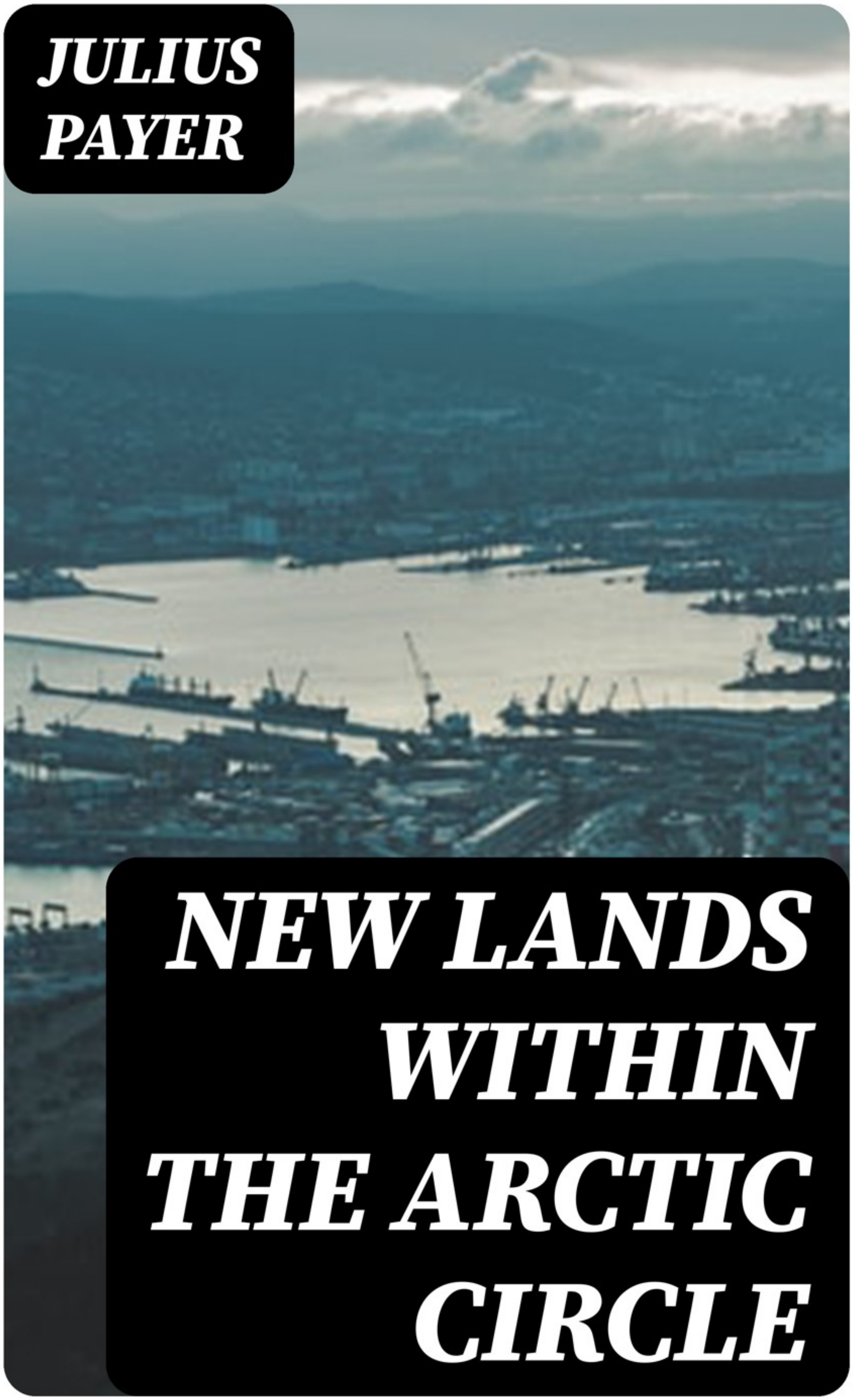
JULIUS PAYER

NEW LANDS WITHIN THE ARCTIC CIRCLE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NEW LANDS WITHIN THE ARCTIC CIRCLE

Julius Payer

New lands within the Arctic circle

Narrative of the discoveries of the Austrian ship "Tegetthoff" in the years 1872-1874

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1. The ice-sheet spread over the Arctic region is the effect and sign of the low temperature which prevails within it. During nine or ten months of the year this congealing force continues to act, and if the frozen mass were not broken up by the effects of sun and wind, of rain, waves, and currents, and by the rents produced in it from the sudden increase of cold, the result would necessarily be an absolutely impenetrable covering of ice. The parts of this enormous envelope of ice sundered by these various causes now become capable of movement, and are widely dispersed in the form of ice-fields and floes.

2. The water-ways which separate these parts are called “leads,” or, when their extent is considerable, “ice-holes.” The meshes of this vast net, which is constantly in motion, open and close under the action of winds and currents in summer; and it is only in its southern parts that the action of waves, rain, and thaw produces any considerable detachments. Towards the end of autumn, the ice, forming anew, consolidates the interior portions, while its outer edge pushes forward, like the end of a glacier, into lower regions, until about the end of February the culminating point of

congelation is attained. Motionless adhesion of the fields, which naturally reach their greatest size in winter, does not, however, exist even then; for during this period they are incessantly exposed to displacement and pressure from the currents of the sea and the air.

3. When the ice is more or less closed, so as to render navigation impossible, it is called “pack-ice,” and “drift-ice” when it appears in detached pieces amid predominating water. Since there are forces operating which promote the loosening process at its outer edge, and its consolidation within, it is self-evident, that the interior portions tend to the character of “pack-ice,” and its outer margin to that of “drift-ice.” This general rule, however, is so modified in many places, by local causes, currents, and winds, that we find not unfrequently at the outer margin of the ice thick barriers of pack-ice, and in the inner ice, ice-holes (polynia[1]) and drift-ice.

4. Ice navigation, during its course of three hundred years, has created a number of terms to designate the external forms of ice, the meaning of which must be clearly defined. Ice formed from salt-water is called “field-ice;” that from the waters of rivers and lakes “sweet-water ice.” The latter is as hard as iron, and so transparent that it is scarcely to be distinguished from water. Icebergs are masses detached from glaciers. The words “patch,” “floe,” “field,” express relative magnitude, descriptive of the smallest ice-table up to the ice-field of many miles in diameter. The term “floe,” however, is generally applied to every kind of field-ice, without reference to its size. The ice which lies along coasts, or which adheres to a group of

islands within a sound, is called “land-ice.” Sledge expeditions depend on its existence and character. Along the coast-edge land-ice is broken by the waves and tide, and the forms of its upheaval and deposition on the shore constitute the so-called “ice-foot.” Broken ice, or “brash,” is an accumulation of the smaller fragments of ice which are found only on the extreme edge of the ice-belt. “Bay-ice” is ice of recent formation, and its vertical depth is inconsiderable.

5. Land-ice is less exposed to powerful disturbances, and its surface, therefore, is comparatively level, and is only here and there traversed by small hillocks called “hummocks” or “torrosy.” These are the results of former pressures, and they are gradually reduced to the common level by evaporation, by thawing, and by the snow drifting over them.

6. But ice-floes exposed to constant motion from winds and currents, and to reciprocal pressure, have a more or less undulating character. On these are found piles of ice heaped one upon another, rising to a height of twenty or even fifty feet, alternating with depressions, which collect the thawed water in clear ice-lakes during the few weeks of summer in which the temperature rises above the freezing point. The specific gravity of this water, where it does not communicate with the sea by cracks, is in all cases the same with the specific gravity of pure sweet water; and as the salt is gradually eliminated from the ice, the water produced is perfectly drinkable. In the East Greenland Sea ice-floes frequently measure more than twelve nautical miles across—these are ice-fields properly so called.[2] In

the Spitzbergen and Novaya Zemlya Seas, they are much smaller, as Parry also found.

7. The thickness which ice acquires in the course of a winter, when its formation is not disturbed, is about eight feet. In the Gulf of Boothia, Sir John Ross found the greatest thickness about the end of May; it was then ten feet on the sea and eleven feet on the lakes. In his winter harbour in Melville Island, Parry met with ice seven or seven-and-a-half feet thick; and Wrangel gives the thickness of a floe on the Siberian coast, which had been formed in the course of a winter, at nine-and-a-half feet. According to the observations of Hayes the ice measured nine feet two inches in thickness in Port Foulke. He estimates it, however, by implication, far higher in Smith's Sound: "I have never seen," he says, "an ice-table formed by direct freezing which exceeded the depth of eighteen feet."

8. The rate at which ice is formed decreases as the thickness of the floe increases, and it ceases to be formed as soon as the floe becomes a non-conductor of the temperature of the air by the increase of its mass, or when the driving of the ice-tables one over the other, or the enormous and constantly accumulating covering of snow, places limits to the penetration of the cold.

9. While therefore the thickness which ice in free formation attains is comparatively small, fields of ice from thirty to forty feet high are met with in the Arctic Seas; but these are the result of the forcing of ice-tables one over the other by pressure, and are designated by the name of "old ice," which differs from young ice by its greater density, and

has a still greater affinity with the ice of the glacier when it exhibits coloured veins.

10. When the cold is excessive a sheet of ice several inches thick is formed on open water in a few hours; this, however, is not pure ice, but contains a considerable amount of sea-salt not yet eliminated; complete elimination of the saline matter takes place only after continuous additions of ice to its under surface. A newly-formed sheet of ice is flexible like leather, and as it becomes harder by the continued cold, its saline contents come to the surface in a white frosty efflorescence.

11. Hayes mentions that he met with fields of ice from twenty to a hundred feet thick in Smith’s Sound. But if it is difficult in many cases to distinguish glacier-ice, when found in small fragments, from detached portions of field-ice, it is often still more difficult to distinguish between old and new ice, and the attempt to do so is merely arbitrary, because their masses depend not on their age alone, but on other processes to which they are exposed. A floe of normal thickness is never more than two or three years old; and if it is to exist and preserve its size for a longer period, it must somewhere attach itself to land-ice, so as to escape destruction from mechanical causes, and dissolution from drifting southwards. Many floes run their course from freezing to melting within a year.

12. The perpetual unrest in the Arctic Sea, which continues undiminished even in the severest winter, and the incessant change in the “leads” and “ice-holes,” are the main causes of the increase of the ice, both in its area and in its vertical depth. Were this constant movement to cease,

the result would be the formation of a sheet of ice of the uniform thickness of about eight feet over the whole Polar region.

13. A layer of snow, which, like the ice itself, is at a minimum in autumn, covers the whole surface of all the ice-fields. This snow, which in winter is sometimes as hard as a rock, sometimes as fine as dust, takes, towards the end of summer, more and more the character of the glacier snow of our lofty Alpine ranges. Its grains, in a humid state, exceed the size of beans, and when in motion they make a rustling noise like sand. This granular snow is the residuum of the incomplete evaporation of what fell in the winter, and of the surface of the ice which has become "rotten" and porous. Its crystals are frequently from a third to a sixth of an inch in length, and firm ice is found even in autumn only at the depth of one or two feet. In the North of Spitzbergen, Parry observed that the surface of the ice was frequently cut up into ice-needles of more than a foot long by the drops of rain, which in summer fall upon it, and in some places he found it overspread with red snow. We ourselves never saw the phenomenon observed by Parry, and the ice-crystals we met with seldom exceeded the length given above.

14. Field-ice is of a delicate azure-blue colour, and of great density, and there is, in these respects, no difference between that of the Arctic and Antarctic regions. Cook, indeed, calls the South Polar ice colourless, though Sir James Clark Ross speaks expressly of the blueness of its ice-masses. Sea-ice surpasses the ice of the Alps both in the beauty of its colour and in its density. The glorious blue of the fissures is due to the incidence of light, the blue rays of

which only are reflected, while the other rays are absorbed. A spectrum observation made in 1869 on a Greenland ice-field gave brownish red, yellow, green and blue. The yellowish spots observed in ice are due to the presence of innumerable microscopic animalculæ.

15. Sea-ice, which, when the cold is intense, is hard and brittle, loses this quality with the increase of temperature till it acquires an incredible toughness, far exceeding that of glaciers; and floes several feet thick bend under mutual pressure before they split. Hence the fruitlessness, especially in summer, of all attempts to loosen the connexion of its parts by blasting with gunpowder.

16. The specific gravity of sea-ice is 0.91, and accordingly about nine parts of a cubical block of ice are under water, while one part only rises above the surface. If, however, the ice of a floe be irregularly formed and full of bubbles, the specific gravity will be correspondingly reduced, and the volume submerged may diminish to two-thirds of the whole mass.

17. The irregularity of the forms of ice is so great, that no deduction can safely be drawn from them; cases may occur where a recently-formed ice-floe, which has been attached to old ice, is forced by its neighbour to sink under the normal level; hence the submergence of floes beneath the level of the sea is often overstated.

18. The temperature of the Arctic Sea at the surface is generally below the freezing point, and then increases slightly with the depth. Sir James Ross observed that the temperature in all oceans does not alter at great depths, and placed this constant temperature at 39° F. In summer

the temperature of the atmosphere rises little above freezing point, and, according to Sir James Ross, it is still less at the South Pole, because he saw no thaw-water streaming down from the icebergs there as he did in the North. It was first observed in Forster's days, that is about a century ago, that the salt was gradually eliminated from frozen sea-water. Of this fact Cook knew nothing; and even Sir James Ross endorses Davis's remark that "the deep sea freezes not." But the fact that ice is formed on the open sea, and far from the vicinity of land, was first asserted by Scoresby, and has been confirmed by all subsequent observers, though it was long disputed.

19. The crackling sound so commonly heard along the outer edge of the ice exposed to the action of the waves, is a consequence of the penetration of its pores by the sea-water, which is then immediately frozen, and disruption follows at once. But disruption on a far grander scale is due to a cause the very opposite of this, the sudden contraction and splitting of the ice, even in the great ice-fields, which is produced usually in winter by the sudden fall of the temperature.

20. When light falls on a field of pack-ice, it is reflected in the stratum of air above it, and this span of light, called the "ice-blink," just above the horizon, warns the navigator of the impossibility of penetrating further. This phenomenon is often observed also over drift-ice, although not so intense nor so yellow in colour as over pack-ice.

21. Water spaces, on the other hand, show their presence by dark spots on the horizon, produced by the formation of clouds from ascending mists. These are the so-

called “water-sky,” and faithfully indicate the “leads” beneath them. Above the larger “ice-holes,” they assume the dark colours of a thunder-sky, though they are never so strongly defined.

22. The annual evaporation from the surface of the ice, which even in winter is never entirely interrupted during the severest frost, and the destruction of ice by the action of rain and waves, are balanced, to speak generally, by its re-formation by frost. The maximum accumulation of ice takes place in spring, its minimum in the beginning of autumn. We observed in the autumn of 1873 not only the evaporation of the snow of the preceding winter, but also a vertical decrease of ice of about four feet. Evaporation is, therefore, the most potent regulator of the balance between waste and growth in the accumulation of ice; and next in importance is the drifting of its masses towards the south through all those openings by which the Polar waters mingle with the waters of lower latitudes.

23. However great the agitation of the sea may be in the open ocean, and though it may dash its waves with wild fury on the edge of the ice, within the icy girdle it is undisturbed, in consequence of the enormous weight of the superincumbent masses. It is only in the large “ice-holes,” and when the winds are very high, that the action of waves is discernible. An isolated accumulation of floes in a circular form, suffices to produce a calm interior sea, and its outer edge only encounters the beat of the ocean.

24. The ceaseless attack to which the ice is exposed on its outer edge is the cause of its excavation and undermining. Hence its centre of gravity is constantly

displaced; and the overturning of its masses and its strange transformations are the consequences of this instability. The smaller the masses of the ice, the more fantastic are the shapes they assume.

25. Change of colour in the sea as we enter the ice-region is frequently, though not invariably, observed. Almost immediately on entering the ice, its normal dull green colour gives place to a deep ultramarine blue, especially in the East Greenland seas, and this colour is maintained under all changes of the weather, and is only modified by local currents. Two hundred and fifty years ago it appeared to Hudson, on the coast of Spitzbergen, that the sea, whenever it was free from ice, was green, and that its being covered with ice and its blueness of colour were intimately connected. Sir James Ross states that in both Polar oceans the colour of the sea changes in the neighbourhood of ice, and that the dull brownish colour sometimes seen near pack-ice in the Antarctic Ocean is owing to an infinite number of animalculæ. The rapid fall of the temperature of the water to the zero point is another indication that ice is near.

26. Of all the ice-formations in the Arctic Seas, icebergs are the most enormous. “It is well known that ice is not by any means so heavy as water, but readily floats upon its surface. Consequently whenever a glacier enters the sea, the dense salt water tends to buoy it up. But the great tenacity of the frozen mass enables it to resist the pressure for a time. By and by, however, as the glacier reaches deeper water, its cohesion is overcome, and large fragments are forced from its terminal front and floated up from the

bed of the sea to sail away as icebergs."[3] This process is sometimes called "the calving" of the glaciers; and the direction of the cleavage is a pre-indication of the forms of the masses when detached. The characteristic features of icebergs are their simple outline, differing widely from the fantastic shapes which the fragments of sea-ice tend to assume; their great height as compared with their breadth—their greenish-blue colour—their distinct stratification—their slight transparency—and the roughly-granulated character of their ice. Icebergs with long, sharp-pointed peaks, like those exhibited in numerous illustrations, have no real existence. It is only fragments of field-ice, raised up by pressure, exposed to the action of waves and the process of evaporation which are transformed into fantastic shapes. Icebergs are generally of a pyramidal or tabular shape, and in time they are usually rounded off into irregular cones. They vary in height from 20 to 300 feet. Sir John Ross (1818) mentions an iceberg of 51 feet; Baffin (1615) of 240 feet; Parry (1819) of 258 feet; Kane (1853) of 300 feet; and Hayes (1861) one 315 feet high, the depth of which below the water-line he estimated at half a mile. On the coast of East Greenland, Scoresby once counted 500 icebergs, some of which reached the height of 200 feet; and during the second German North-Pole expedition, we saw many at the mouth of the Kaiser Franz-Josef fiord which measured 220 feet in height. In Austria Sound, and on the east coast of Kron-Prinz Rudolph's land, their altitude varied from 80 to 200 feet. From the covering of mist which envelops them, icebergs generally appear much higher than they really are, and their depth below the surface is not so considerable as is generally supposed. In an iceberg 200 feet above the water, a total height of 600 to 800 feet may, as a mean, be inferred. It is only glaciers of a very great size which shed icebergs; smaller glaciers, like those of Novaya Zemlya, only strew the sea with a multitude of fragments which resemble broken sea-ice. Hence the appearance of icebergs is connected with the proximity to glacier-covered lands, and with the currents which prevail along their coasts. Baffin's Bay, Smith's Sound, East Greenland, the South-East of Greenland, Austria Sound, are the principal places where they collect together and lie like fleets before the entrances of bays and gulfs. Under-currents of the sea take them not unfrequently in directions contrary to the drift of the field-ice, which depends only on upper-currents; and abnormal winds may sometimes carry them out to seas where they have been seldom or never seen.[4] This appears to be the case even with those met with on the north-west coast of Novaya Zemlya. On the other hand, they have never been seen on the coasts of Siberia, which have no glaciers.

27. The constant displacement of the centre of gravity of an iceberg, resulting from the unsymmetrical decrease of its form, causes its periodical oversetting; and the different temperature of the internal and external ice is the principal cause of its rending asunder with a noise like thunder; a process which occurs generally in the height of summer.

CHAPTER II.
NAVIGATION IN THE FROZEN OCEAN.

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1. Although it be impossible to give any one, who has not with his own eyes seen the Arctic Sea, a perfectly clear conception of its character, the phenomena described in the preceding chapter are sufficient to indicate the difficulties and dangers to which its navigation is necessarily exposed. And to these difficulties and dangers, formidable enough in themselves, are often added the evil influences of preconceived theories and exaggerated expectations, usually followed by bitter disillusions. The calm judgment, which, to all the bold plans of navigation within the Polar basin, opposes distrust in their feasibility, while it points to the hundred expeditions which have at last returned home after penetrating but a little way into the frozen sea, is an attainment of slow growth. Years, too, must be devoted to the theoretical study of the Polar question, to the examination of all that predecessors have experienced and recorded. But this study is very important to Polar navigators; for the discoveries which they too readily regard as exclusively their own prove sometimes to have been made centuries before them.

2. A most essential element of success is the choice of a favourable ice year; and the commander of an expedition must possess sufficient self-control to return, as soon as he becomes convinced of the existence of conditions unfavourable for navigation. It is better to repeat the same attempt on a second or even a third summer, than with conscious impotence to fight against the supremacy of the ice.

3. Polar navigators have learnt in the school of experience to distinguish between navigation in the frozen

seas remote from the land, and navigation in the so called coast-waters. The former is far more dangerous, entirely dependent on accident, exposed to grave catastrophes, and without any definite goal. It affords no certainty of finding a winter harbour for the long period when cold and darkness render navigation impossible. On the other hand, a strip of open water, which retreats before the growth of the land-ice only in winter, forms itself along coasts, and especially under the lee of those exposed to marine currents running parallel to them; and this coast-water does not arise from the thawing of the ice through the greater heat of the land, but from the land being an immovable barrier against wind, and therefore against ice-currents. The inconstancy of the wind, however, may baffle all the calculations of navigation; for coast-water, open as far as the eye can reach, may be filled with ice in a short time by a change of the wind. Land-ice often remains on the coasts even during summer, and in this case there is nothing to be done but to find the open navigable waters between the extreme edge of the fast-ice and the drift-ice. Should the drift become pack-ice, the moment must be awaited when winds setting in from the land carry off the masses of ice blocking the navigation, and open a passage free from ice, or at least only partially covered with drift-ice. It is evident that navigation in coast-waters must be slow and gradual, though it has always been attended with the greatest advantages. Barentz was the first who tested its value; but it was Parry, the most distinguished of all Polar navigators, who discovered its full importance, and from his day it has been accepted as an incontrovertible canon of ice-navigation. On this point he himself says: “Our experience, I think, has clearly shown, that the navigation of the Polar Seas can never be performed with any degree of certainty without a continuity of land. It was only by watching the openings between the ice and the shore that our late progress to the westward was effected; and had the land continued in the desired direction, there can be no question that we should have continued to advance, however slowly, towards the completion of our enterprise.”[5]

4. The successes of the English in the North American Archipelago were the result of this mode of navigation. Its principle is to search for and sail along the network of narrow channels when the main passage is blocked by pack-ice, and to turn to account the narrowest opening between the ice and the land. In the Siberian coast expeditions also this method of constantly following the coast-waters has been successfully observed. Where coast-water does not exist, or only to a limited extent, as on the East Coast of Greenland, this method is of course impracticable. The fate of the second German North Pole expedition is an illustration of this; it was ordered to penetrate in this direction, and its failure was inevitable. On the other hand, all the unsuccessful attempts of expeditions to penetrate northward from Spitzbergen—expeditions whose course and termination resemble each other as one egg resembles another—may be reckoned among those in seas remote from land. To the same category belong the expeditions for the discovery of a north-east passage, and simply because of the great extent of frozen sea between Novaya Zemlya and Cape Tcheljuskin.

5. In the frozen sea remote from the land, from 200 to 300, or at the most 400, nautical miles must, according to all past experience, be regarded as the greatest distance which a vessel is able to compass, under the most favourable conditions, during the few weeks of summer in which navigation is possible. The fact that Sir James Ross at the South Pole, and Norwegian fishermen in the Sea of Kara, accomplished still greater distances, only proves that they were little or not at all impeded by ice. Ross observed that the ice-floes of the Southern Arctic Seas are smaller than those of the Northern: "The cause of this is explained by the circumstance of the ice of the southern regions being so much more exposed to violent agitations of the ocean, whereas the northern sea is one of comparative tranquillity."[6] The rarer occurrence of land at the South Pole permits freer scope to the currents of the sea, diminishes the opportunity for the growth of ice on the coasts, tends to widen the passages in the network of water-ways, and thus facilitates navigation. Even the swell of the sea within the ice is observed in the South Polar Ocean, while it is never seen in the North. Besides the greater hindrances peculiar to the whole North Polar Sea, there is the specially unfavourable circumstance, in the case of the North-East passage, that the shallowness of the Siberian Sea prevents a close navigation of its coasts.

6. The choice of the most appropriate season is another important consideration in ice-navigation; for this period does not fall at the same time in all seas, and the disregard of season was a common cause of the failures of the expeditions of earlier centuries. Since the frozen sea

remains unbroken and almost unaffected by the action of the sun even in June, and at that time extends far to the south, it is evident that all attempts to force a passage in that month are labour thrown away. The ice-barrier retreating northward, or the transformation of pack into drift-ice, leaves free navigable water four or five weeks later. The month of August is the best time for ice-navigation in Baffin’s Bay; the end of July or beginning of August on the East Greenland coasts; the second half of August and the beginning of September in the Spitzbergen waters; and in the region of the Parry Islands the favourable opportunity ends about the beginning of September. In general, it seems that the time most propitious for all the coast-water routes, begins some weeks earlier than the corresponding period in the frozen seas remote from land. But since, even in the first weeks of September, the most promising conditions are often succeeded by a sudden reaction due to storms, to cold setting in rapidly, or to excessive falls of snow, navigation in the land-remote frozen seas, in itself so extremely hazardous, becomes specially critical, just when the ice-sheet at its minimum appears to promise the greatest results.

7. The help of steam power is an indispensable requisite, as by it a vessel is able to defy the capricious changes of the wind. The movements of a ship amid the ice are made in interminable curves, and the power to describe an arc with the least radius enables a vessel to follow up narrow and often blocked water-ways. As it is incessantly exposed to severe shocks from the ice, a paddle-wheel steamer is

useless; and even in screw-steamers care must be taken to protect the propeller by a special construction.

8. The rate of speed of a vessel in the ice must necessarily be moderate. From three to six miles an hour are sufficient: and a rate of eight or ten miles would soon render her not seaworthy. But even with this reduced rate, her whole frame-work is shaken and loosened at last by the incessant shocks she sustains; and this condition of the ship becomes apparent when concussion with the ice is followed not by a noise as of thunder, but by a low, dull, groaning sound. The larger a vessel, the less her capacity to withstand these shocks, and the sooner will these signs of her diminished strength betray themselves.

9. An Arctic ship should be built with sharp rather than with full lines, so that when pressed by the ice, she may more easily escape being nipped and crushed. A ship built with what is called—in England—full lines, a full, round ship, is not easily raised but is liable to be crushed by ice-pressure. The *Hansa* was built in this manner, and was crushed by the first squeeze from the ice; the *Germania* and the *Tegetthoff* were both of them sharp-built ships, and stood the test of the ice excellently well. To protect it from the effects of grinding on ragged "ice-tongues," the hull is generally iron-plated for some feet under water, and the bows are strengthened as much as possible, because this part of the ship is exposed to the greatest shocks.

10. The tactics of a ship in the ice are guided entirely by the character of the hindrances to be overcome. If the ice-fields be large and heavy, they are then generally separated by broader water-ways and "leads," and a ship may often

amid such ice follow her course for hours with few deviations subject always to the danger of being “beset” and crushed. When the passage is blocked by a barrier of ice, the situation becomes grave and serious; for such fields are not to be displaced by any force which the ship may exert, and nothing is left to the navigator but to await their parting asunder in a position as sheltered as possible. When the ice is loose and the floes comparatively small, the impeding barriers may be charged by the ship. She may then force asunder some of these floes or separate them by the continuous pressure of steam-power. In cases of this kind, large vessels have the advantage, and can bring to bear a greater amount of pressure, whereas smaller ones stick fast and remain immovable. These accumulations of ice, while they make a “besetment” more likely, diminish the danger of pressure.

11. Hence it is clear that small are to be preferred to large vessels for ice-navigation, except under circumstances of rare occurrence; first, because they are more readily handled, and next, because of their greater power of resistance and of their being more easily raised under pressure from the ice. Their one disadvantage of lesser momentum is of comparatively slight consequence. The experience of all the North Pole expeditions of this century shows, that ships of 150, or at the most of 300 tons, are best suited for all purposes.

12. Iron ships have often been employed, but with no success; they are far less able to bear pressure than wooden ships, as was proved, among other things, by the fate of the

River Tay in 1868, in Baffin's Bay, and of the *Sophia*, a Swedish ship of discovery in the north of Spitzbergen.

13. It admits of no question, that two vessels should be employed in preference to one, and this should be accepted as a first principle whenever the means at our disposal admit of it. Both ships should also be provided with steam-power, for otherwise their separation is almost inevitable,—a danger, however, for which, under all circumstances, they must be prepared.

14. All that is commonly understood about piercing the ice by sawing and boring through it is a delusion, and arises from the misunderstanding of technical expressions. Where there is navigable water, there any one can sail—where there is none, no one. In 1869 and 1870, after coming on a *cul-de-sac* of ice in Greenland to the east of Shannon Island, we could not penetrate a yard further; in 1871, in loose, but solid ice, we drew away only by warping on the smaller floes, without being able to make the slightest progress, and in 1872 we were twice "beset," in heavy ice, in spite of our steam power. The penetration of close pack-ice is an impossibility: in this case patient endurance is alone of any avail, and hence Sir John Ross so emphatically recommends the Polar navigator "never to lose sight of the two words caution and patience."[7] If a vessel, therefore, is arrested by impenetrable masses barring its way, the breaking up of the ice must be patiently awaited, and this, generally, is effected by calms, although the ebb and flow of the tide appear to have an influence on the solidity of the ice. It is then usual with sailing ships to seek the larger "ice-holes," or keep in the freest water-ways, in order to guard against

the danger of being completely inclosed. These precautions, however, are not so requisite for steam-vessels, as their power to escape quickly and in any direction secures them against this danger. A steam-vessel may even venture to fasten on to an ice-floe by means of an ice-anchor, and of course under its lee, the fires being banked up, so that by getting up steam she may shift her place as soon as the ice moves nearer. As a principle, and so far as it is possible without the exhaustion of her powers, a ship in the ice should endeavour to be in constant motion, even though this entail many changes of her course and the temporary return to a position which had been abandoned. The making fast to a floe, however, should never be attempted, except when every hope of navigating in the surrounding waters has been proved fruitless. The fastening a vessel to an iceberg diminishes, indeed, its drifting, but is, if possible, to be avoided, because of the danger of the iceberg overturning or rending asunder, things which occur far more frequently than we should be led to expect from their great appearance of stability. When a ship, notwithstanding every possible caution, is “beset,” it is then advisable to “ship” the rudder in order to protect it from injury, to which it is peculiarly liable from its unusual weight and size. A ship is exposed to considerable danger when she finds herself among icebergs in a calm; but since these are over-spread by a dazzling sheen, even in the thickest mist, the peril of the position is to be avoided at the last moment by warping.

15. As the happy choice of a sea-way is one of the essential conditions of success in ice-navigation, the ability to determine the ship’s position and to ascertain whether a

surface covered with ice to the horizon, admits of being penetrated, is most desirable. Hence the employment of a balloon would be of the last importance in Arctic navigation. The advantage of being able to ascend from the ship in a balloon secured by a rope, to the height of a few hundred feet, is self-evident; and, undoubtedly, the first vessel which avails herself of this great resource will derive extraordinary benefit from it.

16. From the deck of a ship even drift-ice appears to be of such solidity at a little distance as to defy navigation, while from the mast-head more water than ice may be descried. In order then to extend the horizon, a look-out, called "the crow's nest," is fixed on the mast-head, in which an officer is always on the watch, and from which all the operations of the vessel are directed. In a ship of the size and height of the *Tegetthoff* the horizon visible from "the crow's nest" extends to about eleven miles,[8] but at the distance of even five miles the possibility of penetrating cannot be determined with sufficient exactness. It is the business of the officer in "the crow's nest" to observe the passages through the ice and distant objects generally, as he is in the best position to fulfil this most important duty. It is the special business of the watch on the forecastle to mark what lies in the immediate neighbourhood of the vessel, and his constant care is demanded to avoid isolated ice-floes and prevent collision with them. The seaman at the helm steers the ship by the signs and calls which come to him from "the crow's nest," and modifies them according to those of the watch on the forecastle. The rest of the crew remove the smaller fragments of ice from the vessel's

course, special care being taken to prevent their damaging the screw.

17. While sea-currents move the ice in close and continuous lines, winds produce great disturbances in their movement, and open long “leads” in the direction of their course, which often alternate with strips of the thickest pack-ice. This movement of the ice varies with each accumulation of floes, as its rate of motion depends on the height of the ice-field, which then acts as a sail. It is ascertained by experience that calms, on the other hand, have the remarkable property of breaking up the ice. The knowledge and application of these circumstances are essential to the Arctic navigator. If the course of a ship lies across or against a current, it is constantly deflected. The deflection on the coast of East Greenland, for example, amounted to five, even ten miles, within twenty-four hours; hence the importance of choosing routes with and not against the course of currents.

18. Lastly, it is of the greatest moment to choose betimes an appropriate winter harbour, and it is therefore necessary to keep near the coast towards the close of the season for navigation. To find one suitable for shelter during the winter in an unknown Arctic region is a matter of great difficulty, for it very often happens, that the ice drifts out from these “docks”[9] in the storms which constantly occur, or perhaps the “dock” is so sheltered, that the ice, if it breaks up at all, breaks up only in the following summer. Shallow bays which freeze almost to the bottom, lying under the lee of a current or within a fiord, are the most appropriate spots in which to winter.

CHAPTER III.
THE PENETRATION OF THE REGIONS WITHIN THE POLAR CIRCLE; THE PERIOD OF THE NORTH-WEST AND NORTH-EAST PASSAGES.

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1. Around the lonely apex of the Pole stand cairns of stone which serve to mark the points to which the restless spirit of human enterprise and discovery has penetrated. In its zenith wheels the sea-gull in its flight, and the harpoon-persecuted seal finds on its ice-floes an unapproachable asylum; but the Pole itself remains the goal which no human effort has yet reached.

2. As all knowledge is perfected slowly and gradually, so man's knowledge of the earth and its configuration forms no exception to this general rule. Of the few attempts of early antiquity to enlarge the domain of geographical knowledge, tradition tells us only of the Argonautic expedition of the Greeks, of the voyage of the Phœnicians to Ophir, and their bolder circumnavigation of Africa. With the conception of the spherical form of the earth the still vague notion of climatal zones makes its appearance, and to this, four centuries before Christ, Pytheas of Marseilles gave the first scientific elucidation and the first approximation to modern theories by his doctrine of the Polar Circle. Almost contemporaneously Alexander's expedition to the wonder-land of India created a paradise for commerce and navigation, to secure which a shortened route, *the route through the ice*—the most perverse notion that ever entered into the mind of man to conceive—was one thousand eight hundred years afterwards eagerly and passionately sought.