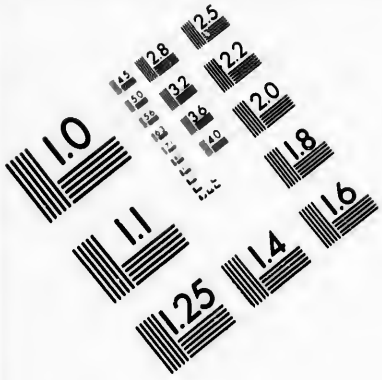

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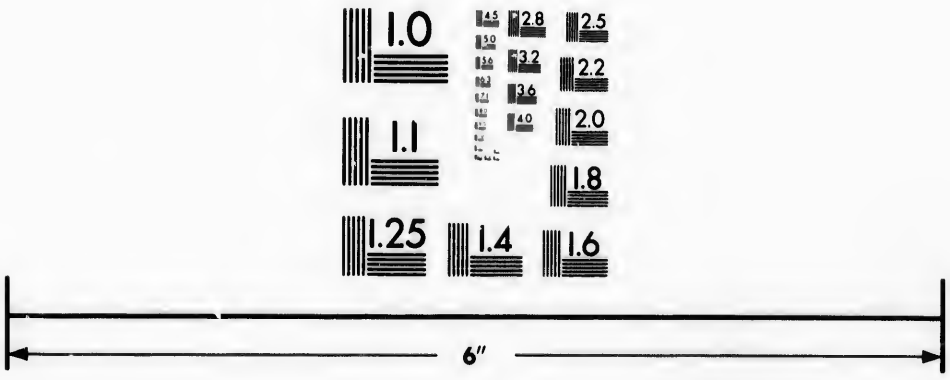

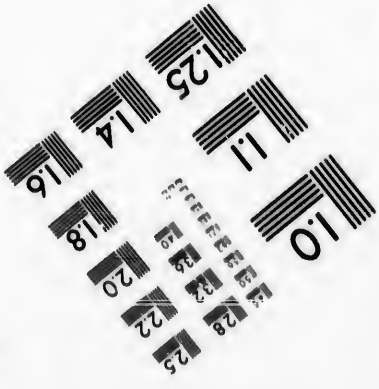

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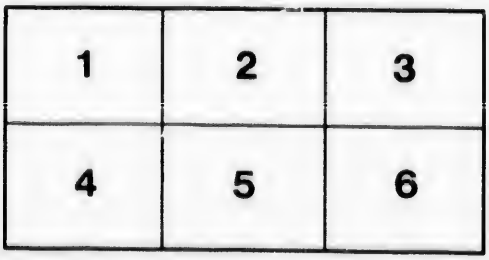

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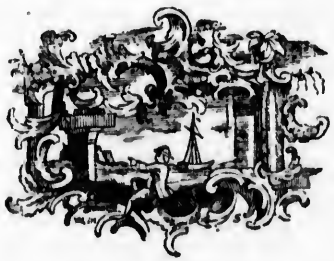
OBSERVATIONS
ON THE
FLOATING ICE
WHICH IS FOUND
IN HIGH NORTHERN AND SOUTHERN LATITUDES.

TO WHICH ARE ADDED
EXPERIMENTS
ON THE
FREEZING OF SEA WATER.

By B. HIGGINS, M. D.



LONDON,
Printed for *C. HEYDINGER*, oppoſite the Theatre Royal, Drury Lane, in Bridges-Street, STRAND.
M. DCC. LXXVI.

OBSERVATIONS

ON THE

FLOATING ICE,

WHICH IS FOUND

IN HIGH NORTHERN AND SOUTHERN LATITUDES.

SINCE the return of the King's ſhips from voyages of diſcovery, both in high Northern and Southern latitudes, I have found that it hath been a diſputed point, whether the ice which they have met with, was formed chiefly from the ſalt or freſh water. I ſhould rather conceive that this doubt muſt have ariſen from what is mentioned by the great Mr. BOYLE, in his experiments on heat and cold, or from an obſervation of M. ADANSON at the end of his voyage from Senegal, becauſe from the quantity of ice merely, (at leaſt to the Northward) the early navigators never conceived that it was produced from ſea water.

In full proof of this, not to ſtate the opinion of ſeveral others on the ſame head, I ſhall content myſelf with citing that of Sir MARTIN FROBISHER, who is well known to

 have

have made three ſucceſſive voyages to Groenland, with a further intent of diſcovering the North Weſt paſſage from Europe to the Pacific Ocean. In the ſecond voyage of this celebrated navigator, he obſerves:

" We found none of theſe iſlands of ice ſalt in taſte, whereby it appears that they were not of the Ocean water congealed, which is always ſalt, but of ſome ſtanding or little moving lakes; the main ſea freezes not, and therefore there is no *Mare Glaciale*." In his third voyage he moſt anxiouſly repeats this ſame opinion, and in ſtill ſtronger terms, ſo that what he hath thus laid down, was not an occaſional obſervation merely, but what he had much reflected upon, and found to be confirmed by his experience in thoſe Northern Seas (*a*).

This opinion of Sir MARTIN FROBISHER's, ſeems not to have been diſputed by any one, till the time of Mr. BOYLE, who obſerves, that there are diverſe in Amſterdam, who uſed to thaw the ice of Sea water for brewing, and then cites BARTHOLINUS *de Nivis uſu. De glacie ex aquâ marinâ, certum eſt ſi reſolvatur, ſalſum ſaporem depoſuiſſe, quod non ita pridem expertus eſt Clariſſimus* FINKIUS *in glaciei fruſtis, ex portu noſtro allatis* (*b*).

I ſhall not now criticiſe either what falls from Mr. BOYLE himſelf, or from BARTHOLINUS, though it is very clear that the ice alluded to by both, muſt have probably been formed from freſh water, either in the rivers or lakes which empty themſelves into the Zuyder Sea, becauſe I ſhall hereafter contradict the

(*a*) See HAKLUYT, Vol. II. p. 62, and 67.
(*b*) BOYLE's Works, Vol. II. p. 264. Folio.

the aſſertion of BARTHOLINUS, by the actual experiment, which I have tried myſelf during the late hard froſt.

To do juſtice indeed to Mr. BOYLE, he afterwards upon more mature conſideration, ſhews it to be his opinion agreeable to that of Sir MARTIN FROBISHER, that the freſh water obtained from ice floating in the Sea, proves it could not have been formed from the Ocean, " becauſe the main Sea is ſeldom or ever frozen." *(c)*

The next Author who ſuppoſes that congealed ſea water, is by this proceſs rendered ſweet to the taſte, is Monſ. ADANSON, who informs us, that upon his return from Senegal in 1748, he carried two bottles of Sea water taken up on the coaſt of Africa, from Breſt to Paris, which, during an intenſe froſt, was ſo frozen as to burſt the bottles, and the contents afterwards became palatable. *(d)*

To this fact I ſhortly anſwer, either that the bottles were changed, or otherwiſe that Monſ. ADANSON does not mention the circumſtance by which the taſte of the ſea water was thus altered upon it's being diſſolved. Mr. NAIRNE hath been much more accurate in ſtating his experiments with regard to the freezing ſea water, in a Paper read before the Royal Society on the 2d of February, 1776, as he mentions that in order to clear the ice from any brine which might adhere to it, he waſhed it in a pail of pump water for a quarter of an hour, after which he informs the Society, that to his palate it was perfectly free from any taſte of ſalt.

 This

(*c*) BOYLE's Works, Vol. II. p. 302.
(*d*) Voyage au Senegal, p. 190.

This is moſt undoubtedly the fact, but Mr. NAIRNE does not ſeem to be aware from what circumſtance the ice thus melted had become freſh water; *(e)* and indeed I muſt admit, that upon the firſt experiment which I made with regard to freezing ſea water, I deduced the ſame inference that he hath done, having waſhed it in freſh water for the ſame reaſon that he did, viz. to get rid of the brine which might adhere to the ſurface of the ice.

To determine therefore whence this freſhneſs in the thawed ice might ariſe, I placed a large piece of what remained frozen (without being waſhed at all in pump water) to be diſſolved before the fire, which taſted very ſalt as one might naturally ſuppoſe.

The weather continuing to be very ſevere, I froze more ſea water, repeating the experiment of freſhening it or not, by leaving it, or not leaving it in pump water, which always turned out uniformly to be the ſame; and the reaſon of which, is the following.

When Sea water is frozen, it does not form ice ſimilar to that from freſh water, being by no means ſo ſolid or tranſparent as the former, as it conſiſts of thin laminæ or plates, between which the brine is depoſited, and if the ice

(*e*) As Mr. NAIRNE in his Letter to Sir JOHN PRINGLE, ſays that one of his great reaſons for trying theſe experiments, was to determine whether the ice which floats in the Northern Seas is formed from the ſalt water or not, he therefore ſhould have thawed the ice preciſely under the ſame circumſtances with the Sea water adhering, as the navigators take it up. The truth is that if the piece is at all large, the adhering ſalt water can ſcarcely affect the taſte at all, and I have melted the central parts of a pretty large maſs, which became very ſalt after diſſolution, though entirely detached from the Sea water, in which it had been frozen.

ice is accurately examined, the ſmall portions of brine between the plates may be eaſily diſtinguiſhed. If this brine therefore is removed, the laminæ of ice when diſſolved become ſweet to the taſte, but if thawed together with the brine intercepted between the laminæ, the taſte is ſalt, nor can the ice be diverted of the brine, by merely leaving it to drain.

Having ſatisfied myſelf thus far from the freezing ſea water by the natural cold, and under the common circumſtances of expoſing it to the air in ſmall china cups, I applied to Dr. HIGGINS to proſecute theſe experiments with his more ample apparatus, and knowledge of chemiſtry; who was immediately ſo good as to ſuggeſt and try the following experiments, which will throw further light upon this ſubject. *(f)*

"JANUARY 2d, *(g)* 1776. A gallon, Wincheſter meaſure, of Sea water, which I had freſh imported from Mr. OWEN, in Fleet-Street was placed in a ſhallow diſh of Welch ware, glazed yellow; the depth of the water in this diſh was three inches and a half, this ſhallow diſh I marked A. and placed it on a brick wall eight feet high above the ground, behind my houſe; this wall on the Eaſtern ſide is the boundary between my premiſes

(f) It would be great injuſtice to Mr. LOMONOS , a Sweediſh chemiſt, not to mention that he ſeems to have tried experiments ſimilar to thoſe which I have made myſelf, and found the reſult to be as I have ſtated it. See *Collection Académique*, Tom. XI. p. 5. & ſeq. 4to. *Paris*, 1772. See alſo The Probability of reaching the North Pole diſcuſſed, p. 37, Note *(y)*

(g) Mr. NAIRNE began his experiments at the latter end of this month.

premiſes and the ſeveral gardens belonging to five or ſix houſes in the ſame Street with mine; and on the Weſtern ſide of it, is the area between my houſe and the elaboratory; and Weſtward of my area is the garden of Meſſ. WEDGWOOD and BENTLEY, which I believe is forty feet wide, bounded on the Weſt by high buildings."

"At the ſame time I placed another gallon of the ſame Sea water in a glaſs body. The column of water in this veſſel was about thirteen inches high, about ſix inches diameter at the baſe, and about three inches at the mouth of the veſſel. I placed this body with the ſea water, cloſe by the veſſel marked A. ſo that both were equally diſtant from the adjoining houſes; and after marking the glaſs body B. I covered both veſſels A and B, with glaſs baſons, in ſuch manner, that the air might communicate with the ſurface of the water, but rain or ſnow might be excluded."

"A Thermometer was placed between theſe veſſels."

"From the 2d to the 7th of January, the mercury in the Thermometer ſtood at various times, as low as thirty-one of Farenheite; and Thames water in ſhallow wooden veſſels, placed on the ground, near the wall above mentioned, was often frozen to the thickneſs of a crown piece. But an earthen oil-jar containing twenty gallons of Thames water, and a like jar containing twenty gallons of diſtilled water, and each covered with a pewter diſh, preſerved the water contained in them, from freezing during this interval."

"About the 7th of January, the mercury in the courſe of twenty-four hours, did not riſe above thirty-one, but ſometimes ſunk to thirty. Ice was formed in the veſſel marked A.

but

but none in the veſſel marked B. Ice was at the ſame time formed in the great jars containing Thames water and diſtilled water; and to a thickneſs much greater in the Thames water, than in the ſame water diſtilled. The ice obtained from the veſſel A. was all formed on the ſurface of the water; and conſiſted of thin laminæ adhering to each other weakly, and intercepting in their interſtices a ſmall portion of water, which was ſaline to the taſte. This ice beaten gently with a glaſs peſtle to divide the laminæ, then drained, and then waſhed in diſtilled water, taſted like the ice of freſh water; and being placed in a glaſs funnel before a culinary fire, ſo that the water might drain off as ſoon as formed, it diſſolved in half an hour, and not in leſs time, although the Thermometer placed at the ſame diſtance cloſe to the funnel roſe to 160; and the ſide of the funnel next the fire was hot to the like degree as nearly as could be aſcertained by the touch. The water of the ice thus melted was freſh and palatable, and meaſured half a pint."

" From the 9th of January to the 11th inclusive, the mercury roſe ſome days to forty, and during three or four hours on other days, it ſunk and remained at thirty, and ſometimes for an hour or leſs, it ſunk to twenty-nine. But it did not remain at thirty during any of theſe days, for more than four or five hours, unleſs at the hours of reſt, when no obſervation was made. During this period, a thin coat of ice, like the former, was produced on the water in the ſhallow veſſel A. but no ice was formed in the veſſel B."

" January 12, the Thermometer pointed for ſeveral hours between thirty-one at the higheſt, and twenty-nine at the

loweſt

loweſt. A thick cruſt of ice, of the texture before deſcribed, was formed in the veſſel A. This ice broken, waſhed, and diſſolved, became freſh water, meaſuring a pint or more. This quantity of ice placed in a funnel, before a fire, in the circumſtances already deſcribed, was not all diſſolved in an hour and ten minutes. No ice was formed in the veſſel B. *(h)*."

" January the 13th at night, and 14th in the morning, the Thermometer ſunk for ſome hours below twenty-ſeven, and did not riſe during ſixteen hours above twenty-eight. The water in the veſſel A, remaining after the foregoing congelations, was frozen to the thickneſs of a quarter of an inch in the center, and three quarters of an inch in the circumference, but no ice was formed at any greater depth in the water. This ice, like the former, was laminated, and when bruiſed and waſhed, it formed freſh water to the quantity of three pints."

" On the ſame day, *viz.* 14th of January, in the morning, the Thermometer pointing below twenty-ſeven, the Thames water in the great jar was frozen to the thickneſs of three or four inches, if not more, contiguous to the jar and the ſurface. The diſtilled Thames water in the other jar was frozen to the thickneſs of two inches, or thereabouts, and contiguous to the jar and ſurface of the water; and the ſea water in the

(*b*) " The foregoing obſervations were committed to writing, on the days when they were reſpectively made, but the day of the month was not then accurately noted. It may therefore be found that I have placed ſome of the foregoing temperatures a day anterior, or poſterior to the day on which they were obſerved."

the glaſs body marked B, was for the firſt time frozen. On the ſurface and in the center of this ſurface, the ice was half an inch thick, at the circumference it was an inch thick; and from the circumference and ſurface, the ice formed contiguous to the glaſs, in ſuch manner, that the cruſt was an inch thick near the glaſs and ſurface, but as it advanced downwards towards the wider part of the glaſs, it tapered to an edge, terminating within an inch of the bottom of the veſſel."

" Thus all the ice was formed on the ſurface and contiguous to the glaſs, and was thickeſt where the veſſel was narroweſt; that is, the quantity of ice was inverſely as the diameter of the veſſel. This ice reſembled that obtained in the ſhallow veſſel in its laminated ſtructure and ſponginess, and in its enveloping a portion of the ſalt water; with this difference only, that the laminæ ſhot vertically, and from the circumference inclining towards the center, not directly, but ſo as to form with the center an angle of about 15 degrees. This ice bruiſed and waſhed, melted to a pint and a half of pleaſant freſh water. The time and heat was nearly the ſame as I deſcribed above."

" Mr. BARRINGTON at this and former periods obſerved, that the ſeparation of the laminæ of the ice by bruiſing, accelerated the effect produced by waſhing; that is, the extrication of the intercepted brine."

" January the 19th at night, the mercury in the Thermometer ſunk to twenty-ſix. The Sea water remaining after the foregoing congelations in the flat diſh marked A, was frozen ſo far, that only a pint remained fluid at the

bottom. This ice was in all reſpects like the former portions. Bruiſed, waſhed and melted, as on former occaſions, it gave a quart of freſh water. At the ſame time, the water in B. was frozen, in the manner before deſcribed, but in a larger quantity, and ſome laminæ of ice ſhot cloſe to the glaſs as far as the bottom of the veſſel. This ice bruiſed and waſhed as formerly, and placed before the fire in a glaſs funnel, melted in a heat of a hundred and ſixty, in an hour and a half, to one quart of freſh water."

" January the 20th, the mercury which ſtood at twenty-ſeven, and fell to twenty-ſix, towards twelve o'clock, fell in a few hours to twenty-four, and before nine at night, fell to twenty-three. Only a thin coat of ice was formed on the water, in A, which I did not diſturb, expecting it to freeze deeper, during the night. The water in the veſſel B, was frozen to ſome thickneſs at the ſurface, and contiguous to the ſides of the glaſs body, but not at the bottom. Expecting a ſtronger congelation, I ſuffered this alſo to ſtand untill the next morning, and conſequently could not determine the quantity of ice formed in it, otherwiſe than by feeling near the ſurface, whereby I preſumed the quantity of ice to be equal to that laſt obtained, and formed in the ſame manner."

" January the 21ſt in the morning, the Thermometer pointed to twenty-eight. The thin cruſt of ice obſerved on the preceding night, did not appear to be encreaſed or diminiſhed in the veſſel marked A. The laminæ of this ice adhered ſo weakly, that the whole cruſt could not be raiſed without breaking. This ice bruiſed and well waſhed, diſſolved to

near

near half a pint of water brackiſh to the taſte. And the ſame day, in the morning, the ice in B, was removed, bruiſed and waſhed; it melted to a pint or more of freſh water."

" From the 21ſt to the 26th of January, the water in the veſſel marked B, was frozen twice, and the ice formed each time, was bruiſed and waſhed, and melted to freſh water, both portions meaſuring one pint or more."

" From the 26th of January at Sun ſet, to the 27th, at eleven o'clock in the morning, the mercury in the Thermometer, ſtood at the uſual hours of obſervation, between twenty and eighteen. The water remaining after the foregoing congelations, in B, was frozen ſo far, that only half a pint remained fluid. The ice bruiſed, waſhed and diſſolved, taſted a little brackiſh, and meaſured one pint and a half."

" On the 28th of January the mercury ſtood in the morning, and until four o'clock at noon, between twenty-two and nineteen, at before eleven o'clock, it ſunk to ſeventeen. Very little ice was formed in the veſſel B, and what was formed, very eaſily crumbled or fell to ſmall flakes in attempting to take it out. I therefore ſuffered it to remain in the liquor until the morning."

" On the 29th of January, the mercury ſtood between twenty and twenty-two, until ſix o'clock; and between twenty and nineteen, from ſix until twelve at night. The quantity of ice formed on the preceding day, was not notably augmented or diminiſhed; bruiſed, waſhed, and melted, it yielded two ounces of water brackiſh to the taſte, in a greater degree, than any of the foregoing portions which were waſhed."

" On the 30th of January, finding that the temperature of the preceding evening, of the night, and of this day, which was between nineteen and twenty-one, had cauſed no notable congelation in the ſmall quantity of water remaining in B. finding alſo that the reſidue of the water in A, admitted of no further congelation worth notice; and conſidering that the ſlender laminæ of ice lately formed in theſe waters, melted to ſalt water, and conſequently, that no further congelation capable of ſeparating the freſh water from the brine, even with the aſſiſtance of waſhing, could take place; I mixed the concentrated brine in A, with that in B, and found both ſcarcely meaſured a wine pint: ſome ſmall cryſtals were found in the bottom of both veſſels, which ſunk in the brine, and were to the taſte Sea ſalt. It is thence evident, that ſome Sea ſalt is formed cryſtaline, by the concentration produced by cold, gradually applied, and cauſing congelation only on the ſurface of water, or not affecting that part of it, which is contiguous to the bottom of the veſſel."

" The quantity of theſe cryſtals of Sea ſalt was about two grains. I poured them together with the water into a china plate, ſet in a ſand heat, and by cryſtalization obtained from Sea ſalt, and the ſaline contents of Sea water, in a dry form near two ounces, averdupoiſe."

" Now as this quantity of Sea water, (that is two gallons), taken on our coaſt, generally yields about ſeven ounces of ſaline matters; it appears, that two thirds or more of the ſea ſalt, and bitter ſalts of Sea water, are intercepted in the ice of the ſucceſſive congelations, and are waſhed away by freſh water, applied as above mentioned. Hence it appeared, that

that Sea water may be freſhened by freezing, provided the brine enveloped between the laminæ of this ice, is waſhed away. And in cold countries, ſalt might be prepared from Sea water at a very moderate expence, by freezing ſhallow ponds of this water, by turning the ice to drain off the brine, and then, when the brine is reduced to a twentieth part or leſs, very little evaporation and fuel will be neceſſary towards the formation of the ſalt (*i*). But all the ſalt of the Sea water employed, will not be obtained, becauſe the greater part of it will be retained between the laminæ of the ice which muſt be removed; and the concentration, by freezing cannot be advantageouſly carried further than is above expreſſed, becauſe at that degree of concentration, the cold and the time neceſſary to cauſe further congelation, muſt be very conſiderable, as will the waſte of ſalt likewiſe; ſince then the ice is ſtrongly ſaline."

" A ſmall portion of the ice taken at various times from B, ſince the 26th of January, was not waſhed, but only left to drain in a funnel, and each portion thus drained during five or ſix days, being ſeparately diſſolved, taſted ſtrongly of ſalt; although the like ice which was bruiſed and waſhed, yielded freſh water. This proves that waſhing removes the intercepted brine; and that this brine does not ſeparate by draining."

" January the 20th, at eight o'clock in the evening, the Thermometer pointing at twenty-three in the open air, where the

(*i*) " WALLERIUS ſays, this art is practiſed in the Northern countries."

the Thermometer ſtood, I mixed ſnow with ſpirit of nitre, and placed in the mixture a glaſs half pint tumbler full of Sea water; and at the ſame time placed the Thermometer in the mixture. In two minutes, the mercury ſunk out of the tube quite into the globe. The ſcale extends only twenty-five degrees below O. of Farenheit; wherefore I could not determine how many degrees lower it would have ſunk on a more extended ſcale. In five minutes, ſome ſlender laminæ of ice began to ſhoot from the circumference of the water, and adhered to the glaſs. The whole water was *not frozen in leſs than an hour*, at which time, the mercury in the Thermometer, roſe to twenty degrees below O. Having another mixture of the ſame kind ready made, I briſkly removed the tumbler with the ice it contained into the freſh mixture, which like the former, ſunk the mercury into the globe."

" The ice of Sea water is more opaque than that of freſh water, when both are naturally congealed. For, the elaſtic fluid in common water forms bubbles only in the central parts of the water laſt frozen; but the ice of ſea water conſiſts of alternate parts of ice and brine; the denſity of which being unequal, and the matter of them being alſo diſſimilar, light cannot be freely tranſmitted, but is partly reflected and refracted, according to Sir I. NEWTON's Ideas of Viſion."

" In the experiment laſt mentioned, the ice was uncommonly opaque; and when it was expoſed to the freſh frigorific mixture, it became like a maſs of ſnow compreſſed, having a ſnowy whiteneſs and opacity, perfect near the ſurface, but not perfect towards the bottom."

" The

" The tumbler with the ice it contained, was kept in this laſt mentioned mixture an hour, when the mercury denoted, that no further degree of cold could be given by this mixture. The tumbler was then placed in ſnow until the next day, to preſerve the ice for further obſervation. Notwithſtanding the extreme cold to which it had been ſo long expoſed; and the cold medium in which it was placed, the ice was not ſolid like that of freſh water, but on the contrary could eaſily be cut through the center of the maſs with a knife. The ice taſted equally of ſalt through the whole maſs, in the ſame manner, as a like quantity of Sea water doth. Bruiſed briſkly, waſhed as already deſcribed, and melted, it yielded freſh water, to the quantity of four fifths of the water frozen; wherefore in waſhing, very little ice was diſſolved, whilſt the ſalt water intercepted in the ice was removed."

" M. BARRINGTON having obſerved, that an artificial freezing, commences from the bottom and ſides of the maſs of water, placed as uſual in the frigorific mixture; but natural freezing commences on the ſurface, and proceeds downwards: and it occurring to me that the ſpecific gravity of incongealable brine, is greater than that of the congealable water; and conſequently that this greater ſpecific gravity, favours the ſeparation of brine from the ice of Sea water, when the freezing commences on the ſurface of Sea water; and may be an impediment to the ſeparation of the incongealable brine from the ice artificially formed in Sea water, when the congelation proceeds from the bottom upwards. On theſe conſiderations it ſeemed, that the foregoing experi-

experiments, only indicate, that ice formed in Sea water, cannot when melted become freſh water, unleſs it be waſhed in freſh water; but do not fully prove, that ice formed on the ſurface only, and proceeding ſlowly downwards, in Sea water, may not conſiſt of freſh water, and be freed from brine, by reaſon of the ſpecific gravity of brine, and other unnoticed circumſtances. Therefore, on the 21ſt of January at two o'clock, when the mercury ſtood in the open air at twenty-nine, I made the following experiment, with a view to determine whether Sea water frozen artificially from the ſurface downwards, in the manner performed by nature, would not yield ice of a ſolid texture, and capable of melting to freſh water without waſhing, and merely by draining; which muſt take place in mountains of ice, if any are formed in the Northern Sea: becauſe ice being ſpecifically lighter than water, and the acceſs of congealed water being at the baſe, the portions firſt frozen, will be raiſed above the water by ſucceeding portions frozen, and thus a mountain of ice may be raiſed, whoſe maſs and height above water, will be to the maſſive baſe immerſed in water, as the ſpecific gravity of ice, is to that of water."

"I placed therefore a gallon of Sea water in a glazed earthen veſſel, whoſe diameter was one third greater than the depth of the water. In this water I ſlung a thin glaſs baſon cut from a bolt-head, capable of containing near two quarts of water. I ſlung it in this manner that it might be immerſed two inches deep in the Sea water. The veſſel containing the Sea water, was ſurrounded with ſnow. I then filled the baſon which was ſuſpended in the Sea water, with ſnow preſſed down with a glaſs

a glaſs peſtle, and poured into the ſnow the uſual quantity of ſtrong nitrous acid."

" In fifteen minutes, ſome cryſtals of ice were formed on the interior glaſs baſon, in the part where it was contiguous to the ſurface of the Sea water. In three hours, the whole bottom of the baſon, containing the frigorific mixture, was coated with ice; the thickneſs of which was half an inch or leſs at the bottom of the baſon, encreaſing to three fourths of an inch at the part which correſponded with the ſurface of the water."

" I eaſily ſeparated it entire from the baſon, found it ſomewhat firmer in its aggregation than the ice ſlowly formed by natural freezing, and not compoſed of lamina like this latter; but ſimilar in texture to the ſalt water frozen by artificial cold applied in the uſual manner. I placed it on a heap of ſnow, where it remained to drain, upwards of ſix hours, but ſtill was wet to the touch on the ſurface, and in the freſh ſurfaces of the fractured parts. I then placed a part of it in a glaſs funnel before the fire, to melt; and found the water ſtrongly ſaline to the taſte, but not near ſo ſaline as equal parts of Sea and river water mixed."

" Another portion of this ice, which was wrapped up in filtering paper, and left to drain on a heap of dry ſnow, during four days, when melted, was ſaline to the taſte, and not ſenſibly different from that which had drained only ſix or ſeven hours. Whence it appeared, that ice formed in the Sea water, in circumſtances ſimilar to thoſe which

attend natural congelation, is, nevertheleſs, ſaline to the taſte."

" The ſeveral portions of water obtained in the foregoing experiments, from the waſhed ice of Sea water, being preſerved in ſeparate bottles, ſtopped with ground glaſs, were next examined. Although they were freſh to the taſte, it appeared by the quantity of *luna cornea*, which they all formed with ſaturated nitrous ſolution of ſilver, that they were ſtrongly impregnated with marine ſalt, comparatively with Thames and New River water, examined in the like manner."

" Mr. BARRINGTON obſerving, that ſalt in water is an impediment to the congelation of that water, preſumed, that ſalt in water would accelerate the thawing of ice immerſed in it; and that in equal temperatures, ice would be thawed in Sea water ſooner than in freſh water. I therefore made the following experiment."

" January the 20th, when the Thermometer pointed to twenty-three, about nine o'clock at night, I placed five ounces and half a drachm, averdupoiſe, of Thames water in a half pint glaſs tumbler; and the like quantity of the ſame water diſtilled, in another half pint glaſs tumbler of equal figure and capacity with the foregoing. The tumblers were placed on the wall formerly deſcribed, and left there covered with glaſs untill eleven o'clock next morning."

" In the morning, at eleven o'clock, the Thermometer pointed to twenty-eight. The water in both tumblers was frozen quite through, and formed maſſes of ice, tranſparent as cryſtal

cryſtal in every part, except the center, and near the bottom, which parts were rendered opaque to the thickneſs of half an inch, by a number of air bubbles locked up in the ice. The diſtilled water had been kept ſeveral days in the jar above deſcribed, whoſe mouth was only covered with an inverted pewter diſh."

"Into a glaſs tumbler, capable of holding a Wincheſter pint or more, I put a wine pint of Thames water; and into another tumbler of the ſame figure and capacity, I poured a wine pint of Sea water concentrated, by freezing one fourth of it, the better to repreſent Sea water of the great oceans, which are not affected by rivers, ſo much as the Sea water uſed in theſe experiments, muſt be, as it was taken up near the North Foreland. The Sea water was thus concentrated, for theſe further reaſons: firſt, that the effect of ſalt in the water might be more conſpicuous during the thawing of the ice; and ſecondly, to prevent the firſt portions of ice thawed from diluting the ſalt water to a degree, which never is found in the ocean. I reduced the Sea and the Thames water contained in theſe tumblers to the ſame temperature exactly, in the open air; then taking hold of each by the ſummit of the glaſs above the water, I carried them into my ſtudy, and placed them on a carpet, fifteen feet equally diſtant from the fire, and three inches from the wainſcot of the wall oppoſite the fire, and equally diſtant from a door on one ſide, and a window which extends within fourteen inches of the floor on the other. The tumblers, containing the frozen water, were immerſed in a large pan of hot water, cloſe to each other, and near the center of the pan, the water riſing to the height of the ice in

the tumblers; after a few minutes the ice was thrown out, by inverting the glaſſes on clean paper. The two pieces of ice were equal in ſize, figure, and weight; the weight of each being five ounces averdupoiſe."

" The moment before the ice was taken out of the tumblers, I found the temperature of the Sea and freſh water placed as above mentioned, to be equal, and exactly thirty-four; the temperature of the air in that part of the room being forty-ſix. I plunged the pieces of ice immediately, one in the Sea water, the other in the freſh water. It was at this inſtant two o'clock, in the afternoon. In ten minutes the temperature of the Sea water was thirty-two, that of the freſh water was thirty-three and a half. In half an hour the Sea water raiſed the mercury to thirty-three, the freſh water raiſed it to thirty-four and a half."

" At this inſtant, viz. half an hour paſt two o'clock, I took both the pieces of ice at the ſame time, weighed them briſkly, and replaced them in their reſpective veſſels at the ſame inſtant. Of the ice placed in the Sea water, half an ounce was diſſolved: of the ice placed in the freſh water, only four drachms and a half were diſſolved."

" From half an hour paſt two o'clock, until ſix, I frequently changed the poſition of the tumblers, making one take the place of the other. At ſix, the temperature of the Sea water was thirty-ſix, that of the freſh water was thirty-ſeven and a half. In the manner already mentioned, the ice was at this time weighed, and replaced. Of the ice in Sea water three ounces and four drachms were diſſolved; of that in freſh water, only two ounces and eight drachms."

" It

" It is obſervable, that the Sea water was a degree and a half colder, ever ſince the immerſion of the ice, than the freſh water, acted on by the like maſs of ice, and placed in the like circumſtances; and nevertheleſs the ice was diſſolved much quicker in the colder Sea water. The quicker ſolution of the ice in Sea water, was evidently the cauſe of the greater degree of cold preſerved in it during four hours; and it already appeared, that ſalt water is a more powerful ſolvent of ice than freſh water in the like temperature. And agreeable to Mr. BARRINGTON's ſuggeſtion, the matter which impedes the congelation of water muſt of courſe facilitate the thawing of ice. The nitrous acid furniſhes us with another ſtriking inſtance to this effect; for no cold can be produced to freeze the water in it, and a red hot ladle cannot thaw ice placed in it, ſo quickly as ice is thawed by nitrous acid."

" At ten o'clock, or in eight hours after the pieces of ice were firſt placed in the Sea and Thames water, the temperature of the Sea water was thirty-nine, that of the Thames water only thirty-eight. At this time, of the ice in Sea water four ounces eight drachms were diſſolved; of the ice in Thames water, four ounces only were diſſolved. The Sea water being at this period warmer than the Thames water, correſponds with the ſmall portion of ice remaining in it, compared with that remaining in the freſh water. The temperature of the room in the place where the tumblers ſtood, being, by reaſon of the fire kept conſtantly in it, forty-four, or forty-five, for the laſt ſix hours."

" In twelve hours, or at two o'clock in the morning, the temperature of the room near the veſſels of water, being nearly

nearly the ſame as formerly deſcribed; thet emperature of the Sea water was forty; the temperature of the freſh water was thirty-nine. Four ounces fifteen drachms of the ice in ſalt water, were diſſolved, only one drachm remaining; four ounces ten drachms of the ice in freſh water were diſſolved, only ſix drachms remaining."

" At the end of the thirteenth hour after the immerſion of the maſſes of ice in the freſh and in the ſalt water; that is, at three in the morning, the temperature of the room was forty-five, near the place where the tumblers ſtood. The temperature of the open air was thirty-one. The ice in the Sea water was melted. The quantity of ice remaining in the freſh water was one drachm, which in fifteen minutes more was entirely melted."

" At this period, when the ice in the freſh water was melted; that is, a quarter of an hour paſt three, the mercury ſtood at forty in the freſh water; in the ſalt water it ſtood at forty-one. In a quarter of an hour after this, the mercury ſtood at forty-two in the ſalt water, and at forty-one in the freſh water. In a quarter of an hour more, the temperature remained unaltered in the ſalt and freſh water, although the temperature of the air between, and near the veſſels was forty-five, and the veſſel on the right was placed on the left, and replaced ſeveral times. And both veſſels were at all times equidiſtant from the wainſcot, which was perfectly cloſe, as were the boards of the floor alſo."

" In a quarter of an hour more the temperature of the air near, and between the tumblers, remained forty-five: the

tempera-

temperature of the freſh water was ſcarcely forty-two: the temperature of the ſalt water was forty-two and a half."

" In a quarter of an hour more the temperature of the air between the tumblers being forty-four and a half, the temperature of the ſalt water was forty-three; the temperature of the freſh water was ſomewhat more than forty-two. It was now paſt four o'clock in the morning on Monday the 22d of January. I went to bed, leaving the tumblers in the poſition deſcribed."

" It was obſerved, during the foregoing and other experiments, and it is viſible from the experiments related, that fire in diffuſing itſelf from warm bodies to contiguous cold bodies, proceeds ſlowly; that cold bodies do not acquire the temperature of the warmer medium in which they are immerſed, ſo ſoon as is commonly imagined; but on the contrary, require a conſiderable time for that purpoſe; and this time is directly as the diameter of the cold body."

" It was alſo obſerved and inferred from theſe experiments, that a temperate body, like water, placed in a cold medium, as in air, cooled to thirty or thirty-one of Farenheit, requires many hours before it acquires the temperature of the ſurrounding medium, and before a congelation commences; and that the time neceſſary for the commencement of the congelation is directly as the maſs and ſhorteſt diameter of the water, and the progreſs of the congelation is univerſally as the depth of the water."

" It may be alſo obſerved, that of a given maſs of water, as much was frozen in five hours, in a temperature of twelve degrees below the freezing point, as was frozen in one hour

hour in a temperature fifty degrees below the freezing point. And that long duration of the temperature between twenty and thirty-two, is towards the congelation of water, equivalent to intenſity of cold, (ſuch as is marked O. and below O. in Farenheit) but of ſhort duration."

" It may be likewiſe obſerved, that water in thick jars covered was not frozen, when water in open veſſels was frozen; and that water included in maſſive veſſels of wood, or ſurrounded by any matter, except water, to ſome thickneſs, preſerved its temperature, and reſiſted congelation, longer than the like quantity of water expoſed to the cold air; and that water in thick veſſels was not frozen ſo ſoon as a like quantity of water in thin veſſels of like matter, figure, and capacity; and it may be thence inferred, that fire doth not ſo quickly pervade thick bodies, as it does thin bodies; and that fire pervades water more freely than it does any other body, and ſooner diffuſes itſelf from water to air, than it doth diffuſe itſelf from any other body to air."

" Thence it followed, that in reaſoning on the phenomena of congelation, the maſſes of water, the duration of cold temperature in the atmoſphere, and the maſſes of other matter ſurrounding water, are to be conſidered. Deep rivers, and lakes, do not freeze ſo ſoon as ſhallow rivers and lakes. Large bodies of water are never frozen in any temperature of ſhort duration; but ſhallow waters are often frozen in the ſummer."

" It need not be preſumed, that certain lakes which are never frozen, communicate with ſubterranean fires, or hot mineral ſtreams; or that they are impregnated with matter which impedes

impedes congelation; but rather it is to be preſumed, that as fire ſlowly pervades, enters or quits bodies, the time neceſſary for its diffuſing itſelf from deep lakes to the cold atmoſphere, is greater than ever ſuch temperature of the atmoſphere, continues without intermiſſion below the freezing point."

"By the like reaſoning applied to maſſes of earth, and other matter, which are not ſo quickly pervaded by fire as water is, we can conceive why deep wells, and ſprings at or near their iſſuing from the earth, are never frozen in this climate, even when navigable rivers are ice bound. We alſo underſtand why the main pipes, buried in our ſtreets, retain the water fluid, when the pipes leading from theſe to the houſes, and croſſing the area of each houſe, are choaked with ice; and why hay bands twiſted round theſe ſmall pipes, prevent the freezing, &c. &c."

"On theſe grounds it is preſumed, that no conſiderable congelation ever takes place in the Sea, becauſe this is the greateſt and deepeſt maſs of water we know of; and becauſe it is always in motion, and communicates with the water of temperate climates; becauſe Sea water is not ſo eaſily frozen as freſh water; becauſe the ice found in the Sea is ſolid, and in tranſparency not different from the ice of freſh water; and laſtly, becauſe this floating ice which is met with by navigators, both in high northern and ſouthern latitudes, when melted is palatable to the taſte; whereas the ice formed from Sea water is very ſaline, if it is thawed, without having been freſhened by being placed in pump water."

"It is alſo preſumed, that in the deep Northern Seas, the water near the ſurface will be found warmer than that near

the

the bottom, at the approach of ſummer; and will be found colder near the ſurface than at the bottom, in the firſt month of the cold ſeaſon, for the reaſons already expreſſed. And in like manner, that during the firſt ſix or eight hours of any freezing in England, the water in any deep lake will be found colder near the ſurface, than the water near the bottom; but that the water near the bottom will be found colder than the water near the ſurface, in twenty-four hours after a perfect thaw, provided the air be temperate, or nearly ſo."

IT having been proved from what hath been already urged, as well as by the preceding experiments, that the floating ice which is obſerved both in high ſouthern and northern latitudes, cannot be probably formed from Sea water, it may be thought incumbent upon me to ſhew how ſuch quantities can be ſupplied from ſprings, rain, or frozen ſnow.

The rivers which are always found at certain intervals in any large tract of land, undoubtedly ſupply conſiderable part of ſuch ice; but there are not wanting other ſources from which theſe floating maſſes may be produced.

The larger and higher ice iſlands, I conceive to be chiefly what are called *Ice-bergs*, undermined by the rills, and melted ſnow, during the ſummer, of which we have an accurate account in the late voyage towards the North Pole (*k*).

Others

(*k*) " Large pieces frequently break off from the Ice-bergs, and fall with " great noiſe into the water: we obſerved one piece which had floated out " into

Others, which happen to have projected over the ſea may have had their foundations ſo ſapped by the waves during

 a ſtorm,

" into the bay, and grounded in twenty-four fathoms; it was fifty feet high " above the ſurface of the water, and of the ſame beautiful colour as the " Ice-berg." p. 70.

I have likewiſe been favoured with the following account of the formation of ice iſlands on the coaſt of Labradore, from Lieutenant John Cartwright, of the Royal Navy, to whom I have not only this obligation. [See the Probability of reaching the North Pole, p. 5.]

DEAR SIR,

Thurſday, Feb. 28, 1776.

In conformity with my promiſe of yeſterday, I now ſend you, as neary as I can recollect, my brother's account (who hath reſided four years on the Labradore coaſt) of the formation of thoſe great maſſes of frozen ſnow, ſeen annually in very great numbers on the northern coaſts of America, and by mariners uſually called *Iſlands of Ice.*

Along the coaſt of Labradore, the ſea, in winter, is frozen to a great diſtance from the land, [how this ice is produced, will appear p. 145.] The north weſt is the prevailing and coldeſt wind. The ſnow, carried by this or any other weſterly wind over the cliffs of the coaſt, falls becalmed upon the ice at the foot of the ſaid cliffs, drifting up to the very tops of them, although many of them are not inferior to that of Dover or thoſe about Lulworth. The current of the ſtrong weſtern winds, having paſſed theſe precipices, takes its courſe downwards into the undiſturbed air below; but it is not until it arrives at ſome diſtance from the land, that it can be felt on the ſurface of the ſea. Having the frozen ſurface of the ſea for a baſe, the precipice for a perpendicular, an hypothenuſe is made by the deſcending direction of the wind. The incloſed triangle, be the cliffs ever ſo high, will be filled with ſnow; becauſe the tops of the adjoining hills being quite naked, are entirely ſwept clear of ſnow by the violence of the ſtorms, and what would otherwiſe have lain there, is carried to the leeward of the hills, and under the ſhelter of the cliffs, where it is depoſited in infinitely

greater

a ſtorm (*l*), as to have loſt their ſupport, whilſt others again may have been reft from the maſs to which they before adhered, by the expanſive power of the froſt (*m*). Great

greater quantities than it would fall without ſuch a cauſe. The hypothenuſe of ſuch triangle is frequently of ſuch a ſlope as that a man may walk up or down without difficulty. By frequent thaws, and the occaſional fall of moiſture interrupting the froſt, during the firſt parts of the winter, the ſnow will, in ſome ſmall degree, diſſolve, by which means it only acquires a greater hardneſs when the froſt returns; and during the courſe of that rigourous ſeaſon it generally becomes a very compact body of ſnow-ice. In the ſpring of the year, the icy baſe gives way, and its burden plunges into the ſea, ſometimes entire, ſometimes in many fragments. As the depth of water in many parts is forty, fifty, one hundred fathoms, and upwards, cloſe to the ſhore, theſe bodies of ice, vaſt as is their bulk, will frequently float without any diminution of their contents, although the very large ones do often take the ground, and ſometimes are not ſufficiently reduced by either the penetration of the ſea and the rain water, or of a whole ſummer's ſun to get at liberty again before another winter.

The above relation which my brother gives from his own Obſervation, in North Latitude, 52 deg. 15 min. accounts very naturally and eaſily for the formation of that ſurprizing number of the vaſt pieces of ice which is annually ſeen on the Labradore coaſt, and conſiderably to the Southward.

JOHN CARTWRIGHT.

(*l*) "The ſea has waſhed underneath the ice cliffs, as high as the Kentiſh "Forelands, and the arches overhanging, ſupport mountains of ſnow, which "have lain ſince the creation." WOOD's *Voyage*, p. 20.

"Cuncta gelu, canaque æternùm grandine tecta,
"Atque ævi gluciem cohibent, riget ardua montis
"Ætherii facies, ſurgentique obvia Phœbo,
"Duratas neſcit flammis mollire pruinas."

SIL. ITALICUS, Lib. III. l. 480.

(*m*) "The rocks along the coaſt burſt with a report equal to that of artil-"lery, and the ſplinters are thrown to an amazing diſtance." Mr. WALE *in Philoſophical Tranſactions*, Vol. LX. p. 125.

Great part of the field, or lower ice, I take to be formed by the ſnow falling on the ſands left bare for ſix hours, (from half ebb to half flood) which immediately diſſolves upon touching the ſand, and before the tide returns, becomes ſolid ice; part of theſe pieces are by the wind, or tide, again returned to the ſame ſands, where they again meet with another ſtore of ice, formed during another ſix hours, which, in the courſe of a winter, muſt, by packing, accumulate to immenſe maſſes. That this is not mere conjecture, but the fact, I appeal to Capt. JAMES's account of what he himſelf was witneſs of whilſt he wintered at Charlton Iſland, in Hudſon's Bay.

Now if we examine a globe, we ſhall find, that from north latitude ſixty to ſeventy degrees, more than half its circumference is land, which is open to a Northern Sea, from which large tract of coaſt much greater quantities of floating ice may be derived, than have ever been met with by navigators, without being obliged to ſuppoſe that any part of it is formed from Sea water.

But it may be ſaid, that our late enterprizing navigators to the ſouthward, have alſo met with as great a quantity of ice in the oppoſite hemiſphere, without ſcarcely diſcovering any land.

To this I anſwer, that their circumnavigation was, at a medium, about fifty-five degrees ſouth latitude, though they made puſhes greatly to the ſouthward in three points, and in one of theſe to ſeventy-one degrees ten minutes. In the other inſtances as far as 67 deg. and 67 deg. 30 min. at leaſt, as I have been informed.

There

There is conſequently a very large ſpace in which there may be many a frozen region, which they have not had any opportunity of diſcovering. If, for example, a navigator from the ſouthern, was ſent upon diſcoveries to the northern hemiſphere; and Europe, as well as Aſia and North America having been ſunk by earthquakes, was to report that he had circumnavigated at fifty-five degrees north latitude, at a medium; made puſhes even to ſeventy-one degrees in different directions, without ſeeing any continent, and that therefore there was no land to the north of fifty-five degrees, his countrymen would be much deceived by ſuch report; becauſe Denmark, Norway, Sweden, Muſcovy, Tartarian Aſia, and part of North America continued in their preſent ſituation.

Beſides, however, the ice which may come from *Tierra del Fuego*, Captain Cook hath diſcovered two frozen iſlands between Cape Horne, and that of Good Hope, which were covered with ice and ſnow *(n)*. The firſt of theſe ſituated in fifty-four degrees, is called, *Georgia Auſtralis*, and the ſecond in fifty-nine degrees, *Thule Auſtralis*, which appeared ſo large, to ſome eyes, at leaſt, that it was conceived to be part of a continent.

It is believed alſo that no ſhip hath been beyond forty-eight degrees to the ſouthward of New Zealand, and from the coldneſs of the moſt ſouthern of theſe large iſlands, I cannot but ſuſpect that there is a conſiderable tract of land between it and the Pole. Having

(*n*) Hence, whatever land is diſcovered to the ſouth of this latitude, muſt produce ice. There is alſo a large tract of land named in ſome maps, the *Gulph of St. Sebaſtian*, which is not far diſtant from *Georgia Auſtralis*, and which poſſibly may have eſcaped Captain Cook.

Having thus endeavoured to account how all the floating ice which is met with may be ſuppoſed to be formed from freſh water, I cannot but riſk another conjecture that the time of the year at which attempts are commonly made to penetrate both to high northern and ſouthern latitudes, (though favourable in many other circumſtances) *(o)* is probably the ſeaſon when it is moſt probable the greateſt quantity of floating ice will be ſeen.

This ſeems to follow as a neceſſary conſequence from the puſh being never made before Midſummer, and often a month later, which is preciſely the time when the ice begins to break up in the freſh water rivers, &c.

I have accordingly minuted down from ſeveral voyages into high northern latitudes, the day on which navigators firſt mention ſeeing the floating ice.

The reſult of which is as follows:

Sir MARTIN FROBISHER on the 23d of June. *Hackluyt*, Vol. II. p. 77.

DAVIS in his firſt voyage, July 19th.——In his third, July 2d. *Ibid.* p. 99.

PET and JACKMAN on the 13th of July. *Ibid.* p. 447.

BURROW, on the 21ſt of July. *Ibid.* p. 277.

Governor ELLIS, July 5th. *Voyage to diſcover the North Weſt Paſſage*, p. 127.

" The ſhores of Hudſon's Bay have many inlets or friths, " which are full of ice and ſnow, and frozen to the ground.

" Theſe

(o) Viz. The nights being ſhorter, and the rigging not being ſo ſubject to be frozen.

" Theſe are broke looſe, and launched into the ſea by land " floods, during the months of June, July, and Auguſt." *Ibid.*

" The firſt floating ice which is obſerved on the coaſt of " Labradore is a joyful preſage to the inhabitants of the ap- " proach of ſummer." *Lieutenant* CURTIS, in *Philoſophical Tranſactions.*

" The ice begins to break up the 18th of June." *Daniſh Account of Groenland.*——*Voyages au Nord*, Vol. I. p. 167.

" The lakes of Lapland continue frozen on June the 24th." *Linſchoten*'s *Voyage*, *ibid.* Vol. IV.

" On the 5th of July, the Sea on two ſides is obſerved to be covered with ice." *Ibid.* p. 187.

WOOD ſees the firſt ice in north latitude ſeventy-five degrees fifty-nine minutes on June 22d.

On the 17th of Auguſt vaſt pieces of floating ice. *Ibid.*

" In the month of Auguſt the French obſerve, on the La- " bradore coaſt, mountains of ice as high as the ſhips." " *Boyle's Works*, Vol. II. p. 303.

" On June 16th, a river in Hudſon's Bay breaks up." Mr. WALES, in *Philoſophical Tranſactions*, Vol. LX. p. 126.

" The mouth of the Lena is not open till the middle of Au- " guſt." *Obſervations géographiques, par Mr.* ENGEL. *p.* 229.

With regard to the ice which may be obſerved in ſouthern latitudes, I ſhall only take notice that Sir FRANCIS DRAKE, FEUILLEE, and CLIPPERTON paſſed Cape Horn, or the Straits of Magellan, during the month of December, with-

out

out mentioning ice (*p*), from which it ſhould ſeem that it breaks up chiefly during the months of January, February, and March, anſwering to our July, Auguſt, and September (*q*).

Three Dutch ſhips which ſailed on diſcoveries, with Commodore Roggewein, in 1721, met with much ice to the ſouth of Cape Horn in the middle of January. The Author of the Narrative afterwards makes this obſervation: "Theſe mountains of ice, which are ſeen in the latitude "of Cape Horn, prove that there is land towards the "ſouthern pole, it being certain that this ice cannot be "formed in the ocean, though the cold is ſo ſevere (*r*)."

But it may, perhaps, be ſaid, that the ice which breaks up in June, July, and Auguſt, or during the correſpondent months in the oppoſite hemiſphere, may remain floating for years without being much diſſolved.

To this I will not take upon myſelf to ſay that ſome ſuch iſlands when very large, may not continue more than a year, but I ſhould conceive this not to be very common. Storms and other accidents muſt probably break them into ſmall maſſes which

(*p*) See CALLANDER's Voyages under theſe three articles.

(*q*) It may poſſibly break up in ſome years earlier, perhaps in December; but ſome time muſt be allowed for its floating to the north, as far as the latitude of *Tierra del Fuego*. From the inſtances cited, it appears that the earlieſt floating ice which is ſeen in the northern hemiſphere is not obſerved ſooner than the 16th of June, whilſt in much the greater part mention is not made of it till July.

(*r*) Hiſtoire de l'Expedition de trois Vaiſſeaux, &c. *Hague*, 1739, p. 81.

which will quickly be thawed; not only becauſe it appears, that ice diſſolves ſooner in Sea water, from Dr. HIGGINS's experiments; but that able Geographer and promoter of diſcoveries, Mr. Bailiff ENGEL, obſerves, that if a piece of ice is faſtened by a cord and let down into the ſea, it is preſently melted *(s)*.

Mr. WALES alſo informs us that he conceives moſt of theſe iſlands of ice are ſoon waſted, in the following words: " The " truth is, their motion and diſſolution are apparently ſo very " quick, that I am of opinion it muſt be a pretty large iſland " which is not diſſolved in one ſummer *(t)*."

How ſoon likewiſe does the ice diſappear, which is diſcharged from our own rivers into the ſea, after our moſt intenſe froſts?

I have omitted ſtating the degree of cold at which the Sea water I expoſed to the air begun to be frozen, and cannot now recover the memorandum which I made at the time. I am pretty confident, however, that the mercury had ſunk only to twenty-ſeven.

But though congelation thus took place at five degrees below the freezing point, it is proper that I ſhould ſtate ſome other circumſtances attending the experiment.

The Sea water which I uſed came from the north Foreland, which is at the mouth of the Thames, and conſequently not being the ſame with that of the ocean, was more eaſily frozen.

Beſides

(*s*) See *Obſervations Geographiques*, p. 224.

(*t*) Philoſophical Tranſactions, Vol. LX. p. 112.

Beſides this, the quantity was ſo ſmall as not to cover a china baſon deeper than an inch, both which particulars contribute greatly to the more ſpeedy formation of ice: it need ſcarcely be mentioned alſo, that the liquid to be frozen was in a quieſcent ſtate.

How much a conſiderable degree of motion impedes congelation may be inferred from what may be obſerved in every river; for as high as the tide has any force, I doubt much whether any ice is ſcarcely ever formed in the fair open channel, during our moſt intenſe froſts. I attended to the Thames, in this reſpect, during the late ſeverity of the weather, and it ſeemed to me that all the ice floated down from the upper parts of the river; but packing afterwards between the lighters, occaſioned the formation of very large maſſes.

I have little doubt from theſe circumſtances, that the open ſea, if to be frozen at all, muſt require a much more intenſe cold than twenty-ſeven; but allowing any greater degree of cold in the higher latitudes, it ſeems deducible from the experiments of Dr. HIGGINS, that Sea water cannot be frozen into a ſolid ſtate, if compared with that of ice formed from the water of rivers; nor will ſuch ice when melted become palatable, unleſs it hath been previouſly waſhed in freſh water.

Hence it ſeems to be almoſt demonſtration that the floating ice met with by navigators being both ſolid, and ſweet to the taſte after diſſolution, cannot be produced from the water of the ocean.

I will venture alſo to inſiſt, that if ſuch ice was actually frozen from the ocean, it muſt very quickly be melted, becauſe

cauſe as it muſt conſiſt of detached laminæ intercepting the brine, the ſea would ſoon inſinuate itſelf between the interſtices, ſo as to cauſe its diſſolution. If any ice, therefore, ſhould be formed in thoſe parts of bays which are land-locked, have little or no tide, and receive conſiderable quantities of freſh water, when ſuch ice is wafted fairly out to ſea, I ſhould conceive that it muſt diſappear in a very ſhort time.

DAINES BARRINGTON.

POST-

POSTSCRIPT.

I TAKE this opportunity of laying before the Public the following letter from Captain MARSHALL, maſter of a Greenland ſhip, to Lieutenant HEATH, of the 41ſt Regiment, who formerly made a voyage or two to Spitzbergen.

SIR,

IN compliance with your requeſt of Wedneſday laſt, I acquaint you, that ſix years ago I was as high as eighty-two degrees, thirty minutes, north latitude, by obſervation, which is the higheſt I have ever been in; at that time I was mate of the Royal Exchange Greenlandman, of Newcaſtle. I do not know of any one who has been in a higher degree; but it has been reported at Newcaſtle (with what truth I cannot ſay) that Captain Greenſhaw, of London, had told his friends, that he had been as high north as eighty-four degrees.

The Dutch, I have been informed, have penetrated to eighty-three degrees, thirty minutes; but I have it only by hear-ſay.

In reſpect to your ſecond query, I remember, that about five years ſince, when I was maſter of the above-mentioned ſhip, I was in eighty-one degrees, north latitude, by obſervation, when there was a clear ſea to the northward, as far

as the eye could reach from the maſt-head; and I could not help obſerving to my people, that if it had happened that we were then upon diſcovery, we might have had a fine run to the north, as the wind blew freſh at South. The like clear ſea I have obſerved ſeveral times during the time I have been in the Greenland ſervice, which is now about twenty-one years. I have no doubt but that a navigator might penetrate into a higher latitude than I have been in, provided he was well acquainted with the currents, and the ice, for much depends thereon; and took the advantage of a favourable ſeaſon. I have remarked, that when the froſt has been ſevere in England, and to the ſouthward, there has been a great deal leſs ice to the northward, the enſuing ſummer than uſual; and the weather has been remarkably fine in Greenland. I have, for this reaſon, great expectations that the approaching ſeaſon will produce a ſucceſsful fiſhery, and that it will alſo afford an opportunity for a trial to reach the pole *(t)*,

But the greateſt difficulty attending a navigator in very high latitudes is how to get back again, for ſhould he be beſet there in the ice, his ſituation would be very dangerous; for he might be detained a long time, if not for

(*t*) I am ſorry to have been informed, ſince the Bill for promoting diſcoveries paſſed, that the attempts to penetrate to the northward will not be ſo frequent as I had flattered myſelf; becauſe moſt of the Greenland veſſels being inſured, if any accident ſhould happen to a ſhip which is not proſecuting the whale fiſhery, the owners will not be entitled to recover.

D. B.

for the whole winter. I ſpeak this from experience, for I was once beſet for three months, and was given up for loſt, and with difficulty got out.

Any further information in reſpect to the land, the currents, ice, or other particulars, you may wiſh to have, I ſhall very readily communicate it, and am,

S I R,

No. 5, *Spring-ſtreet*,
Shadwell, *Feb.* 25, 1776.

Your veryhumble Servant,

JAMES MARSHALL.

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