captain Phipps with the ſmall ſextant ſuc-
" ceſſively; and the altitudes of the Moon and Sun at the
" very inſtant the diſtances were obſerved, are deduced
" from the changes in theſe altitudes during the interval
" of obſervation.

" I have

"I have calculated the longitude from each ſet of "obſervations ſeparately, to ſhew how near they agree "with each other, and what degree of preciſion one "may expect in ſimilar caſes.

"Obſervations of the diſtances of the Moon and Sun, or "Stars, may be uſeful to inform us if the time-keepers "have ſuffered any conſiderable change in their rate of "going. For if the longitude deduced from the moon "differs above two degrees from that found by the "watches, it is reaſonable to imagine, that this difference "is owing to ſome fault in the watch, as the longitude "found by lunar obſervations can hardly vary this "quantity from the truth: but if the difference is much "leſs, as about half a degree, it is more probable that the "watch is right, ſince a ſmall error in the diſtance will "produce this difference.

"The diſtances of the Moon from Jupiter were ob- "ſerved, becauſe Jupiter is a very bright object; and the "obſervations are eaſier and leſs fallacious, particularly "that of the altitude, than thoſe of a fixed ſtar, whoſe "light is much fainter. This method, however, requires "a different form of calculation, from that of the obſerved "diſtance of the Moon from a fixed ſtar, whoſe diſtances "are computed for every three hours, in the Nautical "Almanac. The principal difficulty in the calculation "is to find the Moon's longitude from the obſervation of

"the

" the diſtance. This I have endeavoured to facilitate by " the following problem, which may be applied to any " zodiacal ſtar, and will be of uſe when the ſtar ſet down " in the Ephemeris cannot be obſerved.

"PROBLEM.

" Having given the diſtance of two objects near the " ecliptic, with their latitudes, to find their difference of " longitude.

"SOLUTION.

" Find an arc A, whoſe logarithmic ſine is the ſum of " the logarithms of the ſines of the two latitudes and the " logarithmic tangent of half the diſtance, rejecting twenty " from the index of the ſum.

" Find an arc B, whoſe logarithmic ſine is the ſum of " the logarithmic verſed ſine of the difference of latitude, " and the logarithmic cotangent of the diſtance, rejecting " ten from the index of the ſum.

" Then A added to the obſerved diſtance, and B ſub- " tracted from the ſum, leaves the difference of longitude.

" If one of the latitudes is South, and the other North, " the ſum of the two arcs A and B ſubtracted from the " diſtance, leaves the difference of longitude.

"EXAMPLE.

" August the thirty-first, the observed distance of the " Moon's center from Jupiter, cleared of refraction and " parallax, was 32° 35′ 52″, the Moon's latitude being " 1° 47′ N, and that of Jupiter 1° 36′ S.

" Latitude ☽	1° 47′	Sine 8,4930	Difference of Latitude,	3° 23′	Vers. Sin. 7,2413
" Lat. ♃ -	1 36	Sine 8,4459			
" Half distance	16 18	Tang. 9,4660	Distance	32 36	Cotang. 10,1941
" Arc A.	0′ 52″ - -	Sine 26,4049	Arc B.	9′ 25″ - - -	Sine 17,4354
" The sum of these Arcs	— 10′ 17″	Subtracted from			
" the distance -	32° 35 52				
" leaves	32 25 35	the difference of Longitude between the Moon and Jupiter.			

" Knowing the longitude of Jupiter from the Ephe- " meris, and the difference between it and that of the " Moon, we may infer the longitude of the Moon by " observation: and from the longitudes set down for " noon and midnight of each day in the Nautical " Almanac, find the apparent time at Greenwich when " the Moon had that longitude, which compared with " the apparent time at the Ship, will give the difference " of meridians.

A Table

A Table ſhewing what the Mean Time is at Greenwich, by each Time-keeper, when the Pocket Watch made by Arnold is at 12^h.

Day of the Month.	Arnold.			Kendal.			Watch.		
	h	′	″	h	′	″	h	′	″
June 2	12	0	38	11	59	56	12	1	49
3	12	1	1	12	0	14	12	2	2
4	12	1	16	12	0	25	12	2	15
5	12	1	36	12	0	45	12	2	27
6	12	1	50	12	0	55	12	2	39
7	12	2	6	12	1	10	12	2	51
8	12	2	8	12	1	10	12	3	4
9	12	1	50	12	0	53	12	3	16
10	12	2	3	12	1	5	12	3	28
11	12	2	11	12	1	28	12	3	40
12	12	2	16	12	1	34	12	3	53
13	12	2	4	12	1	28	12	4	5
14	12	2	10	12	1	38	12	4	17
15	12	2	16	12	1	48	12	4	29
16	12	1	59	12	1	35	12	4	42
17	12	2	6	12	1	48	12	4	54
18	12	2	5	12	1	51	12	5	6
19	12	2	14	12	2	7	12	5	18
20	12	2	2	12	2	3	12	5	31
21	12	1	57	12	2	5	12	5	43
22	12	1	43	12	2	3	12	5	55
23	12	1	13	12	1	30	12	6	8
24	12	1	2	12	1	39	12	6	20
25	12	0	24	12	1	17	12	6	32
26	11	59	52	12	0	59	12	6	44
27	11	59	44	12	1	4	12	6	57
28	11	59	26	12	1	2	12	7	9
29	11	59	11	12	1	3	12	7	21
30	11	58	55	12	0	59	12	7	34
July 1	11	58	45	12	1	7	12	7	46
2	11	58	29	12	1	10	12	7	58
3	11	58	20	12	1	21	12	8	10
4	11	58	14	12	1	31	12	8	23
5	11	58	2	12	1	39	12	8	35
6	11	57	50	12	1	47	12	8	47
7	11	57	42	12	1	59	12	8	59
8	11	57	26	12	2	10	12	9	12
9	11	57	20	12	2	25	12	9	24
10	11	56	59	12	2	33	12	9	36
11	11	56	47	12	2	45	12	9	49
12	11	56	25	12	2	45	12	10	1
13	11	56	13	12	2	58	12	10	13
14	11	55	33	12	2	44	12	10	25
15	.	.	.	.	.	.	12	10	38
16	11	55	20	12	2	34	12	10	50
17	11	55	5	12	2	52	12	11	2
18	11	54	56	12	3	18	12	11	14
19	11	54	21	12	3	22	12	11	27
20	11	54	1	12	3	32	12	11	39
21	11	53	39	12	3	59	12	11	51
22	11	53	15	12	4	18	12	12	4
23	11	52	50	12	4	38	12	12	16
24	11	52	15	12	4	47	12	12	28
25	11	51	48	12	5	9	12	12	40
26	11	51	10	12	5	16	12	12	53
July 27	11	50	34	12	5	27	12	13	5
28	11	49	59	12	5	48	12	13	17
29	11	49	31	12	6	12	12	13	29
30	11	48	57	12	6	40	12	13	42
31	11	48	9	12	6	52	12	13	54
Aug. 1	11	47	24	12	7	0	12	14	6
2	11	46	34	12	7	12	12	14	19
3	11	45	50	12	7	32	12	14	31
4	11	44	39	12	7	34	12	14	43
5	11	43	43	12	7	38	12	14	55
6	11	42	36	12	7	31	12	15	8
12	11	58	7	.	.	.	.	.	.
13	11	56	32	.	.	.	.	.	.
14	11	55	16	12	5	21	12	16	45
15	11	54	3	12	5	38	12	16	58
16	11	52	46	12	5	53	12	17	10
[illegible]	11	51	27	12	6	10	12	17	23
18	11	50	8	12	6	33	12	17	35
19	11	48	41	12	6	38	12	17	47
20	11	47	7	12	6	52	12	18	0
21	11	45	23	12	6	58	12	18	12
22	11	43	34	12	6	47	12	18	24
23	11	41	51	12	6	55	12	18	36
24	11	39	51	12	6	58	12	18	49
25	11	37	56	12	6	56	12	19	1
26	11	35	56	12	6	58	12	19	13
27	11	34	7	12	7	15	12	19	25
28	11	32	17	12	7	32	12	19	38
29	11	30	17	12	7	32	12	19	50
30	11	28	9	12	7	43	12	20	2
31	11	26	14	12	7	57	12	20	15
Sept. 1	11	24	5	12	8	13	12	20	27
2	11	21	46	12	8	13	12	20	39
3	11	19	43	12	8	38	12	20	51
4	11	17	29	12	8	53	12	21	4
5	11	14	59	12	9	4	12	21	16
6	11	12	22	12	9	22	12	21	28
7	11	9	38	12	9	22	12	21	40
9	11	3	53	12	9	44	12	22	5
11	10	57	16	12	9	46	12	22	30
13	10	50	45	12	10	16	12	22	54
14	10	35	0	12	10	31	12	23	6
15	10	42	31	12	10	47	12	23	19
16	10	39	36	12	11	4	12	23	31
17	10	35	59	12	11	31	12	23	43
18	10	31	53	12	11	47	12	23	56
19	10	27	11	12	11	52	12	24	8
20	10	23	0	12	12	15	12	24	20
21	10	18	38	12	12	40	12	24	32
23	10	8	54	12	13	39	12	24	57
24	10	4	13	12	14	10	12	25	9
25	9	58	52	12	14	37	12	25	21
26	9	53	54	12	14	59	12	25	34
27	9	48	8	12	15	35	12	25	46

 Obſervations

Obfervations for finding the Longitude by the Time-keepers.

May 30, P. M. off Sheernefs.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ' "	° ' "	° ' "	h ' "	h ' "	' "		
5 48 46	17 46 0	17 55 0	5 53 47	5 50 57	2 11	Mean of the two laft, 3' 15"	Eq. Time 2'—50"
5 51 12	17 14 0	17 23 0	5 57 25	5 54 35	3 23		
5 53 12	16 57 0	17 6 0	5 59 10	5 56 20	3 8		

	h ' "		h ' "		h ' "
At 12h by the Watch, mean Time at the Ship,	12 3 15	. . . . .	12 3 15	. . . . .	12 3 15
At Greenwich, by the Watch,	12 1 13	by Arnold,	12 0 27	by Kendal,	11 59 49
Difference of Meridians,	0 2 2		0 2 48		0 3 26
Longitude of the Ship,	0° 30' 30" E		0° 42' 0"		0° 51' 30"

June 4, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ' "	° ' "	° ' "	h ' "	h ' "	' "		
9 44 15	51 47 30	51 56 30	9 52 44	9 50 37	6 22	Mean 6' 9"	Eq. Time 2'—7"
9 47 30	52 8 0	52 17 0	9 55 32	9 53 25	5 55		
9 50 0	52 27 30	52 36 30	9 58 16	9 56 9	6 9		

	h ' "		h ' "		h ' "
At 12h by the Watch, mean Time at the Ship,	12 6 9	. . . . .	12 6 9	. . . . .	12 6 9
At Greenwich, by the Watch,	12 2 15	by Arnold,	12 1 16	by Kendal,	12 0 25
Difference of Meridians,	0 3 54		0 4 53		0 5 44
Longitude of the Ship,	0° 58' 30" E		1° 13' 15"		1° 26' 0"

June 6, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ' "	° ' "	° ' "	h ' "	h ' "	' "		Eq. Time. 1'—48"
9 49 15	52 25 0	52 33 50	9 59 43	9 57 55	8 40	Mean 8' 51"	
9 51 10	52 38 45	52 46 35	10 1 41	9 59 53	8 43		
9 52 45	52 51 30	53 0 20	10 3 43	10 1 55	9 10		

	h ' "		h ' "		h ' "
At 12h by the Watch, mean Time at the Ship,	12 8 51	. . . . .	12 8 51	. . . . .	12 8 51
At Greenwich, by the Watch,	12 2 39	by Arnold,	12 1 50	by Kendal,	12 0 55
Difference of Meridians,	0 6 12		0 7 1		0 7 56
Longitude of the Ship,	1° 33' 0" E		1° 45' 15"		1° 59' 0"

Observations for finding the Longitude by the Time-keepers.

June 8, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too slow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
9 28 0	48 48 0	48 56 45	9 35 11	9 33 45	5 45	Mean 5′ 49″	Eq. Time 1′—26″
10 54 0	57 10 0	57 19 0	11 1 19	10 59 54	5 54		1′—25″

	h ′ ″		h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 5 49	. . . . .	12 5 49	. . . . .	12 5 49
At Greenwich, by the Watch,	12 3 4	by Arnold,	12 2 8	by Kendal,	12 1 10
Difference of Meridians,	0 2 45		0 3 41		0 4 39
Longitude of the Ship,	0° 41′ 15″ E		0° 55′ 15″		1° 9′ 45″

June 8, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too slow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
5 42 0	19 53 0	20 0 0	5 48 12	5 46 56	4 56		Eq. Time 1′—16″
5 44 35	19 32 0	19 38 50	5 50 38	5 49 22	4 47	Mean 4′ 51″	
5 46 50	19 12 0	19 18 50	5 52 56	5 51 40	4 50		

	h ′ ″		h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 4 51	. . . . .	12 4 51	. . . . .	12 4 51
At Greenwich, by the Watch,	12 3 4	by Arnold,	12 2 8	by Kendal,	12 1 10
Difference of Meridians,	0 1 47		0 2 43		0 3 41
Longitude of the Ship,	0° 26′ 45″ E		0° 40′ 45″		0° 55′ 15″

June 11, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too fast.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		Eq. Time 0′—51″
9 4 35	44 41 0	44 49 40	9 1 17	9 0 26	4 9	Mean 4′ 2″	
9 6 10	44 55 0	45 3 40	9 3 1	9 2 10	4 0		
9 7 50	45 9 0	45 17 40	9 4 45	9 3 54	3 56		
10 12 49	52 36 0	52 44 50	10 5 19	10 4 28	8 21		

At 12^h by the Watch, mean Time at the Ship,	11 55 58	. . . . .	11 55 58	. . . . .	11 55 58
At Greenwich, by the Watch,	12 3 40	by Arnold,	12 2 11	by Kendal,	12 1 28
Difference of Meridians,	0 7 42		0 6 13		0 5 30
Longitude of the Ship,	1° 55′ 30″ W		1° 33′ 15″		1° 22′ 30′

Observations

Obſervations for finding the Longitude by the Time-keepers.

June 13, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
10 16 17	49 39 0	49 50 10	10 20 37	10 20 11	3 54		Lat. 59° 24′
10 20 17	49 55 0	50 6 10	10 24 8	10 23 42	3 25	Mean	Eq. Time 0—26″
10 25 35	50 18 0	50 29 10	10 29 27	10 29 1	3 26	3′ 26″	

	h ′ ″		h ′ ″		h ′ ″
At 10^h by Arnold, mean Time at the Ship,	10 3 26	. . . .	10 3 26	. . .	10 3 26
At Greenwich, by the Watch,	10 3 50	by Arnold,	10 1 49	by Kendal,	10 1 13
Difference of Meridians,	0 0 24		0 1 37		0 2 13
Longitude of the Ship,	0° 6′ 0″ W		0° 24′ 15″ E		0° 33′ 15″ E

June 13, P. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
5 36 22	22 10 30	22 18 0	5 41 6	5 40 44	4 22	*	Lat. 59° 46′ 0″
5 38 55	21 52 0	21 59 30	5 43 18	5 42 56	4 1	*	Eq. Time 0—22
5 39 57	21 44 30	21 54 10	5 44 20	5 43 58	4 1	* Mean of	
5 41 17	21 35 0	21 42 30	5 46 25	5 46 3	4 46	the five	
5 43 3	21 20 0	21 27 30	5 48 8	5 47 46	4 43	marked *	
5 45 9	21 6 30	21 13 50	5 49 43	5 49 21	4 12	4′ 8″	
5 47 40	{ 20 46 30	20 56 0	5 52 7	5 51 45	4 5	*	
	{ 20 47 0	20 54 20	5 52 53	5 52 31	4 51	*	

	h ′ ″		h ′ ″		h ′ ″
At 6^h by Arnold, mean Time at the Ship,	6 4 8	. . . .	6 4 8	. . . .	6 4 8
At Greenwich, by the Watch,	6 3 52	by Arnold,	6 1 49	by Kendal,	6 1 14
Difference of Meridians,	0 0 16		0 2 19		0 2 54
Longitude of the Ship,	0° 4′ 0″ E		0° 34′ 45″		0° 43′ 30″

June 14, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too faſt.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
9 44 32	45 57 0	46 8 0	9 43 56	9 43 43	0 49		Lat. 60° 17′
9 48 41	46 21 0	46 32 0	9 48 20	9 48 7	0 34	Mean 0′ 48″	Eq. Time 0′—13″
9 52 53	46 41 0	46 52 0	9 52 4	9 51 51	1 2		

	h ′ ″		h ′ ″		h ′ ″
At 10^h by Arnold, mean Time at the Ship,	9 59 12	. . . .	9 59 12	. . . .	9 59 12
At Greenwich, by the Watch,	10 3 59	by Arnold,	10 1 52	by Kendal,	10 1 20
Difference of Meridians,	0 4 47		0 2 40		0 2 8
Longitude of the Ship,	1° 11′ 45″ W		0° 40′ 0″		0° 32′ 0″

Obfervations for finding the Longitude by the Time-keepers.

June 15, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
8 26 48	38 3 0	38 13 40	8 28 16	8 28 13	1 35		Lat. 60° 17′
8 28 5	38 11 30	38 22 10	8 29 40	8 29 37	1 32	Mean 1′ 33″	Eq. Time 0—3″
8 29 8	38 20 0	38 30 40	8 30 53	8 30 50	1 42		

	h ′ ″	h ′ ″	h ′ ″
At 8h by Arnold, mean Time at the Ship,	8 1 33	8 1 33	8 1 33
At Greenwich, by the Watch,	8 4 9 by Arnold,	8 1 56 by Kendal,	8 1 28
Difference of Meridians,	0 2 36	0 0 23	0 0 5
Longitude of the Ship,	0° 39′ 0″ W	0° 5′ 45″ W	0° 1′ 15″ E

June 17, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
9 33 11	43 41 0	43 52 0	9 35 29	9 35 53	2 42		Lat. 62° 43′ 30″
9 34 58	43 51 0	44 2 0	9 38 36	9 39 0	4 2		Decl. 23 25 20
9 36 45	44 2 0	44 13 0	9 39 36	9 40 0	3 15	Mean 3′ 31″	Eq. Time 0+24
9 37 40	44 6 30	44 17 30	9 40 31	9 41 55	4 15		
9 42 4	44 30 0	44 41 0	9 45 13	9 45 37	3 33		

	h ′ ″	h ′ ″	h ′ ″
At 10h by Arnold, mean Time at the Ship,	10 3 31	10 3 31	10 3 31
At Greenwich, by the Watch,	10 4 50 by Arnold,	10 2 2 by Kendal,	10 1 44
Difference of Meridians,	0 1 19	0 1 29	0 1 47
Longitude of the Ship,	0° 19′ 45″ W	0° 22′ 15″ E	0° 26′ 45″ E

June 18, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
3 32 41	35 58 30	36 9 10	3 33 5	3 33 45	1 4		Lat. 65° 25′ 0″
3 34 24	35 50 0	36 0 40	3 34 35	3 35 15	0 51	Mean 1′ 4″	Decl. 23 26 10
3 37 38	35 29 0	35 39 40	3 38 15	3 38 55	1 17		Eq. Time 0+40

	h ′ ″	h ′ ″	h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 1 4	12 1 4	12 1 4
At Greenwich, by the Watch,	12 5 6 by Arnold,	12 2 5 by Kendal,	12 1 5
Difference of Meridians,	0 4 2	0 1 1	0 0 4
Longitude of the Ship,	1° 0′ 30″ W	0° 15′ 15″	0° 11′ 45

Obfervations for finding the Longitude by the Time-keepers.

June 19, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			
3 55 38	33 33 0	33 43 30	3 54 51	3 55 45	0 7	*	Lat.	66° 27′ 0″
3 56 39	33 20 0	33 30 30	3 57 9	3 58 3	1 24		Decl.	23 27 10
3 58 8	33 12 0	33 22 30	3 58 33	3 59 27	1 19		Eq. Time	0+54
4 5 28	32 30 0	32 40 30	4 5 55	4 6 49	1 21	Mean of all		
4 6 8	32 25 0	32 35 30	4 6 47	4 7 41	1 33	but the two		
4 7 57	32 16 0	32 26 30	4 8 20	4 9 14	1 17	marked *		
4 8 30	32 12 30	32 23 0	4 8 57	4 9 51	1 21	1′ 24″		
6 4 34	20 44 30	20 54 0	6 5 19	6 6 14	1 40		Lat.	66° 35′ 0″
6 5 27	20 41 0	20 50 30	6 5 54	6 6 49	1 22		Decl.	23 27 0
6 9 9	20 9 0	20 18 20	6 11 25	6 12 20	3 11	*	Eq. Time	0+55

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 1 24	. . . .	12 1 24	. . . .	12 1 24
At Greenwich, by the Watch,	12 5 19	by Arnold,	12 2 14	by Kendal,	12 2 7
Difference of Meridians,	0 3 55		0 0 50		0 0 43
Longitude of the Ship,	0° 58′ 45″ W		0° 12′ 30″		0° 10′ 45″

June 21, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			
8 50 33	37 14 0	37 24 40	8 52 41	8 53 56	3 23	Mean	Lat.	67° 35′ 0″
8 54 0	37 30 30	37 41 10	8 56 12	8 57 27	3 27	3′ 25″	Decl.	23 27 55
8 59 22	37 53 0	38 3 40	9 0 57	9 2 12	2 50		Eq. Time	1+15

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 3 25	. . . .	12 3 25	. . . .	12 3 25
At Greenwich, by the Watch,	12 5 43	by Arnold,	12 1 57	by Kendal,	12 2 5
Difference of Meridians,	0 2 18		0 1 28		0 1 20
Longitude of the Ship,	0° 34′ 30″ W		0° 22′ 0″ E		0° 20′ 0″ E

Obfervations

Obſervations for finding the Longitude by the Time-keepers.

June 25, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			
7 58 27	32 31 0	32 41 30	8 34 25	8 36 32	38 5		Lat.	73° 57′ 0″
8 0 40	32 36 15	32 46 45	8 35 56	8 38 3	37 23		Decl.	23 24 25
8 2 58	32 42 30	32 53 0	8 37 41	8 39 48	36 50	Mean	Eq. Time	2+7
8 3 52	32 46 15	32 56 45	8 39 28	8 41 35	37 43	37′ 36″		
8 4 58	32 50 30	33 1 0	8 40 0	8 42 7	37 9			
8 5 42	32 54 0	33 4 30	8 41 0	8 43 7	37 25			

	h ′ ″		h ′ ″		h ′ ″
At 8h by Arnold, mean Time at the Ship,	8 37 36	. . . .	8 37 36	. . . .	8 37 36
At Greenwich, by the Watch,	8 8 36	by Arnold,	8 2 28	by Kendal,	8 3 21
Difference of Meridians,	0 29 0		0 35 8		0 34 15
Longitude of the Ship,	7° 15′ 0 E		8° 47′ 0″		8° 33′ 45″

June 26, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.			
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			
3 31 36	29 17 0	29 27 15	4 10 25	4 12 49	41 13		Lat.	74° 25′ 0″
3 34 59	29 3 0	29 13 15	4 14 10	4 16 34	41 35		Decl.	23 21 50
3 35 31	28 58 30	29 8 45	4 15 21	4 17 45	42 14		Eq. Time	2+24
3 36 55	28 55 0	29 5 15	4 16 52	4 19 16	42 21	Mean		
3 38 14	28 49 0	28 59 15	4 17 52	4 20 16	42 2	42′ 14″		
3 39 10	28 44 30	28 54 45	4 19 6	4 21 30	42 20			

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 42 14	. . . .	12 42 14	. . . .	12 42 14
At Greenwich, by the Watch,	12 6 44	by Arnold,	11 59 52	by Kendal,	12 0 59
Difference of Meridians,	0 35 30		0 42 22		0 41 15
Longitude of the Ship,	8° 52′ 30″ E		10° 35′ 30″		10° 18′ 45″

Obſervations for finding the Longitude by the Time-keepers.

June 28, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
5 56 50	20 45 0	20 54 30	6 33 21	6 36 5	39 15		Lat. 77° 30′ 0″
5 58 40	20 42 0	20 51 30	6 34 18	6 37 2	38 22	Mean	Decl. 23 16 10
5 59 2	20 40 0	20 49 30	6 34 55	6 37 39	38 37	38′ 29″	Eq. Time 2+44

	h ′ ″	h ′ ″	h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 38 29	12 38 29	12 38 29
At Greenwich, by the Watch,	12 7 9	12 59 26	12 1 2
Difference of Meridians,	0 31 20	0 39 3	0 37 27
Longitude of the Ship,	7° 50′ 0″ E	9° 45′ 45″	9° 21′ 45″

June 29, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
3 41 37	27 29 0	27 39 10	4 22 41	4 25 41	44 4		Lat. 78° 1′ 40″
3 43 25	27 20 0	27 30 10	4 25 1	4 28 1	44 36		Decl. 23 13 15
3 46 30	27 11 0	27 21 10	4 28 47	4 31 47	45 17	Mean	Eq. Time 3+0
3 47 44	27 6 0	27 16 10	4 30 28	4 33 28	45 44	45′ 25″	
3 48 53	27 0 0	27 10 10	4 32 36	4 35 36	46 43		
3 50 24	26 57 0	27 7 10	4 33 29	4 36 29	46 5		

	h ′ ″	h ′ ″	h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 45 25	12 45 25	12 45 25
At Greenwich, by the Watch,	12 7 21 by Arnold,	11 59 11 by Kendal,	12 1 3
Difference of Meridians,	0 38 4	0 46 14	0 44 22
Longitude of the Ship,	9° 31′ 0″ E	11° 33′ 30″	11° 5′ 30″

June 30, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
5 58 43	20 27 0	20 36 25	6 40 1	6 43 14	44 31		Lat. 78° 7′ 15″
6 0 4	20 20 0	20 29 25	6 42 21	6 45 34	45 30	Mean	Decl. 23 9 20
6 1 37	20 15 30	20 24 55	6 43 52	6 47 5	45 28	45′ 29″	Eq. Time 3+13
6 2 28	20 14 15	20 23 40	6 44 17	6 47 30	45 2		

	h ′ ″	h ′ ″	h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 45 29	12 45 29	12 45 29
At Greenwich, by the Watch,	12 7 34 by Arnold,	11 58 55 by Kendal,	12 0 59
Difference of Meridians,	0 37 55	0 46 34	0 44 30
Longitude of the Ship,	9° 28′ 45 E	11° 38′ 30″	11° 7′ 30″

Obſervations

Obſervations for finding the Longitude by the Time-keepers.

July 2, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
5 46 4	20 55 0	21 4 30	6 28 59	6 32 34	46 30	Mean	Lat. 78° 23′ 50″
5 47 44	20 52 0	21 1 30	6 29 59	6 33 34	45 50	44′ 58″	Decl. 23 0 50
5 49 59	20 47 0	20 56 30	6 31 41	6 35 16	45 17		Eq. Time 3+35
5 52 57	20 41 0	20 50 30	6 33 47	6 37 22	44 25		
5 53 55	20 37 0	20 46 30	6 35 11	6 38 46	44 51	of the four	
5 54 49	20 35 0	20 44 30	6 35 47	6 39 22	44 33	laſt 44′ 32″	
5 56 35	20 30 30	20 40 0	6 37 20	6 40 55	44 20		

	h ′ ″		h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 44 32	. . . .	12 44 32	. . . .	12 44 32
At Greenwich, by the Watch,	12 7 58	by Arnold,	11 58 29	by Kendal,	12 1 10
Difference of Meridians,	0 36 34		0 46 3		0 43 22
Longitude of the Ship,	9° 8′ 30″ E		11° 30′ 45″		10° 50′ 30″

July 6, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
6 32 12	19 26 0	19 3 40	7 15 59	7 20 16	48 4		Lat. 79° 57′ 0″
6 36 0	19 18 0	18 55 40	7 19 19	7 23 36	47 36	Mean	Decl. 22 28 20
6 38 35	19 13 0	18 50 40	7 21 24	7 25 41	47 6	47′ 41″	Eq. Time 4+17
6 39 23	19 9 0	18 46 40	7 23 4	7 27 21	47 58		
6 40 57	19 5 30	18 43 10	7 24 20	7 28 37	47 40		

	h ′ ″		h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 47 41	. . . .	12 47 41	. . . .	12 47 41
At Greenwich, by the Watch,	12 8 47	by Arnold,	11 57 50	by Kendal,	12 1 47
Difference of Meridians,	0 38 54		0 49 51		0 45 54
Longitude of the Ship,	9° 43′ 30″ E		12° 27′ 45″		11° 28′ 30″

July 11, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Arnold too ſlow.		
h ′ ″	° ′ ″	° ′ ″	h ″ ″	h ′ ″	′ ″		Lat. 80° 4′ 0″
3 32 22	. . . .	17 39 20	4 19 49	4 24 45	52 23	Mean	Decl. 22 7 20
3 38 48	. . . .	17 54 30	4 26 31	4 31 27	52 39	52′ 31″	Eq. Time 4+56

	h ′ ″		h ′ ″		h ′ ″
At 3^h by Arnold, mean Time at the Ship,	3 52 31	. . . .	3 52 31	. . . .	3 52 31
At Greenwich, by the Watch,	3 16 23	by Arnold,	3 3 21	by Kendal,	3 9 19
Difference of Meridians,	0 36 8		0 49 10		0 43 12
Longitude of the Ship,	9° 2′ 0″ E		12° 17′ 30″		10° 48′ 0″

Obſervations for finding the Longitude by the Time-keepers.

July 12, P. M.

Correction for Error of Sextant, —4′ 30″

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.			
h ′ ′	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″			
7 26 25	16 5 0	16 9 10	8 15 9	8 20 18	53 53		Lat.	80° 4′ 0″
7 27 58	16 3 0	16 7 10	8 16 8	8 21 17	53 19	Mean	Decl.	21 53 10
7 28 44	16 2 15	16 6 25	8 16 30	8 21 39	52 55	53′ 38″	Eq. Time	5+9
7 29 48	15 59 0	16 3 10	8 19 3	8 24 12	54 24			

	h ′ ″		h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	12 53 38	. . . .	12 53 38	. . . .	12 53 38
At Greenwich, by the Watch,	12 10 1	by Arnold,	11 56 25	by Kendal,	12 2 45
Difference of Meridians,	0 43 37		0 57 13		0 50 53
Longitude of the Ship,	10° 54′ 15″ E		14° 18′ 15″		12° 43′ 15″

On Shore on an Iſland near Vogel Sang, Latitude 79° 50′

Correction for Error of the Aſtronomical Quadrant, + 7″

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Eq. Time.	Mean Time.	Watch too flow.	Means.	Co. Decl.
	h ′ ″	° ′ ″	° ′ ″	h ′ ″	′ ″	h ′ ″	′ ″	′ ″	° ′ ″
July 15	3 30 53	25 21 50	25 35 29	4 16 31	5+29	4 22 0	51 7	}	68 33 2
P. M.	3 32 57	25 17 0	25 30 39	4 18 23		4 23 52	50 55	} 51 0	
	3 34 22	25 13 20	25 26 59	4 19 52		4 25 21	50 59	}	
A. M.	3 9 50	15 39 47	15 52 6	3 54 59	5+31	4 0 30	50 40	}	68 37 39
16 P. M.	5 55 25	18 55 12	19 8 8	6 41 1	5+35	6 46 36	51 11	} 51 $5\frac{1}{2}$	68 43 44
	5 59 0	18 46 10	18 59 6	6 44 25		6 50 0	51 0	}	
17 P. M.	5 31 45	19 46 40	19 59 43	6 17 17	5+40	6 22 57	51 12		68 54 0
18 A. M.	8 28 3	13 8 20	13 20 0	8 52 53	5+41	8 58 34	50 31		68 55 0

	h ′ ″		h ′ ″		h ′ ″
July 16, at 12^h by the Watch, mean Time at the Iſland,	12 51 0	. . . . .	12 51 0	. . . .	12 51 0
At Greenwich, by the Watch,	12 10 50	by Arnold,	11 55 20	by Kendal,	12 2 34
Difference of Meridians,	0 40 10		0 55 40		0 48 26
Longitude of the Iſland,	10° 2′ 30″ E		13° 55′ 0″		12° 6′ 30″

Obſervations

Observations for finding the Longitude by the Time-keepers.

July 26, P. M.

Time by the Watch. h ′ ″	Alt. of the Sun's lower Limb. ° ′ ″	Alt. of the Sun's Center. ° ′ ″	Apparent Time. h ′ ″	Mean Time. h ′ ″	Watch too slow. h ′ ″		
3 29 25	22 46 0	22 55 40	4 25 41	4 31 43	1 2 18	Mean 1h 2′ 16″	Lat. 80° 20′ 0″
3 31 14	22 42 0	22 51 40	4 27 23	4 33 25	1 2 11		Co. Decl. 70 40 40
3 33 35	22 36 0	22 45 40	4 29 53	4 35 55	1 2 20		Eq. Time 6+2
3 35 34	22 33 30	22 43 10	4 31 4	4 37 6	1 1 32		
3 36 50	22 31 0	22 40 40	4 31 59	4 38 1	1 1 11		
3 38 47	22 29 0	22 38 40	4 32 51	4 38 53	1 0 6		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	1 2 16	. . . .	1 2 16	. . . .	1 2 16
At Greenwich, by the Watch,	12 12 53	by Arnold,	11 51 10	by Kendal,	12 5 16
Difference of Meridians,	0 49 23		1 11 6		0 57 0
Longitude of the Ship,	12° 20′ 45″ E		17° 46′ 30″		14° 15′ 0″

July 27, P. M.

Time by the Watch. h ′ ″	Alt. of the Sun's lower Limb. ° ′ ″	Alt. of the Sun's Center. ° ′ ″	Apparent Time. h ′ ″	Mean Time. h ′ ″	Watch too slow. h ′ ″		
5 51 16	16 15 0	16 23 45	6 58 31	7 4 32	1 13 16		Lat. 80° 23′ 0″
5 53 22	16 10 30	16 19 15	7 0 24	7 6 25	1 13 3	Mean 1h 13′ 3″	Co. Decl. 70 55 45
5 55 26	16 5 45	16 14 30	7 2 24	7 8 25	1 12 59		Eq. Time 6+1
5 58 35	15 58 0	16 6 45	7 5 40	7 11 41	1 13 6		
6 0 56	15 53 0	16 1 45	7 7 47	7 13 48	1 12 52		

	h ′ ″		h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	1 13 3	. . . .	1 13 3	. . . .	1 13 3
At Greenwich, by the Watch,	12 13 5	by Arnold,	11 50 34	by Kendal,	12 5 27
Difference of Meridians,	0 59 58		1 22 29		1 7 36
Longitude of the Ship,	14° 59′ 30 E		20° 37′ 15″		16° 54′ 0″

July 28, P. M.

Time by the Watch. h ′ ″	Alt. of the Sun's lower Limb. ° ′ ″	Alt. of the Sun's Center. ° ′ ″	Apparent Time. h ′ ″	Mean Time. h ′ ″	Watch too slow. h ′ ″		
							Lat. 80° 28′ 10″
5 22 34	17 10 0	17 18 50	6 30 46	6 36 46	1 14 12	Mean 1h 14′ 24″	Co. Decl. 71 9 10
5 28 58	16 54 30	17 3 20	6 37 34	6 43 34	1 14 36		Eq. Time 6+0

	h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	1 14 24	. . . .	1 14 24
At Greenwich, by the Watch,	12 13 17	by Kendal,	12 5 48
Difference of Meridians,	1 1 7		1 8 36
Longitude of the Ship,	15° 16′ 45″ E		17° 9′ 0″

Observations

Observations for finding the Longitude by the Time-keepers.

July 30, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	h ′ ″		
3 14 40	21 17 0	21 26 30	4 37 24	4 43 20	1 28 40		Lat. 80° 33′ 0″
3 22 6	20 59 0	21 8 30	4 45 1	4 50 57	1 28 51		Co. Decl. 71 38 50
3 26 34	20 48 45	20 58 15	4 49 21	4 55 17	1 28 43	Mean	Eq. Time 5+56
3 29 11	20 41 30	20 51 0	4 52 21	4 58 17	1 29 6	1^h 28′ 54″	
3 30 54	20 37 30	20 47 0	4 54 1	4 59 57	1 29 3		
3 32 45	20 33 30	20 43 0	4 55 33	5 1 29	1 28 44		
3 34 43	20 28 0	20 37 30	4 57 59	5 3 55	1 29 12		

	h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	1 28 54	. . . .	1 28 54
At Greenwich, by the Watch,	12 13 42	by Kendal,	12 6 40
Difference of Meridians,	1 15 12		1 22 14
Longitude of the Ship,	18° 48′ 0″ E		20° 33′ 30″,

July 31, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	h ′ ″		
3 53 30	19 26 0	19 35 10	5 18 7	5 24 1	1 30 31		Lat. 80° 37′ 0″
3 55 46	19 21 30	19 30 40	5 19 55	5 25 49	1 30 3		Co. Decl. 71 52 10
3 58 30	19 17 0	19 26 10	5 21 45	5 27 39	1 29 9		Eq. Time 5+54
4 0 2	19 12 30	19 21 40	5 23 29	5 29 23	1 29 21		
4 0 50	19 8 0	19 17 10	5 25 28	5 31 22	1 30 32		
4 1 57	19 7 0	19 16 10	5 26 29	5 32 23	1 30 26	Mean	
4 2 50	19 6 30	19 15 40	5 26 56	5 32 50	1 30 0	1^h 29′ 55″	
4 4 19	19 3 0	19 12 10	5 27 31	5 33 25	1 29 6		
4 5 36	18 59 0	19 8 10	5 29 9	5 35 3	1 29 27		
4 6 35	18 56 0	19 5 10	5 30 23	5 36 17	1 29 42		
4 7 26	18 52 0	19 1 10	5 32 1	5 37 55	1 30 29		
4 8 14	18 50 30	18 59 40	5 32 39	5 38 33	1 30 19		
4 9 23	18 49 0	18 58 10	5 33 15	5 39 9	1 29 46		

	h ′ ″		h ′ ″
At 12^h by the Watch, mean Time at the Ship,	1 29 55	. . . .	1 29 55
At Greenwich, by the Watch,	12 13 54	by Kendal,	12 6 52
Difference of Meridians,	1 16 1		1 23 3
Longitude of the Ship,	19° 0′ 15″ E		20° 45′ 45″

Obfervations

Obfervations for finding the Longitude by the Time-keepers.

At Smeerenberg, Lat. 79° 44′

By the Aftronomical Quadrant, Correction for Error of Quadrant — 32″

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.	Eq. Time.	Co. Decl.
	h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	′ ″	° ′ ″
Auguft 14 P. M.	5 38 30	12 24 0	12 35 0	6 30 21	6 34 31	56 1	4+10	75 50 30
	5 47 37	12 0 0	12 11 0	6 39 31	6 43 41	56 4		
	6 1 15	11 24 0	11 34 40	6 53 24	6 57 34	56 19		
	6 2 39	11 21 0	11 31 40	6 54 59	6 59 9	56 30		75 50 50
	6 5 2	11 15 0	11 25 40	6 56 54	7 1 4	56 2		
	6 6 8	11 12 0	11 22 40	6 58 4	7 2 14	56 6		
	6 7 24	11 9 0	11 19 40	6 59 15	7 3 25	56 1		
	6 8 39	11 6 0	11 16 40	7 0 0	7 4 9	55 30	4+9	
	6 9 45	11 3 0	11 13 40	7 1 31	7 5 40	55 55		
	6 11 3	11 0 0	11 10 40	7 2 42	7 6 51	55 40		
	6 15 44	10 48 0	10 58 30	7 7 23	7 11 32	55 48		75 51 0
	6 16 41	10 45 0	10 55 30	7 8 41	7 12 50	56 9		
	6 17 51	10 42 0	10 52 30	7 9 54	7 14 3	56 12		
	6 19 10	10 39 0	10 49 20	7 11 8	7 15 17	56 7		
	6 20 22	10 36 0	10 46 20	7 12 20	7 16 29	56 7		
15, A. M.	4 56 57	13 6 0	13 17 20	5 48 53	5 52 50	55 53	3+57	75 59 20
	4 59 20	13 12 0	13 23 20	5 51 9	5 55 6	55 46		
	5 2 26	13 21 0	13 32 20	5 54 32	5 58 29	56 3		
	5 3 35	13 24 0	13 35 20	5 55 43	5 59 40	56 5		
	5 4 46	13 27 0	13 38 20	5 56 55	6 0 52	56 6		75 59 30
	5 7 6	13 33 0	13 44 20	5 59 5	6 3 2	55 56		
	5 8 19	13 36 0	13 47 20	6 0 12	6 4 9	55 50		
	5 9 12	13 39 0	13 50 30	6 1 24	6 5 21	56 9		
	5 10 23	13 42 0	13 53 30	6 2 31	6 6 28	56 5		
	5 11 34	13 45 0	13 56 30	6 3 41	6 7 38	56 4		
	5 12 43	13 48 0	13 59 30	6 4 49	6 8 46	56 3		
	5 13 49	13 51 0	14 2 30	6 5 56	6 9 53	56 4		
	5 20 42	14 9 0	14 20 40	6 12 44	6 16 41	55 59		75 59 40
	5 22 56	14 15 0	14 26 40	6 14 59	6 18 56	56 0		
	5 24 2	14 18 0	14 29 40	6 16 5	6 20 2	56 0		
	5 27 25	14 27 0	14 38 40	6 19 28	6 23 25	56 0		
18, A. M.	4 57 8	12 15 0	12 26 0	5 50 51	5 54 19	57 11	3+28	76 56 50
	5 0 31	12 24 0	12 35 0	5 54 13	5 57 41	57 10		
	5 1 46	12 27 0	12 38 0	5 55 21	5 58 49	57 3		
	5 2 51	12 30 0	12 41 0	5 56 29	5 59 57	57 6		
	5 3 57	12 33 0	12 44 0	5 57 35	6 1 3	57 6		
	5 6 11	12 39 0	12 50 10	5 59 51	6 3 19	57 8		
	5 7 20	12 42 0	12 53 10	6 1 2	6 4 30	57 10		
	5 11 52	12 54 0	13 5 10	6 5 35	6 9 3	57 11		76 57 0
	5 13 6	12 57 0	13 8 10	6 6 42	6 10 10	57 4		
	5 15 15	13 3 0	13 14 20	6 9 0	6 12 28	57 13		
	5 16 32	13 6 0	13 17 20	6 10 8	6 13 36	57 4		
	5 17 39	13 9 0	13 20 20	6 11 15	6 14 43	57 4		
	5 19 50	13 15 0	13 26 20	6 13 29	6 16 57	57 7		
	5 20 55	13 18 0	13 29 20	6 14 37	6 18 5	57 10		
	5 22 4	13 21 0	13 32 20	6 15 48	6 19 16	57 12		76 57 10
	5 24 24	13 27 0	13 38 20	6 18 3	6 21 31	57 7		
	5 25 35	13 30 0	13 41 20	6 19 11	6 22 39	57 4		
	5 27 43	13 36 0	13 47 30	6 21 29	6 24 57	57 14		
	5 28 55	13 39 0	13 50 30	6 22 36	6 26 4	57 9		

Obfervations

Obſervations for finding the Longitude by the Time-keepers.

Day of the Month.	Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.	Eq. Time.	Co. Decl.
	h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	′ ″	° ′ ″
Auguſt 18	5 37 58	14 3 0	14 14 40	6 31 44	6 35 11	57 13	3+21	76 57 20
A. M.	5 41 23	14 12 0	14 23 40	6 35 44	6 39 11	57 48		
	5 42 28	14 15 0	14 26 40	6 36 19	6 39 46	57 18		
	5 43 39	14 18 0	14 29 40	6 37 27	6 40 54	57 15		76 57 30
	5 45 49	14 24 0	14 35 40	6 39 1	6 42 28	56 39		
	5 47 4	14 27 0	14 38 40	6 40 49	6 44 16	57 12		
	5 48 13	14 30 0	14 41 40	6 42 1	6 45 28	57 15		
	5 49 21	14 33 0	14 44 40	6 43 9	6 46 36	57 15		76 57 40
	5 59 39	15 0 0	15 11 50	6 53 27	6 56 54	57 15		
	6 0 53	15 3 0	15 14 50	6 54 37	6 58 4	57 11		
	6 1 58	15 6 0	15 17 50	6 55 45	6 59 12	57 14		
	6 3 8	15 9 0	15 20 50	6 56 53	7 0 20	57 12		
	6 4 17	15 12 0	15 23 50	6 58 3	7 1 30	57 13		
	6 5 29	15 15 0	15 26 50	6 59 12	7 2 39	57 10		76 57 50
	6 6 36	15 18 0	15 29 50	7 0 24	7 3 51	57 15		
	6 7 42	15 21 0	15 32 50	7 1 33	7 5 0	57 18		
	6 11 19	15 30 0	15 41 50	7 5 1	7 8 28	57 9		
	6 13 32	15 36 0	15 47 50	7 7 19	7 10 46	57 14		
	6 14 49	15 39 0	15 51 0	7 8 33	7 12 0	57 11		
	6 16 1	15 42 0	15 54 0	7 9 43	7 13 10	57 9		
18, P. M.	5 10 49	12 18 0	12 29 0	6 4 21	6 7 42	56 53	3+21	77 6 50
	5 12 55	12 12 0	12 23 0	6 6 35	6 9 56	57 1		
	5 14 6	12 9 0	12 20 0	6 7 43	6 11 4	56 58		
	5 15 14	12 6 0	12 17 0	6 8 51	6 12 12	56 58		
	5 16 16	12 3 0	12 14 0	6 9 58	6 13 19	57 3		
	5 17 22	12 0 0	12 11 0	6 11 5	6 14 26	57 4		
	5 18 40	11 57 0	12 8 0	6 12 13	6 15 34	56 54		
	5 19 35	11 54 0	12 5 0	6 13 21	6 16 42	57 7		
	5 20 48	11 51 0	12 1 50	6 14 27	6 17 48	57 0		
	5 21 51	11 48 0	11 58 50	6 15 40	6 19 1	57 10		

	I. Aug. 14, P. M.	II. Aug. 15, A. M.	III. Aug. 18, A. M.	IV. Aug. 18, P. M.
At 12h by the Watch, mean Time at Smeerenberg,	12h 56′ 2″	12h 56′ 0″	12h 57′ 11″	12h 57′ 1
At Greenwich, by the Watch,	12 16 45	12 16 45	12 17 35	12 17 35
Difference of Meridians,	0 39 17	0 39 15	0 39 36	0 39 26
Longitude of Smeerenberg,	9° 49′ 15″	9° 48′ 45″	9° 54′ 0″	9° 51′ 30″

Mean of the firſt, ſecond, and fourth, 9° 49′ 40″; of all, 9° 50′ 45″ E.

At 12h by the Watch, mean Time at Smeerenberg,	12h 56′ 2″	12h 56′ 0″	12h 57′ 11″	12h 57′ 1
At Greenwich, by Kendal,	12 5 21	12 5 21	12 6 31	12 6 33
Difference of Meridians,	0 50 41	0 50 39	0 50 40	0 50 28
Longitude of Smeerenberg,	12° 40′ 15″	12° 39′ 45″	12° 40′ 0″	12° 37′ 0″

Mean 12° 39′ 15″ E.

		″
From comparing the 1ſt with the	3d, the Watch loſes in a Day,	19,7
	4th, ...	14,8
2d . .	3d, ...	23,7
	4th, ...	17,4
Mean of all four, ...		18,9

Obſervations

Obfervations for finding the Longitude by the Time-keepers.

Auguft 31, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
6 1 54	4 35 0	4 36 10	6 35 43	6 35 31	33 37		Lat. 68° 46′ 0″
6 4 31	4 23 0	4 23 50	6 38 1	6 37 49	33 18		Co. Decl. 81 37 10
6 6 20	4 10 0	4 10 30	6 40 33	6 40 21	34 1	Mean	Eq. Time 0—12
6 7 40	4 2 0	4 2 10	6 42 7	6 41 55	34 15	33′ 51″	
6 10 1	3 51 0	3 50 50	6 44 16	6 44 4	34 3		
6 11 33	3 44 0	3 43 30	6 45 39	6 45 27	33 54		

	h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 33 51	. . . .	12 33 51
At Greenwich, by the Watch,	12 20 15	by Kendal,	12 7 57
Difference of Meridians,	0 13 36		0 25 54
Longitude of the Ship,	3° 24′ 0″ E		6° 28′ 30″

Sept. 3, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
5 14 0	7 50 0	7 55 30	5 46 31	5 45 25	31 25		Lat. 65° 31′ 0″
5 16 30	7 30 0	7 35 20	5 48 52	5 47 46	31 16		Co. Decl. 82 41 20
5 17 7	7 24 30	7 29 30	5 49 34	5 48 28	31 21		Eq. Time 1—6
5 18 20	7 20 0	7 25 0	5 50 5	5 48 59	30 39	Mean	
5 18 55	7 16 30	7 21 30	5 50 30	5 49 24	30 29	30′ 41″	
5 19 40	7 13 0	7 18 0	5 50 55	5 49 49	30 9		
5 20 50	7 4 30	7 9 20	5 52 16	5 51 10	30 20		
5 21 50	6 58 0	7 2 50	5 52 43	5 51 37	29 47		

	h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 30 41	. . . .	12 30 41
At Greenwich, by the Watch,	12 20 51	by Kendal,	12 8 38
Difference of Meridians,	0 9 50		0 22 3
Longitude of the Ship,	2° 27′ 30″ E		5° 30′ 45″

Sept. 6, A. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		Lat. 62° 50′ 0″
8 56 25	26 50 0	27 0 10	9 22 57	9 20 59	24 34	Mean	Co. Decl. 83 41 30
8 58 27	26 58 0	27 8 10	9 24 36	9 22 38	24 11	24′ 22″	Eq. Time 1—58

	h ′ ″		h ′ ″
At 12h by the Watch, mean Time at the Ship,	12 24 22	. . . .	12 24 22
At Greenwich, by the Watch,	12 21 28	by Kendal,	12 9 22
Difference of Meridians,	0 2 54		0 15 0
Longitude of the Ship,	0° 43′ 30″ E		3° 45′ 0″

Obfervations for finding the Longitude by the Time-keepers.

Sept. 6, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
4 44 14	10 35 0	10 42 10	5 15 17	5 13 14	29 0		Lat. 61° 57′ 0″
4 45 54	10 26 0	10 33 0	5 16 35	5 14 32	28 38		Co. Decl. 83 49 0
4 47 29	10 13 0	10 20 0	5 18 27	5 16 24	28 55	Mean 28′ 49″	Eq. Time 2—3
4 48 59	10 4 0	10 10 50	5 19 45	5 17 42	28 43		
4 50 0	9 56 0	10 1 50	5 21 2	5 18 59	28 59		
4 52 36	9 39 0	9 45 40	5 23 20	5 21 17	28 41		

	h ′ ″		h ′ ″
At 12ʰ by the Watch, mean Time at the Ship,	12 28 49	. . . . .	12 28 49
At Greenwich, by the Watch,	12 21 28	by Kendal,	12 9 22
Difference of Meridians,	0 7 21		0 19 27
Longitude of the Ship,	1° 50′ 15″ E		4° 51′ 45″

Sept. 14, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		
2 54 41	22 39 0	22 48 50	3 30 55	3 26 8	31 27		Lat. 55° 32′ 0″
2 55 40	22 36 0	22 45 50	3 31 21	3 26 34	30 54		Co. Decl. 86 50 0
2 56 34	22 29 0	22 38 50	3 32 17	3 27 30	30 56	Mean 31′ 12″	Eq. Time 4—47
2 57 41	22 18 0	22 27 50	3 33 48	3 29 1	31 20		
2 58 52	22 10 0	22 19 50	3 34 52	3 30 5	31 13		
3 2 24	21 43 0	22 52 50	3 38 31	3 33 44	31 20		

	h ′ ″		h ′ ″
At 12ʰ by the Watch, mean Time at the Ship,	12 31 12	. . . .	12 31 12
At Greenwich, by the Watch,	12 23 6	by Kendal,	12 10 31
Difference of Meridians,	0 8 6		0 20 41
Longitude of the Ship,	2° 1′ 30″ E		5° 10′ 15″

Sept. 25, A. M. in Hofely Bay.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Apparent Time.	Mean Time.	Watch too flow.		
h ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″		Lat. 52° 6′ 0″
9 22 47	30 54 0	31 4 40	9 58 47	9 50 17	28 30	Mean	N. Pol. dift. 91 1 10
9 24 17	31 5 0	31 15 40	10 0 49	9 52 19	28 2	28′ 16″	Eq. Time 8—30

	h ′ ″		h ′ ″
At 12ʰ by the Watch, mean Time at the Ship,	12 28 16	. . . .	12 28 16
At Greenwich, by the Watch,	12 25 21	by Kendal,	12 14 37
Difference of Meridians,	0 2 55		0 13 39
Longitude of the Ship,	0° 43′ 45″ E		3° 24′ 45″

Obſervations for finding the Longitude by the Moon.

June 13, A. M.

Time by Arnold.	Alt of the Sun's lower Limb.	Alt. of the Moon's lower Limb.	Diſtance of the Sun and Moon's neareſt Limbs.	True Diſtance of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
10 16 17	49 39 0	21 17 0	74 37 0	74 30 53	22 17 17	22 20 37	3 20	0 50 0 E
10 20 17	49 55 0	20 54 0	74 37 0	74 30 39	22 17 47	22 24 8	6 21	1 35 15
10 25 35	50 18 0	20 20 0	74 37 0	74 30 22	22 18 23	22 29 27	11 4	2 46 0
							Mean	1 43 45

June 14, A. M.

Correction for Error of the Sextant, — 3′ 46″

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Moon's lower Limb.	Diſtance of the Sun and Moon's neareſt Limbs.	True Diſtance of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
9 44 32	45 57 0	30 42 0	63 47 30	63 45 45	21 52 12	21 43 56	8 16	2 4 0 W
9 48 41	46 21 0	30 26 0	63 44 0	63 41 54	22 0 42	21 48 20	12 22	3 5 30
9 52 53	46 41 0	30 10 0	63 41 30	63 39 3	22 6 59	21 52 4	14 55	3 43 45
							Mean	2 57 45 W

June 15, A. M.

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Moon's lower Limb.	Diſtance of the Sun and Moon's neareſt Limbs.	True Diſtance of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
10 30 36	49 50 0	34 20 0	52 35 0	52 37 41	22 32 3	22 32 1[illegible]	0 9	0 2 15 E
10 32 4	49 54 0	34 20 0	52 34 45	52 37 23	22 34 56	22 33 4[illegible]	1 16	0 19 30 W
10 34 33	50 3 0	34 10 0	52 32 0	52 34 26	22 39 17	22 36 [illegible]	3 8	0 47 0
10 36 23	50 9 0	34 4 0	52 32 0	52 34 18	22 39 35	22 37 5[illegible]	1 36	0 24 0
10 39 54	50 18 0	33 51 0	52 31 15	52 33 20	22 41 44	22 41 5[illegible]	0 14	0 3 30
10 41 34	50 28 0	33 40 0	52 31 0	52 32 51	22 42 47	22 42 1[illegible]	0 37	0 9 15
							Mean	0 17 0 W

June 25, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Moon's lower Limb.	Diſtance of the Sun and Moon's neareſt Limbs.	True Diſtance of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
7 49 2	12 54 0	11 40 0	65 58 0	66 21 55	7 30 23	8 22 13	51 50	12 57 30 E

Obfervations for finding the Longitude by the Moon.

June 26, P. M.

Time by the Watch.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Alt. of the Moon's lower Limb.	Alt. of the Moon's Center.	Diftance of the Sun and Moon's neareft Limbs.	True Diftance of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′	° ′	° ′ ″	° ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
1 24 25	. .	36 18	. . .	12 51	75 39 30	75 41 30	1 25 1	2 4 15	39 50	9 57 30 E
1 28 14	35 58	. . .								
1 29 48	. .	. .	12 50 0							
1 32 5	. .	36 1	. . .	13 6	75 43 0	75 45 13	1 32 5	2 11 55	39 50	9 57 30
1 34 3	. .	. . .	12 58 30							
1 36 9	35 41									

July 11, A. M.

Arnold too flow for Apparent Time 47′ 35″. Correction for Error of the Sextant, + 4′ 24″

Time by Arnold.	Alt. of the Sun's lower Limb.	Alt. of the Sun's Center.	Alt. of the Moon's lower Limb.	Diftance of the Sun and Moon's neareft Limbs.	True Diftance of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
3 28 15		17 20 10	13 6 0	95 44 0	96 3 35	15 32 47	16 15 50	45 3	10 45 45
3 30 12	17 25								
3 32 22		17 39 20	13 9 0	95 40 0	95 59 20	15 41 58	16 19 57	37 59	9 29 45
3 34 7	17 34								
3 38 48		17 54 30	13 13 0	95 36 0	95 55 8	15 51 3	16 26 23	35 20	8 50 0
3 40 24	17 50								
								Mean	9 42 0 E

Sept. 1, P. M. Moon's Diftance obferved from Aldebaran.

Time by the Watch.	Computed Alt. of Aldebaran.	Alt. of the Moon's lower Limb.	Diftance of the Moon from Aldebaran.	True Diftance of the Centers.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
11 45 15	17 49 0	17 3 0	76 57 neareft Limb	77 0 59	11 56 7	12 22 44	26 37	6 39 15 E
12 7 43	20 45 0	17 10 0	77 18 fartheft Limb	76 48 53	12 19 29	12 45 12	25 43	6 25 30
12 22 44	22 8 0	17 6 0	76 44 neareft Limb	76 44 15	12 27 33	13 0 13	32 40	8 10 0

Sept. 3, P. M. Moon's Diftance obferved from Aldebaran.

Time by the Watch.	Computed Alt. of Aldebaran.	Alt. of the Moon's lower Limb.	Diftance of the Moon's W. limb from Aldeb.	True Dift. of the Moon's Cent. from Aldeb.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Diff. of Meridians.	Longitude of the Ship.
h ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″
11 20 35	17 47 0	24 47 0	39 39 0	39 57 5	11 30 43	11 55 47	25 4	6 16 0 E

Obſervations of the Moon and Jupiter.

Auguſt 31, P. M.

Time by the Watch.	Alt. of Jupiter.	Alt. of the Moon's lower Limb.	Diſtance of Jupiter and the Moon's farther Limb.	True Diſtance of the Centers.	Difference between the Diſtance and Difference of Longitude.	Difference of Longitude.	Longitude of Jupiter.	Latitude of the Moon.	Latitude of Jupiter.	Longitude of the Moon by Obſervation.	Longitude of the Moon by Ephemeris.	Difference from Longitude	Apparent Time at Greenwich.	Apparent Time at the Ship.	Difference of Meridians.	Longitude of the Ship.	
h ′ ″	° ′	° ′ ″	° ′ ″	° ′ ″	′ ″	s ° ′ ″	s ° ′ ″	° ′	° ′	s ° ′ ″	at 6h s ° ′ ″	at 6h ° ′ ″	h ′ ″	h ′ ″	′ ″	° ′ ″	
8 51 33	10 25	9 0 0	32 55 0	32 35 52	— 10 17	1 2 25 35	0 7 29 0	1 47 N	1. 36 S	11 5 3 25	11 3 39 54	1 23 29	8 33 22	9 25 37	52 15	13 3 45	
9 3 27	10 59	9 36 0	32 47 0	32 27 47	— 10 10	1 2 17 37	. . . .	. . .	. . .	11 5 11 23	at 9h	1 31 29	8 48 10	9 37 31	49 21	12 20 15	
												at 9h					
9 32 45	13 19	10 55 0	32 29 0.	32 7 33	— 10 10	1 1 57 23	. . . .	. . .	. . .	11 5 31 37	11 5 17 57	0 13 40	9 25 7	10 6 49	41 42	10 25 30	
9 51 54	14 40	11 36 0	32 22 0	31 59 18	— 10 10	1 1 49 8	. . . .	1 43	. . .	11 5 39 52		0 21 55	9 40 17	10 25 58	45 41	11 25 15	Mean 11° 13′ E.
10 38 25	17 45	12 49 0	31 58 0	31 31 27	— 10 10	1 1 21 17	0 7 30 0	. . .	. . .	11 6 7 43		0 49 46	10 31 29	11 12 29	41 0	10 15 0	
11 43 18	20 52	13 6 0	31 28 0	30 57 24	— 10 10	1 0 47 14	. . . .	. . .	. . .	11 6 41 46	at 12h	1 23 49	11 30 34	12 17 22	46 48	11 42 0	
											11 6 55 45	at 12h					
1 35 37	22 45	9 55 0	30 33 0	29 54 38	— 10 10	0 29 44 28	. . . .	1 38	. . .	11 7 44 32		0 48 17	13 29 40	14 9 41	40 1	10 0 15	

September 1, P. M.

Time by the Watch.	Alt. of Jupiter.	Alt. of the Moon's lower Limb.	Diſtance of Jupiter and the Moon's farther Limb.	True Diſtance of the Centers.	Difference between the Diſtance and Difference of Longitude.	Difference of Longitude.	Longitude of Jupiter.	Latitude of the Moon.	Latitude of Jupiter.	Longitude of the Moon by Obſervation.	Longitude of the Moon by Ephemeris, at Midnight.	Difference from Longitude at Midnight.	Apparent Time at Greenwich.	Apparent Time at the Ship.	Difference of Meridians.	Longitude of the Ship.
h ′ ″	° ″	° ′ ″	° ′ ″	° ′ ″	′ ″	s ° ′ ″	s ° ′ ″	° ′	° ′	s ° ′ ″	s ° ′ ″	° ′ ″	h ′ ″	° ′ ″	′ ″	° ′ ″
11 59 20	21 55	17 8 0	18 8 0	17 38 22	— 12 1	0 17 26 21	0 7 23 30	1 4 N	1 36 S	11 19 57 9	11 19 48 53	0 8 16	12 15 39	12 36 49	21 10	5 17 30
12 16 14	22 8	17 8 0	18 4 0	17 33 56	. . . . . .	0 17 21 55	. . . .	. . .	. . .	11 20 1 35		0 13 2	12 24 40	12 53 43	29 3	7 15 45

September 3, P. M. with the Megameter, Correction for Error of Adjuſtment, + 2′ 52″.

Time by the Watch.	Alt. of the Moon's lower Limb.	Alt. of Jupiter.	Diſtance of Jupiter and the Moon's Weſtern Limb.	True Diſtance of the Centers.	Parallax in Longitude.	Parallax in Latitude.	Parallax in Altitude.	Latitude of the Moon.	Apparent Latitude of the Moon.	Difference between the Diſtance and Difference of Longitude.	Difference of Longitude.	Apparent Longitude of the Moon.	Longitude of the Moon corrected by Parallax.	Apparent Time at the Ship.	Apparent Time at Greenwich.	Difference of Meridians	
h ′ ″	° ′ ″	° ′	° ′ ″	° ′ ″	′ ″	′ ″	′ ″	° ′	° ′	″	° ′ ″	s ° ′ ″	s ° ′ ″	h ′ ″	h ′ ″	′ ″	
9 30 53	15 27 0	15 33	6 40 0	6 57 58	— 10 37	+ 52 9	52 13	1 7	1 59 S	— 22	6 57 36	0 14 1 36	0 13 50 59	10 6 5	10 8 43	2 38 W	Latitude of Jupiter, 1° 37′ S
9 45 20	16 47 0	16 50	6 52 44	7 10 42	— 11 48	+ 51 31	52 51	1 8	1 59	— 22	7 10 20	0 14 14 20	0 14 2 32	10 20 32	10 31 14	10 42	Longitude, 0s 7° 4′
10 1 4	18 6 0	18 7	7 1 10	7 19 8	— 13 9	+ 50 44	52 28	1 8	1 59	— 21	7 18 47	0 14 22 47	0 14 9 38	10 36 16	10 45 4	8 48	Watch too ſlow for }
10 26 7	20 14 0	20 12	7 8 4	7 26 2	— 15 16	+ 49 29	51 47	1 9	1 58	— 21	7 25 41	0 14 29 41	0 14 14 29	11 1 19	10 54 24	6 55 E	Apparent Time, } 35′ 12″
10 40 54	21 30 0	21 54	7 16 10	7 34 8	— 16 51	+ 48 30	51 21	1 9	1 58	— 21	7 33 47	0 14 37 47	0 14 20 56	11 16 6	11 7 13	8 53	

The Elements of the above Calculation.

Apparent Time.	Right Aſcenſion of Mid-heaven.	Longitude of Mid-heaven.	Declination of Mid-heaven.	Alt. of the culminating Point.	Angle between the Meridian and the Secondary to the Ecliptic.	Alt. of the Nonageſimal.	Longitude of the Nonageſimal.	Longitude of the Moon.	Diſtance of the Moon and the Nonageſimal.
h ′	° ′	s ° ′	° ′	° ′	° ′	° ′	s ° ′	s ° ′	s ′ ″
10 0	313 2	10 10 35	17 36 S	7 4	15 46	17 4	8 5 4	0 13 47	4 8 43
11 0	328 4	10 25 48	12 56	11 44	19 45	22 5	8 27 22	0 14 17	4 16 55
12 0	343 6	11 11 40	7 12	17 28	22 23	28 7	9 21 14	0 14 48	4 23 34

FINIS.

DIRECTIONS to the BOOKBINDER.