XXII. *The Proceſs of making Ice in the* Eaſt Indies. *By Sir* Robert Barker, *F. R. S. in a Letter to Dr.* Brockleſby.

TO DR. RICHARD BROCKLESBY, F. R. S.

SIR,

Spring-Gardens, March 2, 1775.

Redde, Mar. 9, 1775.

THE proceſs of making ice in the Eaſt Indies having become a ſubject of ſpeculation, I beg permiſſion to preſent you with the method by which it was performed at Allahabad, Mootegil, and Calcutta, in the Eaſt Indies, lying between $25\frac{1}{2}$ and $23\frac{1}{2}$ degrees of North latitude. At the latter place I have never heard of any perſons having diſcovered natural ice in the pools or ciſterns, or in any waters collected in the roads; nor has the thermometer been remarked to deſcend to the freezing point; and at the former very few only have diſcovered ice, and that but ſeldom. But in the proceſs of making ice at theſe places it was uſual to collect a quantity every morning, before Sun-riſe (except in ſome particular kinds of weather, which I ſhall ſpecify in the ſequel), for near three months in the year: *viz.* from December till February.

The ice-maker belonging to me at Allahabad (at which place I principally attended to this enquiry) made a ſuf-

a ſufficient quantity in the winter for the ſupply of the table during the ſummer ſeaſon. The methods he purſued were as follows: on a large open plain, three or four excavations were made, each about thirty feet ſquare and two deep; the bottoms of which were ſtrewed about eight inches or a foot thick with ſugar-cane, or the ſtems of the large Indian corn dried. Upon this bed were placed in rows, near to each other, a number of ſmall, ſhallow, earthen pans, for containing the water intended to be frozen. Theſe are unglazed, ſcarce a quarter of an inch thick, about an inch and a quarter in depth, and made of an earth ſo porous, that it was viſible, from the exterior part of the pans, the water had penetrated the whole ſubſtance. Towards the duſk of the evening, they were filled with ſoft water, which had been boiled, and then left in the afore-related ſituation. The ice-makers attended the pits uſually before the Sun was above the horizon, and collected in baſkets what was frozen, by pouring the whole contents of the pans into them, and thereby retaining the ice, which was daily conveyed to the grand receptacle or place of preſervation, prepared generally on ſome high dry ſituation, by ſinking a pit of fourteen or fifteen feet deep, lined firſt with ſtraw, and then with a coarſe kind of blanketing, where it is beat down with rammers, till at length its own accumulated cold again freezes and forms one ſolid maſs. The mouth of the pit is well ſecured from the exterior air with ſtraw and blankets, in the manner of the lining, and a thatched roof is thrown over the whole. It is here neceſſary to remark,

remark, that the quantity of ice depends materially on the weather; and conſequently, it has ſometimes happened, that no congelation took place. At others, perhaps, half the quantity will be frozen; and I have often ſeen the whole contents formed into a perfect cake of ice: the lighter the atmoſphere, and the more clear and ſerene the weather, the more favourable for congelation, as a frequent change of winds and clouds are certain preventives. For I have frequently remarked, that after a very ſharp cold night, to the feel of the human body, ſcarce any ice has been formed; when at other times the night has been calm and ſerene, and ſenſibly warmer, the contents of the pans will be frozen through. The ſtrongeſt proof of the influence of the weather appears by the water in one pit being more congealed than the ſame preparation for freezing will be in other ſituations, a mile or more diſtant.

To reaſon phyſically upon this proceſs of making ice, it may be ſaid, that had the thermometer been ſuſpended in the air, free from every other body capable of communicating heat, in ſome parts of the night during the cold months of December, January, and February, the quickſilver might have deſcended to the freezing point, and that water, being artfully placed in a ſimilar ſituation, contained in thin porous pans, and ſupported by a ſubſtance little capable of communicating heat from the earth, might alſo freeze, and continue in a ſtate of congelation till the heat of the morning came on. I ſay this may be poſſible; but at the ſame time I muſt beg leave

to

to obſerve, that, during my reſidence in that quarter of the globe, I never ſaw any natural ice. I cannot declare that the thermometer has not deſcended to the freezing point during the night, becauſe I never made the neceſſary obſervations; but the water in every other ſituation, excepting in the pans, has not appeared to be in a freezing ſtate. The climate may probably contribute in ſome meaſure to facilitate the congelation of water, when placed in a ſituation free from the heat of the earth, ſince thoſe nights in which the greateſt quantity of ice has been produced, were, as I before obſerved, perfectly ſerene, the atmoſphere ſharp and thin, with very little dew after midnight. Many gentlemen, now in England, have made the ſame remarks, in their frequent viſits with me to the ice-pits. The ſpungy nature of the ſugar-canes, or ſtems of the Indian corn, appears well calculated to give a paſſage under the pans to the cold air; which, acting on the exterior parts of the veſſels, may carry off by evaporation a proportion of the heat. The porous ſubſtance of the veſſels ſeems equally well qualified for the admiſſion of the cold air internally; and their ſituation being full a foot beneath the plane of the ground, prevents the ſurface of the water from being ruffled by any ſmall current of air, and thereby preſerves the congealed particles from diſunion. Boiling the water is eſteemed a neceſſary preparative to this method of congelation; but how far this may be conſonant with philoſophical reaſoning, I will not preſume to determine (a).

(a) See Part I. Art. XIII.

From theſe circumſtances it appears, that water, by being placed in a ſituation free from receiving heat from other bodies, and expoſed in large ſurfaces to the air, may be brought to freeze when the temperature of the atmoſphere is ſome degrees above the freezing point on the ſcale of FAHRENHEIT's thermometer; and by being collected and amaſſed into a large body, is thus preſerved, and rendered fit for freezing other fluids, during the ſevere heats of the ſummer ſeaſon. In effecting which there is alſo an eſtabliſhed mode of proceeding; the ſherbets, creams, or whatever other fluids are intended to be frozen, are confined in thin ſilver cups of a conical form, containing about a pint, with their covers well luted on with paſte, and placed in a large veſſel filled with ice, ſaltpetre, and common ſalt, of the two laſt an equal quantity, and a little water to diſſolve the ice and combine the whole. This compoſition preſently freezes the contents of the cups to the ſame conſiſtency of our ice creams, &c. in Europe; but plain water will become ſo hard as to require a mallet and knife to break it. Upon applying the bulb of a thermometer to one of theſe pieces of ice, thus frozen, the quickſilver has been known to ſink two or three degree below the freezing point: ſo that from an atmoſphere apparently not mild enough to produce natural ice, ice ſhall be formed, collected, and a cold accumulated, that ſhall cauſe the quickſilver to fall even below the freezing point. The promiſing advantages of ſuch a diſcovery could alone induce the Aſiatic (whoſe principal ſtudy is the luxuries of life, and this may well be called ſuch, when

when I have often regaled with ices when the thermometer has ſtood at 112°), to make an attempt of profiting by ſo very ſhort a duration of cold during the nights in theſe months, and by a well-timed and critical contrivance of ſecuring this momentary degree of cold, they have procured to themſelves a comfortable refreſhment as a recompence, to alleviate, in ſome degree, the intenſe heats of the ſummer ſeaſon, which, in ſome parts of India, would be ſcarce ſupportable, but by the aſſiſtance of this and many other inventions.

Accompanying I beg leave to offer you ſome obſervations, I made in the year 1767 (b), in the province of Allahabad, on the temperature of the weather, which will ſerve to elucidate the extraordinary and ſudden changes incident to that part of Aſia. Alſo ſome remarks on the weather during my voyage to England, particularly ſpecifying the ſituation we were in when the obſervations were made.

I am, SIR, with regard,

Your moſt obedient humble ſervant,

ROBERT BARKER.

(b) See a general account of theſe obſervations Article XVIII.