I. *The History of the Great Frost in the last Winter* 1703 *and* $170\frac{8}{9}$. *By the Reverend Mr.* W. Derham, *Rector of* Upminster, *F. R. S.*

THIS Famous Society having done me the Honour to put into my Hands their Papers relating to the late *Great Frost*, and having also my self received divers Relations thereof from my Friends at Home and Abroad, as well as made Observations my self, I shall endeavour to give an Account of Two Things; *The Degree, and Effects of this Remarkable Frost.*

The Degree of the Frost in England.

As to this Matter, I believe this Frost was greater (if not more universal also) than any other within the Memory of Man. The greatest that hath happen'd within our Memory, was the *Long Frost* in 1683; but the late Frost, although of shorter continuance, was more intense than that. Of which I have already given some Account in a former Paper (which I find in the *Transactions*, No. 321.) and must be forced to Recapitulate it here; *viz.* That my Thermometer was much lower on *December* 30. than it had ever been since 1697. when I first began my Thermometrical Observations; That the self-same Thermometer in our Repository in *Gresham*-College was lower than ever it was before: [The Particulars of its greatest Descents are these; *January* 26. 1696. 41 *Gr.* *January* 5. 1683. 40 *Gr.* and *January* 3. $170\frac{8}{9}$. 43 *Gr.*] And lastly, that in another self-same Glass in *London*

London [Mr. *J. Patrick*'s] the Spirits were four or five degrees lower than in 1683.

In *London* the greateſt Contraction of the Spirits was on *January* 3. which was an exceſſive cold Day at *Upminſter* alſo: But the far greateſt Contraction with us was on *December* 30. before. The reaſon of the Difference is, becauſe my Thermometer is always abroad in the open Air, where no Sun-ſhine toucheth; but thoſe two *London-Glaſſes* are within Doors, in Rooms where no Fires are made. And it is eaſie to obſerve, that the Froſt doth not preſently exert its greateſt force within Doors: And when it doth, neither doth it ſo ſoon abate its force within Doors, as without. The reaſon whereof is plain enough, and needs not be mention'd.

Theſe Obſervations of the Intenſeneſs of the Cold with us, I have received Confirmations of from other Places in the Southern Parts of our Iſland; particularly I find them to agree with ſome Obſervations made at *Streatham* in *Surrey* by Mr. *Creſſener*, an Ingenious Member of our Society.

I had like to have forgotten to Note, That the Deſcent of the Spirits in my Thermometer on *December* 30. was within One tenth of an Inch as great as the Deſcent effected at another time (and that in a cold Day too) with Artificial Freezings perform'd both with Snow and Salt, and alſo Snow and Spirits. Both which Mixtures I have ſeveral times made uſe of, and find them nearly of equal Power: If any difference be, I have ſometimes thought the preference due to the Mixture of Spirit of Wine with the Snow. I ſaid alſo the Contraction of the Spirits in a cold Day, becauſe an Artificial Freezing is leſs vigorous in a warm Day than in a cold one. It is well known that we can in Summer freeze with Ice and Salt, and the ſame may be then done with *Sal Armoniack* diſſolv'd in Water; but we cannot produce ſo intenſe a Froſt

then by theſe means, as in Winter, and eſpecially in a very cold Day. But theſe Things by the by.

The Degree of the Froſt in Scotland *and* Ireland.

But notwithſtanding the Froſt was ſo extreamly rigorous in the Southern Parts of our Iſle, yet the Northern felt little thereof; as I have been certified by Perſons that have come from thence, as well as by ſeveral Letters my Friends have received from thence. My Ingenious and Learned Friend Dr. *Sloane* writes to me in general, That he hath received many Informations from thoſe Parts, which do all agree that the Winter was no way extreamly Cold there, but as other Winters. And as to Particulars, the two following Letters from two eminent Perſons in thoſe Parts, to my Ingenious and Learned Friend Dr. *Woodward*, will give an Account. One is from the Right Reverend and very Learn'd Lord Biſhop of *Carliſle*, dated from *Roſe*, *November* 5. 1709. " In *January* laſt " (ſaith he) I had a ſufficient occaſion to take notice of " the Froſt and Colds being more intenſe in the Southern " Parts than here, and the Snow much thicker. I be- " gan my *London*-Journey on the 26th of that Month, " three days before the Thaw, and can aſſure you that " for ſeveral Miles (near the Banks of the River *Eden*, " in both the Counties of *Cumberland* and *Weſtmorland*) " my Horſes hardly ever trod upon Snow. When we " came to *Stanemoor*, on the Confines of *Yorkſhire*, we " found the Ground covered pretty thick, and the deep- " er ſtill the farther we came to the South. None of our " Rivers or Lakes were frozen over; and the extraordi- " nary Flocks of Swans that reſorted hither (nothing of " the like having been ſeen by the eldeſt Man living) was " a ſure Argument that the Temperature of Climates " was ſtrangely inverted. Thus far that Right Reverend Member of this Illuſtrious Society.

The

The other Letter is from *Edenburgh*, *November* 5. 1709. from a very Curious and Ingenious Perſon, Sir *Robert Sibbald*; who ſaith, " I can learn no extraordinary Ef-" fects of the cold Seaſon here. It was a long Winter: " The Cold came early in *October*, and continued till " near *May*. There was much Snow, which lay long " upon our South Hills near this Place. We had not " much Froſt to ſpeak of, and it laſted not long. There " was but little Sport at *Curling* upon the Ice [A Sport in *Scotland*, uſual in hard Froſts, when the Ice can bear a great Company of People.]

And as in *Scotland*, ſo in *Ireland* the Froſt was very favourable: Of which among other things, I have this Account in a Letter from *Dublin*, from Mr. *S. Molyneaux*, a very curious and ingenious Gentleman there; who ſaith, " They had there an harder Winter than uſual, but judg-" eth they ſuffered not ſo much as their Neighbours: " They had two or three pretty hard Froſts, and ſome " Snow, but not of any remarkable continuance, as he re-" members.

The Degree of the Froſt in other Parts of Europe.

Having thus related how the Caſe was near Home, let us next look farther Abroad, and firſt into the more *Southerly Parts of* Europe.

And in the Compariſon I have already given the Society between Dr. *Scheuchzer's* Obſervations at *Zurich* and mine here, I ſaid, That he noted the Cold to have been exceſſive there; but whether more than uſual, he ſaith not. But by a Letter I have lately ſeen from his Brother (of which more by and by) it appears to have been in as great and unuſual Exceſs there, as here it was with us.

In that Paper alſo I have foreſtall'd my ſelf, and ſaid to what Exceſs the Froſt arrived in *Italy*, *viz.* " That " the Cold there was ſo great, that for 20 Years paſt they " had not been ſenſible of greater, and on *Twelfth-Day* " it wanted but half a Degree of the Extremity.

As to the *Northern Parts*, the before commended Dr. *Woodward* tells me, that in a Letter he received from the Learned Mr. *Otho Sperling*, from *Copenhagen* dated *April* 6. 1709. he calleth it *Hyems Atrociſſima*. And I find it noted in the Minutes of the *Royal Society* of *May* 4. 1709. " That Dr. *Judichar* ſaid the Ice was frozen " in the Harbour of *Copenhagen* 27 Inches; and that " *April* 9. *N. S.* People had gone over between *Schone* " and *Denmark* on the Ice. Which Accounts give me a better Opinion of ſome Papers I have by me, which were ſhew'd to the Society, concerning the Froſt at *Copenhagen*, pretended to be taken from the Obſervations of Mr. *Romer*. I ſhould not entertain any the leaſt diſtruſt of the Accuracy either of the Inſtruments, or Obſervations of that Eminent Perſon, were I ſure they were his. But there are ſome Paſſages and Hints in thoſe Papers that leſſened others, as well as my Opinion about them. 'Tis ſaid there, " That ſuch a Froſt hath not " been known in the Memory of Man in theſe Countries, " and that the Froſt on *January* 7. and *February* 23. 170$\frac{8}{9}$. " did very nearly approach the Point of Artificial Freezing.

In the Northern Parts of *Germany* alſo I find they had the ſame fare with their Neighbours of *Denmark*. Of which I have an Ingenious printed Account put into my Hands by the forementiond Dr. *Woodward*. The Title of the Book is, *Conſideratio Phyſico-Mathematica Hyemis proximè Præterlapſæ*, &c. being an Academical Exerciſe performed in the Univerſity of *Hall*, *June* 13. 1709. by *G. Remus* a *Dantzicker*, and Printed at the ſame Place [*Halæ Magdeburgicæ.*] This Diſſertation relating directly

to

to our Subject, and being I ſuppoſe in but few Hands with us, a ſhort Account thereof may not be unacceptable.

The Ingenious Author having complained of the Defects of Meteorology, and Meteorological Inſtruments, and given ſome Directions concerning obſerving the Winds, *&c.* tells us, he had the help of the Obſervations of three Eminent Perſons in his Diſſertation about the Winter, namely, of Dr. *Wolfius*, Mathematical Profeſſor of *Hall*; Dr. *Hamberger*, Mathematical and Natural Philoſophy Profeſſor of the Univerſity of *Jena*; and of the Reverend Mr. *Teuber*, an excellent Mathematician at *Ciza*. The Winter he diſtributes into five Periods. The firſt of which he begins at *October* 19. 1708. at which time he ſaith the cold Weather began with them, the Northerly Winds then blowing, and froſty Weather accompanying it. But with us at *Upminſter*, it began ſomething ſooner: For all the latter end of *September* the Winds were Northerly, and an Hoar-froſt on *Michaelmas*, and the following Days. After which, a great part of *October* to the 23th Day, my Regiſter ſhews the Weather to have been for the moſt part Hoar froſty, or Froſty, very agreeably to Mr. *Remus*'s Obſervations. The end of this firſt Period he placeth on *November* 3. the ſame with our *October* 23. *O. S.* their Stile I perceive by divers Compariſons, and Hints in his Paper, being the New Style.

As to his next Period, which with its Interval takes in *November* and *December*, I find a pretty deal of Agreement between his Obſervations and mine, the Weather often being Warm, or Cold here, as it was there, and the Winds alſo not very different. Only I obſerve the Cold in one Place commonly to precede the other. Alſo the furious Wind, that he ſaith blew the Night before *December* 13. was not perceivable here 'till the ſecond Day after, *viz. December* $\left\{\begin{matrix}14\ N.\ S.\\3\ O.\ S.\end{matrix}\right.$ about Noon: At

which time it had much ſpent it ſelf, and was only a brisk Eaſterly Wind, but no Storm.

The third Period he begins on *January* 5. Of which he ſaith, " Scena ſubitò mutabatur, & cum univerſæ " Europæ admiratione cœpit Periodus, inſolito prorſus " frigore notabilis. The very ſame {*January* 5 / *Decemb.* 25} the Wind and Weather began here to change, as there he ſaith it did, and the Cold alſo to encreaſe. The moſt remarkable Depreſſions of the Spirits he hath put into a Table, which may be ſeen with mine in this following little Table, fitted to our Old Style.

Day of the Month O. S.		*Degree of the Thermometer at* Hall, *at* 10^h *p. m.*	*Degree of the Thermometer at* Upminſter, *at* 9^h *p. m.*
Dec.	27	84 ½	65
	28	84 ½	75
	29	92 ½	58
	30	100	45
	31	Totus in-	52
Jan.	1	tra Sphæ-	63
	2	ram.	54

For the right Underſtanding theſe Obſervations, it is to be obſerved that the Scale of their Thermometer runs downwards from ſome Point above, down towards the Ball. But the Ball, or Bottom of the Stalk, being a certain Place that all Thermometers agree in, and every one is acquainted with, I therefore make the Degrees of the Scale of my Thermometers to begin at the Top of the

the Ball, or (which is all one) at the Bottom of the little Tube, or Stalk; and ſo reckon upwards; every Degree being One Tenth of an *Engliſh* Inch; the *Freezing-Point* in my old Thermometer (here noted) at 82 gr. equal to 8 Inches Two Tenths from the Ball; and the moſt *Intenſe Cold* at 44 gr. But in my later Thermometers (which I now uſe, and are much nicer than my old one) the *Freezing-point* is at 100 gr. ten *Engliſh* Inches from the Ball, and the moſt *Intenſe Froſt* near to, or juſt in the Ball. Which things I thought convenient to note, as being neceſſary for the right underſtanding the little Table above, and alſo any of my Thermometrical Obſervations, that ſhall be mentioned here or elſewhere.

It may from the foregoing Table be perceived, that the Froſt kept a pretty equal Pace in both Places at its beginning. And my Notes give me reaſon to think it did the ſame the greateſt part of its duration: But I cannot be very ſure thereof, my old Thermometer (the only one I then had) happening to be unfortunately broken on *January* 11. For which reaſon I am unable to give ſuch another Thermometrical Table of his next Period as I have done in this.

This third Period he makes to end *January* $\begin{cases} 25 & N.\ S. \\ 14 & O.\ S. \end{cases}$ with a Weſterly Wind, and a Thaw, which held for a few Days. With us the Wind was Southerly at the ſame time, and a Thaw accompanying it for a few Days likewiſe.

The fourth Period he begins *January* $\begin{cases} 31 & N.\ S. \\ 20 & O.\ S. \end{cases}$ In which I obſerve there is a great Agreement between our Obſervations as to the Cold; and thoſe Days on which he noteth the Weſterly Winds to have been ſtrong, it was the ſame here. And ſome Agreement alſo, but leſs, is in the Coaſting and Shifting of the Winds throughout this Period.

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The fifth and laſt Period he placeth between *February* $\left\{\begin{smallmatrix}17\\6\end{smallmatrix}\right.$ and *March* $\left\{\begin{smallmatrix}17 & N.\ S.\\6 & O.\ S.\end{smallmatrix}\right.$ In this, he ſaith, the cold Weather returned, and continued long: And the ſame it did with us. But as to the end of this Period, I find ſome Difference, and ſome Agreement between our Obſervations. The Snow was more with them than us; the Winds changed with us from the Eaſterly Points, to the Weſterly and Southerly, a Day or two ſooner than with them; then agreed with them; and ſoon after veered about to the Eaſterly and Northerly as it did with them. And I obſerve farther alſo, that when the Winds agreed in both Places, my Notes ſhew the Wind to have been of ſome force here.

As to the Warmth of the Weather all this time, I find a pretty deal of Agreement; only as the Wind changed two Days ſooner here, ſo we had the mild Weather, he mentions, two Days ſooner: Then it grew colder here, as he ſaith it did with them. And whereas he noteth *April* $\left\{\begin{smallmatrix}13 & N.\ S.\\2 & O.\ S.\end{smallmatrix}\right.$ to have been the firſt Day on which the Spirits roſe to the Point of Warmth, I found by my Thermometer (then renewed) the Day before to have been as warm as that, as alſo were the following Days; and each of them warmer than had been all the preceding Winter; but yet that we had divers warm Days before that time, particularly *March* 12, 13, 14, 18, 19, 28. *O S.* were warm Days, but the reſt in that Month for the moſt part Cold.

Our curious Author having given this Relation of the State of their Winter, takes occaſion to ſpeak next of the Barometrical Heights there. Of which he hath given us a little Table: Which I ſhall take a more convenient Opportunity of Communicating to this Honourable Society, together with my own and ſome other Obſervations of the ſame Nature, made at the ſame time.

The

The Effects of the Froſt.

Having thus given the Hiſtory of the *Degree* to which the Froſt arrived in ſeveral diſtant Parts of *Europe*, I ſhall next ſhew what unuſual *Effects* this ſo unuſual a Froſt produced; and that on *Fluids*, *Animals*, and *Vegetables*.

The Effects of the Froſt on Fluids.

The Waters we may eaſily imagine were the firſt thing that felt the dire Effects of this Froſt. And theſe were in many Places frozen to an extraordinary depth; although I hardly believe to that depth, as in the Long-Froſt in 1683. Of which Froſt we have a ſufficient inſtance in our River of *Thames*; whoſe Waters were ſo frozen, that above Bridge, 'tis well known, many Booths were erected, Fires made, and Meat dreſs'd; and on *January* 10. 168¾. I my ſelf ſaw a Coach and two Horſes drive over the River into *Southwark*, and back again, a great number of People accompanying it. But this laſt Winter the Caſe was greatly different, according to this Account I received from my Learned and Ingenious Friend Mr. *Lowthorp*; who ſaith, "He ſaw ſeveral People croſs "the *Thames* at ſome diſtance above the Bridge: But "that was only towards Low-water, when the great "Flakes of Ice that came down, ſtopp'd one another "at the Bridge, 'till they made one continued Bed of "Ice from thence almoſt to the *Temple*. But when the "Flood came, the Ice broke, and was all carried with "the Current up the River. I was told the like happened between *Weſtminſter* and *Lambeth*, a little above "*White-hall*.

As for other Waters, they alſo had their ſhare; eſpecially where they lay expoſed to the Northerly and North Eaſterly Winds. Nay, the Sea-waters themſelves eſcaped not, but were covered with Ice in many Places near the Shore, in Harbours, and where they lay calm and ſtill. Of this I have already given a pregnant Inſtance in the Harbour of *Copenhagen*, and the Sea between *Denmark* and *Schonen*. And in a Letter from Dr. *Newton*, Her Majeſty's Illuſtrious and Learned Envoy at *Florence*, he tells me, " The Sea was frozen both on the Coaſt of " *Genoa* and *Legorne*.

As for the Northern Parts of *Germany*, the laſt cited Diſſertation gives this Account of its Effects on Fluids: *Aqua infra ſolitam profunditatem in glaciem abiit, & alii liquores congelati apparuere, qui aliàs extra congelationis periculum mediâ hyeme conſtituuntur. Pertinet huc Fons in quodam Sileſiæ pago, qui cum aliàs æſtate frigidus, hyeme calidus deprehendatur, hac tamen hyeme ſpiſſa ſatis glacie non ſine omnium admiratione obductus fuit. Certè Novellæ publicæ aliquoties Thermas in glaciem converſas nunciarunt: Id quod tamen calidioribus non accidit* . . . . . Halæ *ſtrias fontibus ſalſis adhærentes vidimus, id quod intra ſeculi ambitum non contigiſſe fertur. Per literas me certiorem reddidit* D. Breynius, *in urbe patria Medicus celeberrimus, Soc. Reg. Ang. Soc. &c. ipſum mare, quouſque oculorum acies etiam armata penetrare poterat, adhuc d.* 8. *Aprilis glacie tectum fuiſſe. Cum is Lixivium cineribus clavellatis ad ſaturitatem ferme impræguatum aeri expoſuiſſet, licet nunquam congelare ab hominibus, qui pluribus annis ad tractaverant, aſſereretur, brevi tamen tempore in glaciem converſum eſſe expertus. Addit, amicum quendam ſuum Tartari quoque ſpiritum dephlegmatum congelatum obſervaſſe. Referunt obſervationes* Halenſes *Sputum ex ore vix dimiſſum in glaciem abiens* . . . . . *Fluvii ter in glaciem abiere, etiam illi, quibus ob celeritatem, qua feruntur, frigus aliàs non infeſtum.* Thus far *D. Remus.*

Theſe

Theſe Effects I am apt to think the Waters felt not only in *England*, *Denmark*, *Germany*, *France* and *Italy*; but in all the *Northern World* alſo, excepting *Scotland*, *Ireland*, and probably ſome other Iſlands, or Places near the Sea; although even ſome of theſe appear from the foregoing Account to have been great Sufferers too. This Univerſality of the Froſt, I ſuſpect from the multitudes of divers kinds of Birds (utter Strangers to theſe Parts, and many of them Inhabitants of the Northern colder Countries) which were ſeen and killed in many Parts of *England*. In our *Eſſex-Marſhes*, near us, we had many wild Swans, Brent Geeſe, many of the rarer Gull-kind, and divers other ſorts of Birds, utter Strangers to theſe Parts. And Mr. *Bellers*, an ingenious *Glouceſterſhire* Gentleman, gave Dr. *Woodward* this following Catalogue of Birds killed within four or five Miles of *Coln St. Aldwins*, or *Edwins*, in *Glouceſterſhire*, between the beginning of *November* and the latter end of *March* 1708, which he ſaith are never found there in moderate Winters.

1. *Lanius cinereus major.* The Greater Butcher-Bird, or Mattageſs: Sometimes ſeen in *Derbyſhire*, but common in *Germany*, as Mr. *Willoughby* ſaith.

2. *Fringilla montana.* The Brambling.

3. *Numenius, ſive Arquata.* The Curlew. Theſe Birds, though Strangers to the inland Parts, I have ſeen common enough on the Sea-coaſts of *Eſſex*: And Dr. *Woodward* ſaith he ſaw them ſeveral times this laſt Winter at the *Poulterers* in *London*.

4. *Gallinula Erythropus major.* The Redſhank, or Pool-Snipe

5. *Gallinula Hypoleucos Geſneri.* The Sand-piper.

6. *Schœniclos.* The Stint.

7. *Corvus aquaticus minor, ſive Graculus Palmipes.* The Shag.

8. *Merganſer.* The Gooſander.

9. *Mergus cirratus longiroſter.* The Dun-diver.

10. *Mergus major cirratus.* The Smew, or White Nun.

11. *Colymbus major.* The Greater Loon.

12. *Larus major.* The Greater Gull.

13. *Cygnus ferus.* The Elk, or Hooper, or Wild Swan.

14. *Brenta.* The Brent-Gooſe.

15. *Anas niger Aldrovandi:* Seldom ſeen in *England*, but frequent in *Norway*.

16. *Tadorna.* The Shel-Drake, or Burrough-Duck.

17. *Anas Fuligula prima Geſneri.* The Tufted-Duck.

18. *Anas fera fuſca Geſneri, Penelops Veterum.* The Poker.

19. *Anas Platyrhynchos mas Aldrov.* The Golden-Eye.

20. *Anas Platyrhynchos roſtro nigro & plano.* The Gadwall.

The Effects of the Froſt on Animals.

In the Diſſertation before cited, we are told, how Animals ſuffered both with them, and in other Places; "That the Freſh-water *Fiſh* were every where killed in "their Parts, and that a vaſt Deſtruction befel their "*ſmall Birds.* Both which things he was informed hap-"pened in his own Country alſo at *Dantzick*. Nay "ſome did not, ſaith the Author, ſtick to affirm, that "they ſaw Birds, as they flew along, to drop down out "of the Air, their Strength failing: That the *Luſatia* "*Letters* ſaid many Cows were frozen to Death in their "Stalls. And many Travellers on the Road, he tells us,

"were

" were ſome quite frozen to Death, others loſt their " Hands, Feet, Noſes or Ears; and others fainted, and " were in great Danger of Life or Limb, when brought " too ſoon near the Fire. Of theſe Particulars he gives " divers Inſtances from their News Papers; of two Gen- " tlemen, and a Smith in *England*, and above 60 Men, " and many Cattle near *Paris*; and the like at *Venice*, and " 80 *French* Soldiers near *Namur*, all killed on the Road, " with the Cold. Whether any ſuch Perſons periſhed on our Roads in *England*, I have not heard. But we were told of ſome that did; particularly ſome Poſt-Boys, and if I miſremember not, ſome Drovers alſo. Our Freſh-water Fiſh alſo were many of them deſtroy'd in Ponds that were ſhallow, and eſpecially if long frozen over; ſome for want of Air, where the Ponds were not kept open; and ſome with the cold Air at the Holes in the Ice, where in great numbers they came to get Breath. On the *Italian* Coaſt ſome of our poor " Mariners on board " our Men of War died of the Cold; and ſeveral loſt " Parts of their Fingers and Toes: As the before named Dr. *Newton* writes to me.

But the greateſt Sufferers in the Animal-Kingdom were *Birds* and *Inſects*. *Robin Redbreaſts*, which before the Froſt were numerous, are ſince that very ſcarce about us, only here and there one to be ſeen. Nay notwithſtanding their Recruits in the following Summer, yet even ſtill, in this ſucceeding Winter, their ſcarcity remains. *Larks* alſo, both *Wood* and *Sky-Larks*, which uſed plentifully to entertain us with their pleaſant Melody, became in a manner Rarities in our Country the following Spring and Summer; only one here, and another half a Mile or a Mile off. Neither are they as yet become ſo numerous as heretofore. But whether this was an univerſal Calamity that befel that Family of Small Birds, or whether it only happened to our *Eſſex-Larks*, or whether they were not driven from theſe Parts by the Froſt, I cannot ſay;

becauſe I have been told that in ſome other Counties of *England*, which abound in large common Plough'd-Fields, and where Larks are commonly more numerous than about us, they have had large Flights of Larks this preſent Winter $17\frac{2}{10}$. But I have lately enquired of the *London*-Poulterers; and they tell me, they have Larks from almoſt all Parts of *England*, and have not this following Year received a Quarter, nay, ſcarce a Tenth part of the Larks they uſed to have, by reaſon the Froſt killed them, as the Bird-catchers ſay.

In the *Inſect-Tribe*, I have particularly obſerved the *Pediculus Pulſatorius*, or *Fatidicus*, or *Death Watch*, to be great Sufferers. 'Tis that *Death-watch* I mean, which there is the Hiſtory given of in *Phil. Tranſ.* No. 271 and 291. where I have taken notice of the great Precaution, and Art of that Inſect, to ſecure it ſelf againſt the hard Weather, in dry Places within Doors, under downy, light Duſt, *&c.* Notwithſtanding which, they ſeem to have been great Sufferers by the Froſt. For few of them appeared the following Summer; and in places where they uſed in *July* to be very ſonorous with their Ticking Noiſe, only now and then one was heard; a manifeſt ſign of their being either killed, or rendered leſs fertile and venereous.

The Effects of the Froſt on Vegetables.

But among all the Sufferers by the Froſt, the *Vegetables* were the moſt univerſal; few of the tender Sorts eſcaping, to the great Dammage of the Owners. About us, *Bays*, *Roſemary*, *Cypreſſes*, *Myrtles*, moſt of the *Phillyrea's*, yea, even *Junipers*, among Shrubs; and *Artichokes*, *Colly-Flowers*, and a great many other Olitory Plants ſuffered greatly. In a word, ſo great were the Dammages done among the Gardens, that by Enquiries made on purpoſe among the *London Gardiners*, I have been informed ſome

of

of them have loſt to the Value of 80 *l.* 100 *l.* yea 200 *l.*

But the moſt exact Account I have met with, is from that accurate Botaniſt of the *Oxford* Phyſick-Garden, Mr. *Ja. Bobart*, in a Letter to the ingenious Mr. *J. Thorpe*, F. R. S. in which he takes notice, That the Dammages of this Froſt do not come up to thoſe in 1683; which Froſt being of longer continuance, cleft the *Oaks*, and Bodies of the *Vines*, &c. But in the laſt Froſt there were Intervals of Relaxation, beſides ſeveral conſiderable Snows, which proved a good Guard to many Plants. But the Snow melting, and the Cold withal continuing, proved of evil Conſequence to many Bulbous and Tuberous Roots, and abundance of other Things. "But (he "ſaith) the ſharp, dry, and cutting Winds from the "North, and North-Eaſt, were moſt Deſtructive to ma-"ny of the Ornaments of our Gardens, which before "ſeem'd ſo good Natur'd, as to be almoſt naturaliz'd to "our Clime; as *Cypreſs*, *Bays*, *Roſemary*, *Alaterni*, *Phillyrea*'s, *Arbuti*, *Lauruſtines*, &c. as alſo to moſt of our "Fruteſcent Herbs, ſuch as *Lavenders*, *Abrotonums*, *Rue*, "*Tyme*, and divers others of ſuch Race, eſpecially ſuch "as had their Heads above the kind covering of the Snow. "And not ſuch Exoticks only, but ſome of our own Na-"tives, as is viſible in moſt of our *Furze-fields*, and di-"vers *Hollies*, eſpecially of the finer ſtrip'd Race, have "felt the ſmart of ſuch the Vigour of the Seaſon, by the "loſs of their Leaves, beautiful enough, and ſometimes "their Lives,

"And what (he ſaith) hath been more obſervable this "Year, than in others, is, The Sap of our finer mural "Fruit-Trees, as of *Peaches*, *Nectarines*, *Apricocks*, &c. "was ſo congealed and diſordered, that it proved ſtagna-"ted in the Limbs and Branches, and equal to Chill-"blains in Humane Bodies; which in too many Parts of "the Tree, turned to ſo frequent Mortifications, that it "is very much to be doubted whether ſufficient Vigour

"to

" is ever to be expected from them, to be worth their " ſtanding, notwithſtanding their weak Endeavours of " ſhooting, and recovering of ſuch their Maladies, ſeem- " ing to make work for another Winter to compleat, " what this hath ſo unhappily begun.

" And it is no leſs obſervable than extraordinary, That " the very Buds in theſe finer Trees, as well Leaf-Buds, " as Bloſſom-Buds (which are but the Ovaries of the " ſucceeding Fruits) were quite killed, and dry'd into a " farinaceous Matter, by the too great Sharpneſs of the " Cold, before they grew out, though Life remained in " the Branch.

" The *Plumbs*, being more hardy, produced their " Bloſſoms well enough; but through the chilling Wets, " before mentioned, which happened too plentiful about " that time, and the great Defect of nutritive Warmth, " they grew weak; with their little Stalks, or Pedicles " languiſhing, and turning Yellow, generally dropt off, " and came to nothing.

" It might (he ſaith) reaſonably have been ſuppoſed, " that ſuch conjoyn'd Cold, with repeated Wets, ſhould " have deſtroy'd the injurious *Inſects*, which uſually in- " feſt the firſt Product; but even in this Year, they have " proved vivid, in too great plenty among the *Apples* " and *Pears* (eſpecially the former) whoſe Bloſſoms, as " well as Leaves, have been too copious pabulum for " theſe voracious *Erucas*, whoſe Eggs lay dormant all the " Winter, ſo dry in their Bags, that there were ſo ma- " ny eſcaped from being frozen, that in many Places they " proved enough to deſtroy the whole Verdure.

" *Fig-Trees* (he tells us) whoſe ſofter Texture was " more eaſily penetrated, have ſuffered much, moſt of " them being cut down, to begin the World again.

" Many *Exotick Greens*, and rare Plants coming from " *Africa* and other warm Regions, have mightily ſuffered,

" eſpe-

" eſpecially in ſuch Stoves and Conſervatories as were too " parſimoniouſly defended by Fire.

What he obſerveth concerning the Deſtruction of *Wheat*, was I believe a general Calamity, as alſo the Particulars he takes notice of much the ſame in other Places too, *viz.* " Where the Land was poor, and coldly expo- " ſed, there the *Wheat* was killed; that many Lands of " Wheat eſcaped tollerably well on the warm ſide, when " the other ſide was quite killed with the Extremity of " Cold.

By the *warm and cold Sides*, I ſuppoſe our ingenious Obſerver meaneth the ſunny and ſhady Sides. But with us the Wheat ſuffered rather more on the Southern, ſunny Side, than the Northern; I ſuppoſe by reaſon the Ground was ſomewhat opened by the Sunſhine, and the covering of Snow melted, and way thereby made to the Severity of the Nocturnal Froſt. Upon which account I have heard it ſaid by ſome skilful Obſervers, *That Vegetables ſuffered more the laſt Winter from the Sun than the Froſt.*

In *Eſſex* alſo, about us, I obſerved many ſmall Fields of three or four Acres of Wheat, to eſcape pretty well, where fenced with thick high Hedges againſt the cold Winds, eſpecially where they were covered long with Snow; at leaſt they came off better than other Parcels of Land expoſed to the Winds, that diſlodg'd the Snow, and aggravated the Cold alſo. So in the Pariſh where I live, the beſt Pieces of Wheat were ſuch, I obſerved, as lay on gentle Deſcents facing the Weſt or S. W. eſpecially when guarded on the Eaſtern, or N. Eaſtern ſide with a Hill, or a Wood; which fenced off the cold piercing Eaſterly and North Eaſterly Winds.

And not only *Shrubs* and *Plants*, but the *larger Trees* have in ſome Places had their ſhare of Suffering too. But it was obſerved by ſome ingenious Perſons at one of the Meetings of our Society, That the Calamities which befell Trees, aroſe not purely from their being frozen,

but

but principally from the Winds ſhaking and rocking them at the ſame time, which rent and parted their Fibres.

Theſe have been ſome of the moſt remarkable Effects of the Froſt on the *Vegetables* of the more *Southerly* Parts of our Iſland, the *Northerly* (as hath been obſerved) eſcaping better; as will appear by another part of the forementioned Letter of Sir *Rob. Sibbald* in theſe Words: "The Corn did not riſe, and ripen ſo ſoon as wont; "but, Bleſſed be God, there hath been a plentiful Har- "veſt, well brought into the Barns and Yards. And "the Price of Victuals (which was high) falls lower "daily. There was no greater number of thoſe who "died, than was uſual during the Winter formerly.

As to other Places, I find the Effects were, in the more Southerly Parts of *Europe*, much the ſame on their Vegetables as in ours. In *Italy* my forementioned Illuſtrious Friend, Dr. *Newton* ſaith, "Almoſt all the *Lemon* "and *Orange-Trees*, with thoſe of the like kind, are de- "ſtroyed in this Country by the Froſt, and a great ma- "ny *Olive-Trees*. The Leaves of the *Bay-Trees* have the "ſame Colour now, as all others have when they are "falling in *October*. Beſides which Calamities upon Vegetables, there are two other Diſaſters he tells me of, owing probably to the Froſt, which I ſhall mention here, for want of a more convenient Place to bring them in. One is a Diſaſter that happen'd at *Florence*, where "on the "ſide of a Hill were formerly many Buildings, which "twice falling down, by the Earth giving way, a Wall "was Erected in the time of this Great Duke's Grandfa- "ther, with an Inſcription on the Wall, which ſeparates "the Ground from the next Street, that for the future "no Perſon ſhould build there. After the Great Froſt, "this Wall hath fallen down too. The Hill is full of "Stones, and they will have it, that as thoſe increaſe, "the Ground is puſhed forward, and thereby thrown

"down

" down. But I am apt to think, the Froſt might have a great Concern herein.

The other Accident befel at *Piſa*, where he ſaith, " That upon the melting of the Snows, and the great " Rains which fell after the Froſt, although the *Arno* did " not ſwell over the Banks at *Piſa*, yet the Water at " ſome diſtance from the River, in a middle Row of " Houſes, betwixt the River and the Great Street on " the North-ſide, with great Violence broke out, and " if it had not been immediately perceived, and the " Breach ſtopp'd by the throwing in of a great quanti- " ty of Bricks and Timber, that part of the Town might " have been in danger of being drowned, where the " *Palace*, and the *Publick-Schools*, or, as they call it, the " *Sapienza* ſtand.

Dr. *Mich. Angelo Tilli*, the Learned Botanick Profeſſor at *Piſa*, hath only told me in a Letter he favoured me with from thence, " That the Froſt hath deſtroyed a " world of Trees both in City and Country about them. But I wiſh he had been as particular in his Account thereof, as our Eminent Botaniſt before mentioned.

In *Switzerland*, among the high *Alpine* Ridges, they felt dire Effects of the Froſt, but yet ſome Places were ſo happy as to eſcape. Of which Dr. *Woodward*, before commended, imparted to me the following Account he received from Mr. *John Scheuchzer*, Brother to our Induſtrious and Ingenious Member, Dr. *John James Scheuchzer* of *Zurich*. His Words are, " Effectus triſtiſſimos, " quos Hyeme præteritâ ſenſêre Arbores noſtræ, etiam " craſſiſſimæ, præſertim *Juglandes*, *Vites*, non prorſus " ſenſêre loca quædam prælatis verſus Septentrionem ju- " gis munita. *Veſenæ* ad Rivarium-Lacum ſalvæ man- " ſêre arbores & Vites, ut Vindemia (apud nos nulla) " ibi ſit copioſa; Juglandes fructibus oneratæ, uti quo- " que arbores reliquæ, ac ſi in diverſo ſuccreviſſent a " vicinis locis Climate. *Galandæ*, montis altiſſimi in con- " finiis *Rhætorum* & *Sarunetum*, radicibus adjacet pagus

" *Vatis.* Hujus incolæ vix unquam mitiorem Hyemem
" habuiſſe teſtantur, dum interim incolæ Pagi proximi
" *Valentiæ*, ſupra Thermas Fabarias ſiti, durante ſummo
" Frigore, aditu mutuo prorſus intercluſo, veriti fuêre,
" ne *Vettienſes* omnes frigore perierunt. E contrá Sylvæ
" Boreæ expoſitæ, & Arboribus etiam vivaciſſimis, Abie-
" tibus, Taxis, Laricibus conſitæ, quaſi aduſtæ rufum in-
" duere colorem, foliiſque nudatæ.

Laſtly, as to the Northerly Parts of *Germany*, the Caſe was there after the manner it was with us; which Mr. *Remus* being very curious and particular in, I ſhall inſert the particular Matters he takes notice of here. " Arbores, ſaith he, et frutices ultra nivis ſuperficiem " prominentes magno numero Frigus deſtruxit. Ceraſus, " Malus, & Prunus riſere Hyemis minas. Multa ramo-" rum ſegmenta menſe adhuc Martio Microſcopio ſuppo-" ſuit D. Præſes [that is Dr. *Wolfius*, the Learned and " Ingenious Author of the *Elem. Aeromet.* Printed at " *Leipſick*] nec quicquam integritati & turgeſcentiæ fibra-" rum deeſſe deprehendit. . . . . Flores copioſi in " Ceraſo, rariores in Malo, &c. . . . . Nuces Amyg-" dalæ, Mali Perſicæ & Mali Armeniacæ nobiliores pa-" riter ac ignobiliores, Roſarum frutices tantum non " omnes interierunt, Pyri plurimum damni perpeſſæ. " Vites ſub terrâ defoſſas & ſatis tectas a frigoris ſævitie " immunes vidimus, at reliquas contra illud non ſuffici-" enter munitas prorſus deſtructas & ipſi conſpeximus, " & Novellæ &c. . . . . Commemoranda vero ſunt " . . . . . quæ D. Præſes annotavit. Cum ſtatim ab æqui-" noctio, nive liquefactâ, & glacie reſoluta, aditus in " Hortos pateret, Cortex, Lignum, & Medulla in iis " arboribus, quibus Frigus infeſtum fuerat, e. g. in Pyro " & Malo Armeniacâ, nigricabant. Unde multi : . . . . " extirpabant. Cum ſegmenta ramorum, qui præteritâ " æſtate adoleverant, miſcroſcopiis ſubjicerentur, fibril-

" læ

" læ hinc inde diſruptæ, non ſecus ac in ligno putrido,
" conſpiciebantur: In reliquâ autem ramorum parte
" nulla iſtiuſmodi diſruptio notari poterat, ſuccus unice
" deſiderabatur & viriditas. Enimvero cum circa medi-
" um Aprilis arbores calore Solis foverentur, in Malis Ar-
" meniacis ex ligno ſeniore paſſim novæ Gemmæ erum-
" pebant, in quibuſdam etiam ex juniore ibi proveniebant, ubi flores progerminare debuerant; in nonnullis nullus ſurculus protruſus. Pyri Gemmæ omnes evolutæ, & Flores prodiere; conſueto tamen vigore plerumque deſtituti, atque hinc nulla Fructuum rudimenta relinquentes. Tunc temporis viriditatem plenariam conſequebatur Cortex, nigrior ex centro Medullæ verſus peripheriam migrabat, Ligni ſubſtantia candorem recuperabat. Fibrillæ novi anni adhuc nigricabant, per Microſcopium tamen conſpectæ non minùs ac fibrillæ eædem in Ceraſo & Malo, quas frigus intactas reliquerat, ſucco turgeſcere videbantur. Equidem medulla ſub Gemmis inſolitâ nigredine paſſim tingebatur; radicula tamen Gemmæ in ſurculum protruſæ admodum turgida & virens oculo armato ſiſtebatur..... Notabile vero, quod, quemadmodum Frigus Pruno, ita etiam gemmis Malorum Armeniacarum intra corticem ſurculorum Pruni immiſſis pepercerit, in proceras frondes nunc excreſcentibus juxta arbores ſui generis, quibus ne unicam Gemmam intactam reliquerat Frigus.

Having diſpatched the two things propoſed, the *Degree* and *Effects* of the Froſt, I intended here to have put an end to my Hiſtory: But upon a review of the forementioned Diſſertation, I cannot eaſily forbear ſaying ſomething to

The Cauſes of the Great Froſt.

Theſe are to me, I confeſs, ſo very much hidden, that upon that Account I intended wholly to have paſſed over

this Matter; but the laſt commended Author having ingeniouſly enquired thereinto, I ſhall as briefly as may be ſhew his Opinion. The Fountain of Heat enjoy'd by the Earth, being the Sun, and that Heat being not always the ſame, he enquireth into the reaſon why it is not ſo. The Variation of the mutual Diſtance between the Earth and Sun at the Apogee and Perigee; the mutation of the Earth's place in reſpect of the Heavens, or its being juſtled at a greater diſtance from the Sun, and the Obſtruction of the Solar Rays by the Spots on the Sun, he (after ingenious Enquiries and Calculations) rejects. And as to the true Cauſes, having aſſigned good Philoſophical Reaſons for the Perpendicular warming more than the Oblique Rays, for the Wind cooling the Air, and the North and Eaſt more than other Winds, *&c.* he then enumerates his Cauſes in theſe Words: *Ex hactenus dictis appareret, quænam ad Frigus hybernum producendum concurrere poſſint. Nimirum ex parte Solis requiritur ingens a vertice diſtantia, & exigua ſupra Horizonte mora: Ex parte Telluris vero, Atmoſphæra exhalationibus plena, & nubibus gravida; Ventique Orientales & Septentrionales, præſertim impetuoſi requiruntur. Omnium autem maximè neceſſarium, ut actiones Solis & diu, & tum imprimis impediantur, quando cauſæ Frigoris concurrunt.*

Having thus aſſigned his Cauſes, he then applies them to his five Periods, and the more remarkable Accidents that happened in them.

But after all, notwithſtanding I like, for the moſt part, his Cauſes, as being thoſe which are the common and ordinary ones, yet there are ſome other more hidden extraordinary Cauſes, that he hath not reached. For we have all his Cauſes very commonly concurring in other Winters, without the ſame Effects as in the laſt. Yea this preſent, next ſucceeding Winter $17\frac{99}{100}$, we have had (beſides what is common to all Winters, the Obliquity

quity of the Sun's Rays, &c. we have had I ſay) the Winds as much Northerly and Eaſterly, and as ſtrong; and as much dark Weather; and all concurring too together, as happen'd during the Great Froſt: And yet no more than ordinary ſevere Weather.

But as to miſty, cloudy, dark Weather, which our ingenious Author reckons among his principal Cauſes, I am ſo far from thinking it a Cauſe, that I rather take it to be the reaſon we have not more frequent ſevere Froſts, at leaſt in our Iſland-places, ſurrounded by the warm Vapours of the Sea. Clouds and Vapours do indeed intercept, and keep off the Sun-beams; and probably imbibe and retain a great deal of Warmth themſelves; nay perhaps they may (as he ſaith) reflect back ſome of the Sun-Rays: But we conſtantly in Winter find, that the fewer the Exhalations are, and the clearer the Air, and after the Warmth of the Sun by Day, the ſharper the Froſt is at Night.

But now, after that I have denied the ſufficiency of the ordinary Cauſes, it may be expected I ſhould ſubjoyn others. But as I have declared my Ignorance of them, little can be expected. Only thus much ſeems to me reaſonable: That the great Mint of Meteors being the Superior Regions of the Air, and the Source of Exhalations being the Terraqueous-Globe, in thoſe two Places we are to ſeek for the farther, and more grand Cauſes of the late Froſt. And in the fourteen and more Years Obſervations I have made of the Weather, &c. I have found a great deal to be attributed to the Increaſes and Decreaſes of the Cold of the Upper Regions, as alſo to the inner Diſpoſitions of our Globe, at leaſt to the greater or leſs Plenty of Vapours and Exhalations. But not as yet having Obſervations enough to clear and demonſtrate my Hypotheſis, I muſt beg leave to defer what I might have ſaid (and may perhaps at ſome other time do,

do, if God ſpare Life) which may give ſome Light to our preſent Phœnomenon.

Thus having given as full, but withal as brief, a Relation, as well I could, of the Great-Froſt in our *European* Parts, I ſhould have been glad to have done the ſame for the *Aſiatick* and *American* Parts of the World. But not having any Accounts thereof, and (living in a ſomewhat obſcure Part of the Country) not having opportunity to make Enquiry of Travellers, I muſt be forced to omit this material Part of the Hiſtory. But if I ſhould be ſo happy as to get any good Accounts thereof, this Honourable Society may expect a Supplement hereunto.
