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THE ANTARCTIC VOYAGE OF THE "BELGICA" DURING THE YEARS 1897, 1898, AND 1899.*

By HENRYK ARCTOWSKI, of the Scientific Staff of the Expedition.

SINCE the date of the memorable voyages of Ross, Wilkes, and D'Urville, the record of antarctic discovery tells us of very few enterprises of the kind for many years subsequently, not a single important step having been taken, after these voyages, towards the improvement of our knowledge of the antarctic, until the moment when the *Challenger* pushed forward, as far as the polar circle, among the ice of the Southern ocean. After this came the years in which Prof. Neumayer and Sir John Murray devoted themselves to the task of arousing the interest of the scientific world in antarctic questions, and stirring it up to new efforts. In this they at last succeeded, for it is doubtless in great measure due to their advocacy that a new era of research has now begun.

On the eve of the departure of the National Antarctic Expedition, organized under the joint auspices of the Royal Society and the Royal Geographical Society, as well as of those to be sent out from Germany, Sweden, and Scotland, I wish to describe to you the doings of the Belgian Antarctic Expedition, a member of which I had the honour to be, and which was the first to winter amidst the ice of the south pole—the first of the several expeditions whose combined harvest of scientific results is destined to effect a complete revolution in our knowledge of the antarctic regions.

Now that the continent of Africa has been traversed in all directions, now that the centre of Asia is already well known in the broad outlines of its geography, while there is no longer a possibility that

* Read at the Royal Geographical Society, June 24, 1901. Map, p. 464.
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anything essential can be added to our geographical knowledge by voyages to the north pole, the efforts of explorers must inevitably tend to disclose to us the mysteries of the "Terra Australis incognita." It is not merely the inaccessible or almost inaccessible coasts of the antarctic continent which have to be explored, but the whole broad expanse of ocean which bathes the lands of the south pole as well. And we can form no estimate what philosophic conclusions will be reached from the mass of new information to be gathered from the scientific exploration of so vast an extent of the surface of the globe. We must steadily advance, and history will teach us how much more important, for the whole future of the human race, are the pacific conquests of science than all the wars of destruction waged between nations in arms. I sincerely hope that the British Antarctic Expedition may meet with full success, and bring back a rich harvest of new scientific facts. And since this expedition is bound for a region not far removed from that in which we laboured, and as the *Discovery* may perhaps be blocked in the ice and winter in the pack as the *Belgica* did, I think that you will be particularly interested in hearing of the life that we lived amidst the ice during the long months in which the vessel remained imprisoned.

I will give but a very brief narrative of the voyage of the *Belgica*, for I wish also to dwell on the researches undertaken by the members of the Belgian Expedition and on the value of the observations brought back. The study of these materials involves the collaboration of a large number of *savants*, and it will therefore be impossible, until several years have elapsed, to form a clear idea of the results obtained, for up to the present two or three memoirs only have been completed.

The object of the Belgian Antarctic Expedition was *not* to pass the extreme points reached by Ross and Weddell. We aimed, on the contrary, at achieving something new—something which might better meet the requirements of modern geography, which year by year asks more of the co-operation of the natural and physical sciences. For this reason the *Belgica* was equipped for scientific work, to the end that at least some of the numberless questions awaiting solution in the antarctic, in the domain of all the sciences affiliated to geography, might be answered.

As regards the area yet unexplored, there is no doubt that the inscription "Antarctica terra incognita" will long remain inscribed in large letters in our atlases, but little by little the outlines of the southern lands will take more definite shape, and our knowledge of the southern continent—of which the existence is still enigmatical—will in time be satisfactory. The Belgian Antarctic Expedition will mark the first step, among contemporary enterprises, in lifting the veil of obscurity from the south polar ice-cap.

1. *Organization of the Expedition.*—The expedition in the *Belgica* was

a private undertaking subsidized by the Belgian Government. The initiative was due to Commander de Gerlache, who, from 1894 onwards, had entertained a wish to undertake a voyage of exploration to the south pole. This wish he expressed to various persons, including among others certain members of the Council of the Royal Belgian Geographical Society. It was one of these latter—M. Lancaster, I believe—who suggested to de Gerlache the plan of a scientific voyage, in the place of one of adventure—an idea which made its way in course of time. M. de Gerlache encountered difficulties from the very beginning. A scheme submitted to his Majesty King Leopold failed to gain his approval, and the original application for a grant of 800,000 francs (£32,000) yielded to a more modest programme involving an outlay of £12,000 only—with which comparatively small sum de Gerlache succeeded in covering the whole cost of the enterprise. Early in 1896 the Brussels Geographical Society, which gave its patronage to the project, organized a national subscription. The first 25,000 francs (£1000) were subscribed by M. Ernest Solvay, the well-known patron of research. Other important gifts, with subscription lists opened by local committees in the principal Belgian towns, the proceeds of lectures, fêtes, etc., helped the sum total to rise by degrees, while at the end of June, 1896, the sum of £4000 was unanimously voted by parliament. In spite of this, however, want of funds delayed the preparations, and the departure of the expedition was put off for a year. The vessel chosen was the smallest of the Norwegian whalers, formerly the *Patria*, which was purchased by de Gerlache for the sum of 70,000 francs (£2800). Although of recent construction, the *Patria* underwent some necessary repairs and alteration of fittings for the new services demanded of her. On July 5 the vessel was rechristened with the name *Belgica*.

The ship was a three-masted barque, 100 feet long, with a displacement of 250 tons, and auxiliary engines of 150 horse-power. The hull was protected by a casing of hard wood, to add strength and afford protection against the friction of the ice. Aft, on the deck, were placed the cabins of the officers and of the scientific staff, while in the fore part, under the bridge, a laboratory was rigged out. While these preparations were being made at Sandefjord, in Norway, the complete scientific equipment was ordered from the best makers in Europe, and our instruments were thus brought together from Paris, Vienna, Copenhagen, London, Berlin, Jena, etc. The purchase of stores, furs, and the whole equipment of the polar explorer likewise required much time and forethought. Even though we had more than a year at our disposal for these preparations, time fell short in the end, and in spite of all our efforts it was necessary to put off the date of departure. Funds, too, were lacking, for it soon became evident that the 233,000 francs (£9320) collected were not sufficient, and it was only on the Government again coming forward with a credit of

£2400 that we were able to leave Antwerp. In spite, however, of the rigorous economy which de Gerlache was forced to practise in order to keep the expenses within the scanty limit of the £12,000, a sufficient sum was devoted to the scientific instruments to save the expedition from any criticism on this score. It is true that the staff of the expedition received no remuneration, and that the wages of some of the crew were insignificant, while others were volunteers. It is equally true that the Belgian Expedition owed a debt of gratitude to many kind friends. Thus during the stay of the ship at Antwerp Mme Osterrieth took so lively an interest in the welfare of each of us that the crew of the *Belgica*, and, later, the whole of Antwerp, applied to her the title of "la mère antarctique." It was due to our President, Sir Clements Markham, and to the interest in the expedition taken by Sir John Murray, that we obtained from the Royal Society the 'Reports of the Voyage of the Challenger,' and from the Admiralty the whole series of nautical charts which were such a necessary part of the equipment of the expedition.

The *Belgica* left Antwerp on August 16, 1897. An accident to the machinery forced us to put into Ostend, and thus delayed our departure by a week, as we only left Ostend at 8 p.m. on the 23rd. One of my good friends, Antoni Dobrowolski, took advantage of this first mishap to embark with us. Two days before we left Antwerp he had come to bid me good-bye, and to inspect my arrangements. Like so many others, he saw over the *Belgica*, and even mounted into the crow's nest to obtain a general view of the Antwerp dock, and at last, when evening came, he disburdened himself of the question which had been on his mind the whole time, What should he do to be taken along with us? The thing was impossible; it was too late. Dobrowolski was a student at the University of Liège, and he would have had some difficulty in returning to collect his baggage and getting back to the ship in time; besides, the commander might perhaps not have accepted him; and, lastly, there was not another berth in the ship, all the beds being occupied.

But, directly we reached Ostend, I telegraphed to him, and he started off at once with two small packages, which he carried in his hand, and which were all he took with him for the long voyage which he meditated making. He came on board, and set to work with the rest of us on the final preparations for the voyage and the arrangement of the laboratory, which, at the moment of sailing, had not yet been completely set in order. The commander was surprised to see an extra hand on board, but, seeing that he was by no means *de trop*, decided to take him with us as laboratory assistant. Dobrowolski, as it turned out, rendered incalculable services to the expedition, for he carried out a good half of the hourly meteorological observations, and he made excellent notes on the clouds and on the phenomena of frost and snow.

It was also during these last days that our two best sailors—the Norwegians Knutsen and Johansen—were engaged in the place of two others who had left the ship. Now, too, the question of the medical officer was settled, for at the last moment we found ourselves without a doctor on board, the last of the three Belgian doctors who had been engaged having calmly remained at home after mature reflection. It was by means of the telegraph that Dr. Cook, of Brooklyn, arranged to go with us, and as there was no time for him to come to Europe, he joined us at Rio de Janeiro. These facts, and many others which I could cite, show how difficult it is to organize an expedition when one's resources are limited. It is true that there is no lack of volunteers. Each day of our stay at Antwerp people came asking to be taken with us, and de Gerlache received several hundred applications by letter, but these were for the most part from adventurers who had no idea of hard work, and who would have been incapable of rendering us the least service. Lunatics too were among the number of those who wished to embark on our ship, which every one came to see from curiosity. In three essential points the organization of the expedition was defective. Firstly, there was no written contract as between the staff and the leader of the expedition, and the functions of the several members were not sufficiently defined. Secondly, no written instructions were provided either by the Belgian Government, or by the Geographical Society, or by any other learned body. And, thirdly, no definite programme for the voyage had been drawn up.

The Belgian Antarctic Expedition maintained, therefore, the character of a private enterprise, in which the individual liberty accorded might easily have led to anarchy on board. If I lay stress on this point, it is because I feel that the example of the *Belgica* ought not to be followed. In a similar expedition, it is requisite not merely to make a good choice of the individuals who are to take part in it, but to do all in one's power, from the outset, to secure a proper organization, to define the duties of each one of the staff, so as to give stability to the enterprise, and, further, to provide a definite plan—just what we lacked.

2. *Ostend to Punta Arenas*.—The speed of the *Belgica* under steam being only from 4 to 5 knots, the crossing of the Atlantic was slow, and was of little interest. We neither sounded nor fished, so that the whole of the scientific work was comprised in the study of the surface water, from the point of view of temperature, colour, and density, and in the meteorological observations taken every two hours. In the Bay of Biscay we had very bad weather and a contrary wind, by which our progress was much hindered. The vessel was, besides, so overloaded that the deck was scarcely 2 feet above the water-line. Our situation was thus scarcely reassuring, and we congratulated ourselves when we had doubled Cape Finisterre. On September 11 we were at the port of

Funchal, Madeira, our first point of call, at which we spent three very pleasant days. Thence we sailed direct for Rio de Janeiro, where we remained a week, starting for Montevideo on October 30. At the entrance of the Rio de la Plata we were stopped by a "pampero," which blew with such violence that the captain felt it necessary to cast anchor in a little sheltered bay near Cape Polonio. On November 11 we were in Montevideo roads, and three days later we once more set our course for the south. On the 26th a storm compelled us to close reef, which caused a fresh loss of time. Finally, on November 29 we entered the Strait of Magellan, where, after halts at Cape Gregory and Elizabeth island, we cast anchor at Punta Arenas on December 1. Punta Arenas was the starting-point of our antarctic voyage. Here the commander took on board the coal necessary for the remainder of the voyage, and, profiting by a liberal offer on the part of the Argentine Government, modified his proposed route so as to complete his supply at the depôt of Llopotaiia, in Beagle channel. It was this circumstance which gave us the opportunity of visiting the channels of Tierra del Fuego. Our departure was delayed by several desertions among our Belgian seamen, and we left Punta Arenas with a quite insufficient crew. The whole complement of the *Belgica* was thus reduced to nineteen men, viz. the following:—

Adrien de Gerlache, commanding; Georges Lecointe, second in command, and Roald Amundsen, officer; Emile Danco, Emile Racovitza, Henryk Arctowski, and Antoni Dobrowolski, scientists; Frederick A. Cook, doctor; Henri Somers and Max van Rysselberg, engineers; Tollew- sen, Melaerts, Johansen, Knutsen, Koren, Wiencke, Michotte, Dufour, Van Mirlo, seamen.

3. *Among the Channels of Tierra del Fuego.*—We took advantage of our stay at Punta Arenas to make some excursions in the neighbourhood. We went into the valley of the Rio las Minas, where a fine series of sections in the Tertiary sandstone and sand is to be seen. Here and there they contain fossils as well as deposits of lignite, one of which is worked. There are some gold-washers at work on the river, but the outturn is extremely small. Afterwards Dr. Cook and I visited the sheep farm at Pecket Harbour, where I was able to examine some fine moraines, which seem to mark the termination of the Magellanic glacier, and which must, I think, have been formed beneath the surface of the sea before the upheaval of that part of Patagonia. We likewise inspected the Catholic mission on Dawson island, where Cook was able to carry out some anthropological measurements among the Fuegians of the Onas tribe, whilst I took some linguistic notes.

In order to pass round Tierra del Fuego, the *Belgica* traversed Magdalena sound and Cockburn channel. We did not get sight of Mount Sarmiento, which was lost in the clouds, but we looked with

admiration on the superb glaciers which descend from the spurs of this mountain *massif*, some of which discharge themselves into the waters of the channel. At the entrance to Darwin channel we put into a small bay on Londonderry island, and on the opposite (Fuegian) side of the channel into a fine fiord, at the head of which debouches an immense glacier from the slopes of Mount Darwin. Here and there we saw well-preserved traces of the former extension of the glaciers. Thus, on Londonderry island, the entrance to the small bay, in which we had cast anchor, was fringed on both sides with fragments of moraines, one of which ran out in the form of a natural jetty.

A little above sea-level a lake occupied the bottom of the valley which debouched into the bay. This lake discharged by a torrent, the bed of which had been cut down into the rock of the sill which separated it from the bay. On the precipitous walls which bounded the funnel, at the bottom of which the lake lay, there were *roches moutonnées*; and higher up, above a second sill, was another smaller lake, which also seemed to occupy a basin hollowed out of the rock. In the Pleistocene period this valley must certainly have been occupied by an immense glacier. From the summit of a mountain 2300 feet high, I could make out that the whole of O'Brien island, which we had opposite us, was likewise strewn with small lakes ranged in line in accordance with the direction of the valleys. Other funnel-shaped hollows which we had seen from the deck of the *Belgica* while passing through Cockburn channel suggested to me that there must be lakes occupying basins abandoned by the ice on the retreat of the Pleistocene glaciers. They thus seem to form one of the characteristics of the region.

The bay of the great glacier on Tierra del Fuego is a superb fiord, into which we advanced as far as was possible, effecting landings at several points in order to study the flora and the geology. Three large transverse moraines divide the fiord into basins. The third moraine leaves only a narrow passage of no great depth, so that the last basin, into which the glacier debouches, is entirely packed with floating ice. It formed miniature icebergs, only the smallest of which can be carried by the current into the fiord and thence into Darwin channel. The doctor and I did our best to make our way to the glacier, which is truly magnificent. We climbed the heights, where we had to hug the extremities of several small hanging glaciers, and climb steep rocks, for along the margin of the basin there is no beach, while the cliffs are mostly precipitous, and to have forced a way among the ice in a canoe would have been an impossibility. In the end we were stopped by a river which flows from a lateral valley, and which we made no attempt to cross, the distance still separating us from the great glacier being too considerable and the ground virtually impassable.

The transversal moraines are not the only indications of the ancient

extension of the great glacier. They rather mark with great clearness the stages of a rapid retreat of this immense river of ice at the close of the glacial epoch. The sides of the mountains which border the fiord bear *roches moutonnées* at considerable altitudes, and one of the mountains has the characteristic outline of a huge sheep's back surmounted by a small hillock. This latter has sharp ridges, whilst all the rest of the mountain is polished and planed by the erosive action of the ice. I have no doubt that during the glacial epoch it was a nunatak rising above the surface of the inland ice which covered the Darwin mountains, and which certainly reached to this point. It was not merely, therefore, the head of the fiord which was blocked with ice, but the whole of this immense valley was buried in this outpouring of the inland ice, until only a few of the mountain summits remained above the surface of the icy mantle.

In Darwin channel we once more cast anchor, in a small bay named by the expedition Asterias bay, from the large number of crustacea collected there by Racovitz. Thence we proceeded direct to Ushuwaia in Beagle channel, whence the *Belgica* went on to Llopotaia fiord in order to take in coal. I went across the forest on foot, accompanied by two Indians, while Dr. Cook remained at the Protestant mission at Ushuwaia to make an anthropological study of the Yahgans. The scenery of Llopotaia fiord is grand. At its head rises a mountain, called the "Bonnet de la République," from the snowy cap which covers the summit; while quite on the horizon, through the wide opening afforded by a valley, the Darwin mountains can be clearly seen in fine weather, with the Pic des Français in front. These mountains are entirely unexplored, and even Lake Acigami, which ends at the settlement of Llopotaia, has never been visited. It was impossible, for want of time, to penetrate as far as the Darwin range, or even to ascend the Martial mountains, which rise just abreast of Beagle channel.

After returning to Ushuwaia, the *Belgica* proceeded to Harborton harbour, where we met with an accident which came near putting an end to the expedition. The *Belgica* struck a submerged rock, on which she remained fast. At low water the ship completely heeled over, and a storm that supervened added still more to the danger of our situation. But, fortunately, the swell that arose, and eventually became very strong, finally lifted the *Belgica* off the rock, after having beaten her against it for several hours. It was most astonishing that our ship had the strength to resist so many violent shocks, and the result was that, far from discouraging us, this accident only gave us confidence for the future.

As soon as liberated, it was in complete disorder on board that we made the best of our way to a good anchorage in which to take shelter. The captain cast anchor in Port Toro, on Navarino island, where we passed the night, and on the following day went back

again to Harberton harbour to take on board Dr. Cook, who had landed, and after a short stay, we started for Staten island. Our putting in here was rendered necessary by the fact that when aground near Harberton, we had been obliged to pump out all our stock of water to lighten the vessel, and, having been told that the water at John harbour was good and abundant, we seized the opportunity of visiting Staten island, which is of especial interest from a geographical point of view. The Admiralty chart shows that the form of this island is most curious. It is long and narrow, cut up by fiords and bays, and forms, in fact, a chain of mountains with a much broken relief, due to the powerful erosion to which it has been subject. But its base is wanting, and the sea encroaches everywhere on the bottoms of the valleys, so as to cut up the island into separate fragments. It is the skeleton of a mountain range emerging but slightly above the level of the sea.

Staten island forms one of the extremities of the Andes, which, curving towards the east, encloses within its bend the plains of Tierra del Fuego, while on the opposite side it falls steeply to the ocean. The chain of the Andes seems to open in the form of a fan, for if Staten island forms the prolongation of the Darwin and Martial ranges, there is another important ridge which runs south and ends at Cape Horn ; and possibly also a third and outermost one, which extends to the islands of Diego Ramirez. It seems to me a natural question to ask if this is really the end of the great chain of mountains which borders the whole Pacific side of South America, or whether, on the contrary, the chain is prolonged in the form of submarine ridges beyond these limits. The existence of Burdwood bank shows us that the base on which Staten island rests is continued to the 53rd degree of longitude, but how is it to be traced beyond this point? Is it connected directly with the South Orkneys, or is the arc still wider, and do South Georgia and the chain of the Sandwich isles belong to the same system? Even before our departure I had been much puzzled to know in what direction the prolongation of the Andes was to be sought, and how the range was connected with the framework of the Antarctic lands situated south of the southernmost point of America, *i.e.* with the volcanic chain of the South Shetlands and Orkneys, and the great range which traverses the lands discovered by Palmer, Ross, and d'Urville, and is continued southward in Graham Land and Alexander Land, and, no doubt, further still towards the south, possibly as far as Mounts Erebus and Terror. And I am now still more puzzled than ever to know the correct solution of this problem of terrestrial morphology.

At the extremity of John harbour, where we anchored, I discovered glacial traces. There were morainic materials, and on the prolongation of the fiord there was a lake bordered by a moraine, while further up there was still another basin excavated in the rock. One of the employés at the lighthouse in John harbour, who has lived several

years on Staten island, assured me that there are many lakes among the heights, and pointed out the position of several of them on the map. At the present day there is not a single glacier on the island, but the traces of ancient glaciation explain clearly the peculiarly characteristic features of its relief.

The *Belgica* left Staten island on January 14, 1898, and it was from this date that our voyage of exploration began. As I have already stated, we had all the equipment necessary for oceanographical investigations, and I was happy to be able at last to commence my researches, which began with an interesting discovery. South of Staten island, in the latitude of Cape Horn, the sounding-lead only touched bottom at 2200 fathoms, and from this point the depths gradually diminish towards the south. It is, therefore, towards the east that I think we must look for the prolongation of the Andes, since south of Cape Horn we are still in the Barker basin. The Pacific ocean ought, therefore, to be extended beyond the meridian of Cape Horn, for its natural limit will certainly be found in the submarine ridge of the Andes.

4. *The Antarctic Lands*.—It was on January 23 that we reached Hughes gulf, the outlines of which are but vaguely traced on the Admiralty chart, from the indications supplied early in the nineteenth century by English and American whalers. We soon saw that the modern charts of Petermann and Friederichsen, intended to illustrate the discoveries of the German Captain Dallmann, were entirely at fault. As the information respecting the lands situated to the south of Cape Horn was extremely scanty, it was with pleasure that we all worked our hardest to collect such *data* as should be obtainable on the nature and extent of these lands. Captain Lecoq, assisted by Commander de Gerlache, was busy from morning till night on survey work, the *Belgica* being moved from place to place in order that all the details of the coast might be seen from near at hand; Dr. Cook was constantly at work taking photographs; Racovitza took notes on the animals and plants which he managed to collect; while I took every opportunity of landing to collect specimens of the rocks and study the glaciers of this region, besides taking numerous photographs.

Our geographical discoveries are already well known, and I will, therefore, not dwell in detail on our zigzag course through Belgica strait, which can be followed in my article on the Antarctic Lands published in the February number of the *Geographical Journal*. The chart constructed by Captain Lecoq gives an idea of the work accomplished during the three weeks devoted by the expedition to cartography, for it was on February 13 that we left the newly discovered lands to push our way south through regions until then completely unexplored. The important point which is brought out by Lecoq's map, is that the east coast of the strait traversed by us is perfectly continuous, and that its contours display the characteristic features of a region of fiords. Towards

the south this land (named by us Danco Land, in memory of Lieut. Emile Danco, who died during the course of the expedition) is connected with



FIG. 1.—CAPE ASTRUP: WIENCKE ISLAND, SEEN FROM NEUMAYER CHANNEL.
(Photo by Arctowski.)



FIG. 2.—SPECIAL FORMS OF GLACIERS SEEN ON WIENCKE ISLAND.
(Photo by Arctowski.)

Graham Land, the northern extremity of which was likewise explored by us. Towards the north, on the contrary, the continental coast-line was not traced by the expedition, for this would have necessitated

retracing our steps, while, the season being already far advanced, we had to continue our onward voyage to the south. But as the inland ice rises to a very considerable height east of Hughes inlet, I have been led to believe that land must reach in that direction as far as Louis Philippe Land. It therefore seems likely to me that the coast-line is continuous to that point, and that Louis Philippe Land is in reality the northern termination of Graham Land, and that the "New Greenland" of the first explorers of this region is not a phantasm. The large islands situated to the west of Belgica strait form an archipelago, which has been named Palmer archipelago, in order to give a place on the maps to the name of this intrepid American navigator.

It has been asserted that the discoveries of Palmer were nothing but a fable, and that the account of them given by Fanning* is mere imagination. Fanning writes as follows:—

"After the *Hersilia's* return from the South Shetlands, a fleet of vessels, consisting of the brig *Frederick*, Captain Benjamin Pendleton, the senior commander, the brig *Hersilia*, Captain James P. Sheffield, schooners *Express*, Captain E. Williams, *Free Gift*, Captain F. Dunbar, and sloop *Hero*, Captain N. B. Palmer, was fitted out at Stonington, Connecticut, on a voyage to the South Shetlands. From Captain Pendleton's report, as rendered on their return, it appeared that while the fleet lay at anchor in Yankee Harbor, Deception Island, during the season of 1820 and 1821, being on the look-out from an elevated station, on the mountain of the island during a very clear day, he had discovered mountains (one a volcano in operation) in the south; this was what is now known by the name of Palmer's Land. From the statement it will be perceived how this name came deservedly to be given it, and by which it is now current in the modern charts. To examine this newly discovered land, Captain N. B. Palmer, in the sloop *Hero*, a vessel but little rising forty tons, was despatched. He found it to be an extensive mountainous country, more sterile and dismal, if possible, and more heavily loaded with ice and snow, than the South Shetlands. There were sea-leopards on its shore, but no fur seals; the main part of its coast was ice-bound, although it was in the midsummer of this hemisphere, and a landing consequently difficult.

"On the *Hero's* return passage to Yankee Harbor she got becalmed in a thick fog between the South Shetlands and the newly discovered continent, but nearest the former. When this began to clear away, Captain Palmer was surprised to find his little barque between a frigate and sloop of war, and instantly ran up the United States flag; the frigate and sloop of war then set the Russian colors. Soon after this a boat was seen pulling from the commodore's ship for the *Hero*,

* Edmund Fanning, 'Voyages round the World, with Sketches of Voyages to the South Seas' (New York, 1833), p. 434.

and when alongside, the lieutenant presented an invitation from his commodore for Captain P. to go on board; this of course was accepted. These ships, he then found, were two discovery ships sent out by the Emperor Alexander of Russia, on a voyage around the world. To the commodore's interrogatory if he had any knowledge of those islands then in sight, and what they were, Captain P. replied he was well acquainted with them, and that they were the South Shetlands, at the same time making a tender of his services to pilot the ships into a good harbour at Deception Island, and nearest by where water and refreshments such as the island afforded could be obtained. He also informed the Russian officer that his vessel belonged to a fleet of five sail out

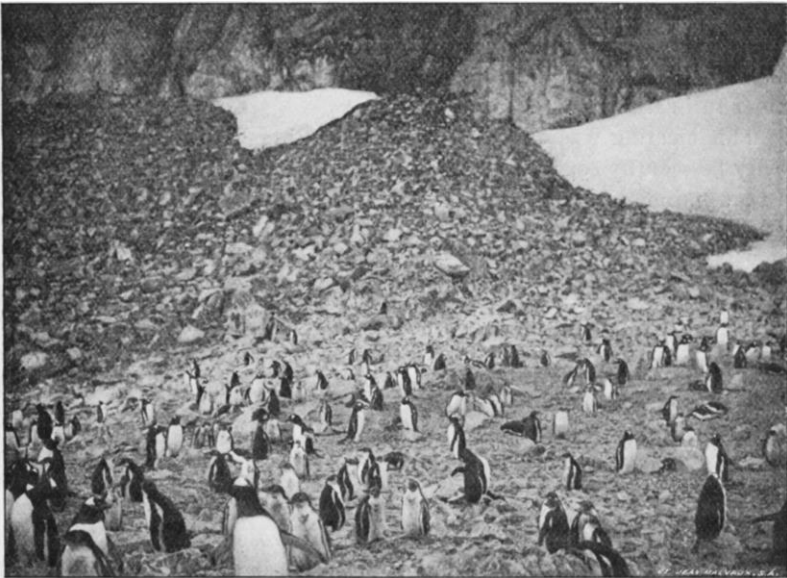


FIG. 3.—A ROOKERY OF SMALL PENGUINS, *PYGOSCELIS PAPUA*.

(Photo by *Racovitza*.)

of Stonington under command of Captain B. Pendleton, and then at anchor in Yankee Harbor, who would most cheerfully render any assistance in his power. The commodore thanked him kindly. 'But previous to our being enveloped in the fog,' said he, 'we had sight of those islands, and concluded we had made a discovery; but behold, when the fog lifts, to my great surprise, here is an American vessel apparently in as fine order as if it were but yesterday she had left the United States; not only this, but her master is ready to pilot my vessels into port. We must surrender the palm to you Americans,' continued he, very flatteringly. His astonishment was yet more increased when Captain Palmer informed him of the existence of an

immense extent of land to the south, whose mountains might be seen from the masthead when the fog should clear away entirely. Captain Palmer, while on board the frigate, was entertained in the most friendly manner, and the commodore was so forcibly struck with the circumstances of the case that he named the coast then to the south Palmer's Land.* By this name it is recorded on the recent Russian and English charts and maps which have been published since the return of these ships. The situation of the different vessels may be seen by the plate; they were, at the time of the lifting of the fog and its going off to the eastward, to the south, and in sight of the Shetland Islands, but nearest to Deception Island. In their immediate neighbourhood were many ice islands, some of greater and some of less dimensions, while far off to the south the icy tops of some two or three of the mountains on Palmer Land could be faintly seen. The wind at the time was moderate, and both the ships and the little sloop were moving along under full sail."

This meeting was also described by Bellingshausen himself, as can easily be seen by consulting the remarkable, but still little-known work of that eminent Russian explorer.†

Further on we read ‡—

"The following season, in 1821 and 1822, Captain Pendleton was again at Yankee Harbor, with the Honington fleet; he then once more despatched Captain Palmer in the sloop *James Monroe*, an excellent vessel of upwards of 80 tons, well calculated for such duties, and by her great strength well able to venture in the midst of and wrestle with the ice. Captain Palmer reported on his return, that after proceeding to the southward, he met ice fast and firmly attached to the shore of Palmer's Land; he then traced the coast to the eastward, keeping as near the shore as the ice would suffer; at times he was able to come along shore, at other points he could not approach within from one to several miles, owing to the firm ice, although it was in December and January, the middle summer months in this hemisphere. In this way he coasted along this continent upwards of fifteen degrees, viz. from 64 and odd down below the 49th of west longitude. The coast, as he proceeded to the eastward, became more clear of ice, so that he was able to trace the shore better. In 61° 41' south latitude, a strait was

* "This continent," it is asserted in Morrell's 'Voyages,' p. 69, "was named 'New South Greenland,' by a Captain Johnson. It is but just to state here, that this most meritorious mariner (Captain Johnson) was a pupil to, and made his first voyage to the South seas with, the author, with whom also he remained, rising to different stations, and finally became one of his best officers. The first information he obtained of the discovery of this land by Captain Pendleton and Palmer was from the author of this work."

† 'Dwukratnyja izyskanija w jushnom Lëdowitom okeanie' (St. Petersburg, 1831), vol. ii. pp. 263, 264.

‡ Fanning, p. 438.

discovered [South Orkneys], which he named Washington Strait; this he entered, and about a league within, came to a fine bay which he named Monroe Bay. At the head of this was a good harbor; here they anchored, calling it Palmer's Harbor. The captain landed on the beach among a number of those beautiful amphibious animals, the spotted glossy-looking sea-leopard, and that rich golden-colored noble bird, the king penguin. Making their way through these, the captain and party traversed the coast and country for some distance around, without discovering the least appearance of vegetation excepting the winter moss. The sea-leopards were the only animals found; there were, however, vast numbers of birds, several different species of the



FIG. 4.—OSSIFRAGA GIGANTEA. SEVENTEENTH LANDING, BOB ISLAND.
(Photo by Arctowski.)

penguin, Port Egmont hens, white pigeons, a variety of gulls, and many kinds of oceanic birds. The valleys and gulleys were mainly filled with those never-dissolved icebergs, their square and perpendicular fronts, several hundred feet in height, glistening most splendidly in a variety of colors as the sun shone upon them. The mountains on the coast, as well as those to all appearance in the interior, were generally covered with snow, except when their black peaks were seen here and there peeping out." *

* This second part is evidently exaggerated, the discovery and the cartography of the South Orkneys being the work of Powell. Their discovery is described by Powell himself in the *Journal des Voyages, découvertes et navigations modernes ou Archives Géographiques du XIX^e siècle*, tome xxii. (Paris, 1824), p. 93: "Extrait du journal du voyage du capitaine Powell, à South-Shetland, pendant les années 1821 et 1822."

It is to be regretted that after the voyage of the German whaling captain Dallmann, the German "armchair geographers" devoted themselves so keenly to the cartography of this region that they did not hesitate to criticize the map of Lecoq, and, in *Petermann's Mitteilungen*,* to treat de Gerlache as an ignoramus. Taking advantage of the fact that Smiley, in 1842, effected a circumnavigation of Palmer archipelago, they indulged in unlimited speculation on Dallmann's *Notes de Voyage*, and "discovered" the King William archipelago and Bismarck strait, which, according to circumstances, can either stretch south-east, east, or north, and which is also the *raison d'être* of that other unfortunate innovation, the Dirk Gerritsz archipelago. Now, the fragments of Dallmann's Journal, which have been published, in no way permit the conclusions necessary for the construction of a new map, and in my opinion the Admiralty—whatever they may say in Germany—has done quite right to pay no attention to the elaborate maps of Friederichsen and Stieler's Atlas. The King William islands are, as a matter of fact, nothing but a part of the Biscoe islands, placed, with exaggerated dimensions, much too far to the east, far inland. As to the strait, Dallmann could not, from his position, have seen anything other than the entrance to the great fiord called by de Gerlache, Flanders bay. Besides, Dallmann, who navigated Hughes gulf, clearly describes Hughes inlet (of Lecoq's map), but, not having advanced sufficiently far, did not discover the northern entrance of Belgica strait. Therefore, if, as is contended in *Petermann's Mitteilungen*, the name Belgica strait ought to have no place on the map, it is Smiley's name that ought to be inserted, rather than that of Prince Bismarck, who never made a voyage of discovery.

There is one other point to which I wish to call attention. Demas, one of Dumont d'Urville's officers, says † that he noticed that Orléans channel extended towards the south-west. It may well be, therefore, that Dallmann passed through Orléans channel, when he discovered that Trinity land was an island. Trinity island is, therefore, the last large island of Palmer archipelago.

The general map of the lands to the south of America must, as we have just seen, be drawn quite differently from its delineation by the Germans. We have there a large peninsula (of the antarctic continent,

On page 111 we read in a note, "On ne peut dire que fort peu de chose sur la terre du S., appelée Palmer's land, attendu qu'elle n'a pas été suffisamment explorée; mais on la représente comme fort élevée et toute couverte de neige. On y voit aussi des entrées en forme de détroits, qui divisent probablement la terre, et constituent des rangées d'îles semblables à celles de South Shetland. Tel est, en un mot, l'aspect de la côte N., qui seule a été aperçue."

* *Pet. Mitt.*, 1900, p. 172; 1901, p. 48.

† Dumont d'Urville, 'Voyage au Pôle Sud et dans l'Océanie' (Paris, 1842), vol. i., 2^{de} partie, p. 338.

if such a continent exists), which terminates northward in a point facing north-east. A series of islands fringe this land on the side of the Pacific. They are, first Biscoe islands, and further north the Palmer archipelago. Another archipelago (the South Shetlands), forming a well-marked chain of mountains, stretches for some distance to the north in a north-east by east direction. It is noteworthy that taken as a whole these lands present a striking analogy with the southern extremity of America, and as the Andes are continued towards the east, so also the mountains which form the backbone of these southern lands reappear above the level of the sea a little to the east of the South Shetlands, in the South Orkneys.

The antarctic lands which we visited are very mountainous, and the mountains reach to the shores almost everywhere. The region of Belgica channel bears the characters of a depressed area, so much so that in spite of one's self one is driven to the conclusion that the whole block has sunk into the sea, under the pressure produced by the accumulation of ice, to a depth sufficient to restore equilibrium. By reason of this ice, which seems to be piled up in quantities almost as great as the extent of the lands permits, the relief of the ground is almost completely masked. Still there are valleys blocked by immense streams of ice, and in these valleys there must be sills, since ice-falls are to be seen here and there. Cirques too occur; so that we find all the forms characteristic of fluvial erosion, and I feel no doubt at all that before the glacial epoch this region was clear of ice, and that the traces of relief noticed were produced by running water. This relief can, however, be only guessed at, at the present day, for the eternal snows have accumulated everywhere, and it is only by the directions of the glaciers and the external forms of the snow-fields, as well as by the crevasses, that we can picture to ourselves the form of the ground on which these ice-masses rest.

Still, it is possible to trace some of the broad lines of the irregularities of the relief, due to tectonic causes. The two principal islands of Palmer archipelago are traversed in the direction of their length by a chain of mountains having a well-defined direction from south-west to north-east, with, I believe, a gentle curvature to the east. The Biscoe islands certainly form the southern prolongation of this chain, while Trinity island is possibly that to the north-east. Moreover, from the few geological data which I could collect, this line of mountains forms likewise a zone of ancient eruptive rocks, with one or more volcanoes of tertiary, or possibly even of recent date. Wiencke island and the northern point of the coast of Graham Land form a similar chain which runs in a direction parallel to the first. As regards the mountains of Danco Land, they form more important *massifs* of granites, metamorphic and sedimentary rocks, while further inland there are also some masses of gneiss, as is shown by the erratics derived from that part of the country.

I am led to believe that the more detailed study of the geology of this "New Greenland" of the first navigators will bring to light analogies between the mountain system of these lands and that of the chains which form the southern extremity of the Andes, and that we are now in a position to formulate and discuss the theory of the "Antarctic Andes." The petrographic study of the rocks which I brought back will give us some data to work from. I propose to call this system of mountains the Copernicus range, and in this way to introduce, into our geographical maps, the name of the immortal Polish astronomer.

5. *The Antarctic Glaciers.*—The glaciers of the antarctic lands visited by the expedition are very characteristic, and differ so completely in appearance from the alpine, or even the arctic glaciers, that it would be difficult to describe them in a few words. The line of perpetual snow running very close to the level of the sea, and in places even at that level, one of the special features of glaciers, which is quite the rule in the case of those of the Alps and arctic regions, is completely wanting to the antarctic glaciers. The terminal portion of the ice-stream—that in which it is laid bare and melts under the influence of solar radiation and the higher temperature of the lower regions to which it has descended—which we have come to regard as quite characteristic of glaciers, is altogether or almost entirely absent. To their very extremities they are, in fact, included within the region of accumulation of snow—the zone in which they are continually enriched by the contributions made by atmospheric precipitation. This fact alone permits the occurrence on the antarctic lands of special types of glaciers, the most remarkable of which is that of ice-caps. The study of the alpine glaciers has led geologists to distinguish only the three forms of "valley glaciers," hanging or "corrie glaciers," and "regenerated glaciers." The idea of a glacier thus presupposes the presence of a valley. This idea is a mistaken one, for it is quite possible that the ice-stream may be wanting. This is the case in the Antarctic whenever it happens that the collecting-ground is sufficiently near the coast for the glacier to terminate at its greatest breadth in an ice-wall. In the antarctic regions perpetual snow can exist on level ground in so low a latitude as 65° , so that even small islands may bear a complete mantle of perpetual snow. On some small islets of less than a mile in diameter, we found a thick accumulation of ice entirely covering the inequalities of the ground, and forming in consequence convex glaciers. These ice-caps ended seawards in perpendicular walls, whilst on the surface they took the form of huge, perfectly even sheep's backs.

It is evident that this form of glacier will be found also on islands of larger extent, whenever the relief is sufficiently uniform to make it impossible for a peak to pierce through the glacial cap. As regards the thickness of these caps, it is plain that it depends on the plasticity of the ice and the extent of ground on which it rests. To my

mind the only difference which exists between these convex glaciers of the antarctic and the inland ice of Greenland consists in the incomparably greater extent of the latter, and in the fact that this does not reach the coast, but melts up into streamlets, and sends glaciers down towards the sea only through the valleys. But it is possible that there may be a sheet of inland ice more extensive even than that of Greenland. We may say that the great ice-cap supposed by Croll * may quite well cover the antarctic continent, since even small islands are seen to have the even and convex covering of ice laid down by Croll for the whole southern continent.†

On the other hand, it may seem surprising that the glacial caps are

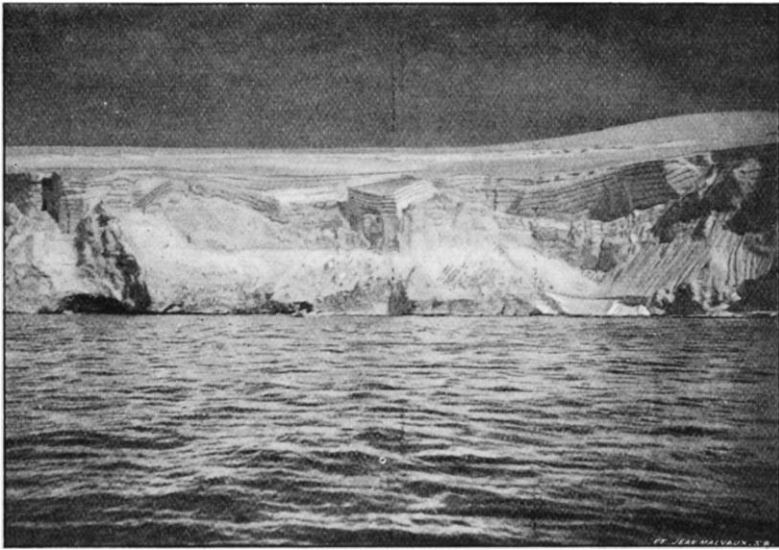


FIG. 5.—A CHARACTERISTIC ANTARCTIC COAST: FLAT GLACIER TERMINATED BY AN ICE-WALL, SHOWING STRATIFICATION OF THE NÉVÉ.

(Photo by Cook.)

not the sole type of glacier in these regions, where the line of perpetual snow is found at sea-level.‡ The reason is that most of the islands are

* 'Climate and Time,' 4th edit. (London, 1897), p. 374.

† Cf. Arçtowski, "Les calottes glaciaires des Régions Antarctiques," *C. R. Acad. Sci. Paris*, December 24, 1900.

‡ The question of the level of perpetual snow in the region of Belgica strait is a very complex one. Prof. Penck, who was present at an address that I delivered at the "Naturforscher-Versammlung" at Aix-la-Chapelle, was tempted to suppose that there might well be two lines of perpetual snow, one above the other, in that region. Low-lying fogs are, in fact, very frequent there, and these protect the snow from the effects of solar radiation, while, on the other hand, the clouds which most frequently give rise to atmospheric precipitation likewise rest very low. The summits and upper portions

too high in proportion to the area occupied by the base, and that therefore the mountains cannot fail to pierce through the coating of ice. The antarctic glaciers are not stationary, any more than those of other regions, and though they remain perpetually under the sway of winter, they still move on. The plasticity of the ice prevents its accumulation beyond a certain limit of height, and the mantles of ice must—even under extremely rigorous conditions of weather—be limited in thickness, while all the forms of the antarctic glaciers must be those of a semi-fluid mass. There are thus both ice-rivers and cascades, and also forms recalling the "corrie glaciers." But all are alike buried beneath a mantle of perpetual snow, and bare ice is nowhere seen. "Inland ice," properly speaking, does not exist on the large islands of the Palmer archipelago. On the other hand, on Danco Land and Graham Land, it is only the mountains situated near the coast which show themselves, while the whole interior of the land lying eastward is completely buried under the inland ice.

We must not, however, imagine that the antarctic lands are at the present day as heavily loaded with glaciers as they might be, for traces of a wider extension, dating doubtless from the glacial epoch, are still preserved. The presence of these vestiges of the glacial epoch seems to me remarkable for various reasons, and on this account I should like to bring forward some facts in support of my assertion. Gaston islet, our eighth antarctic landing-place, lying a mile from the coast, is a huge *roche moutonnée* perfectly polished on the surface. At the time of our visit it was almost entirely bare of snow. Opposite this islet, at Cape Reclus, there rises, along the coast, a large moraine running from north-east to south-west. An examination of the map of the lands discovered by the expedition shows that the direction of the moraine is that of Belgica strait, and we are led to the conclusion that the glacier which produced this moraine must have occupied the strait itself, which has at this point a breadth of 10 miles and a depth of 342 fathoms. Another argument is supplied by our seventeenth and eighteenth landings. On Bob islet, not far from Wiencke island, we discovered some well-preserved fragments of a moraine, from 15 to 20 feet high, resting against the sloping shore at a height of 80 feet above the sea. This moraine has the same direction as the channel, and its height decreases gradually towards the west. On it were some huge blocks of gneiss perfectly polished. The red granite is in the form of rounded boulders, and the same is the case with other rocks, while the diorite is often angular.

of the flanks of the mountains (1000 feet and over) are therefore subject to a climatic *régime* decidedly different from that which prevails at sea-level. The mean temperature of the air is possibly lower, but on the other hand the amount of atmospheric precipitation is less and the effect of radiation greater. This would explain the fact that the mountain slopes are sometimes bare of snow at an altitude of 1500 feet or even higher. It follows that the idea of two levels of perpetual snow is quite a plausible one.

On the other side of Belgica strait, exactly opposite the former spot, we discovered a fine moraine on Banck island. Its height was 65 feet, and its direction parallel to that of the strait. It rested against the sloping side of the mountain, which here displayed characteristic *roches moutonnées*. These moraines can only be explained as the product of an immense glacier which must have flowed through Belgica strait westward, *i.e.* towards the Pacific ocean. Other proofs of the former wide extent of the antarctic glaciers are furnished by the erratics collected in Hughes gulf, at our third, fifth, and sixth landings, as also by those found on Antwerp island at the fourteenth landing-place, where a bank of rolled pebbles and blocks extends for a certain distance from the shore. Further, in Errera channel, a remarkable moraine runs transversely across. Lastly, we frequently saw perfectly polished *roches moutonnées*, either along the shore-lines or on small islands.

The discovery of the former greater extension of the antarctic glaciers seems to me so important a fact to record, that I could not refrain from entering into these details. The discovery is interesting from various points of view. I will here merely call attention to a question which seems to me closely bound up with it—I allude to the climate of the glacial epoch. In fact, this question aroused a keen interest in me, from the moment when I noticed the morphologic analogy which exists between the southern extremity of South America and this northern point of the antarctic continent, and which suggests the question whether the more thorough study of the climates of the two regions and of the glaciers might not permit us to calculate the point to which the mean temperature of the air must have fallen during the glacial epoch.

This epoch has left its mark in both regions, and the aspect presented by the antarctic lands in our day seems to afford an indication of the condition of the channels of Tierra del Fuego during the glacial epoch. We are, therefore, justified in asking whether the existing climate of the antarctic lands in 64° may not be the same as that which prevailed in 54° during the ice-age.*

I am confident that the investigations of the next antarctic expeditions which may visit the two regions will furnish us with the key to the problem here indicated.

6. *Antarctic Icebergs*.—The icebergs of the arctic regions are, in general, of very varied form, and usually of small dimensions, although heights of 80 metres (260 feet) are frequently measured, and it seems that as much as 110 metres (360 feet) above sea-level may be attained.†

* H. Arętowski, "A propos de la question du climat de l'époque glaciaire," *Ciel et Terre*, March, 1901.

† E. V. Drygalski, 'Grönland Expedition,' vol. i. p. 381.

The tabular form has rarely been recorded, although the icebergs do show it near the glaciers from which they are derived, if the slope of the glacier is slight and the berg retains its original position of equilibrium after detachment.

The antarctic, on the other hand, is the region of immense tabular icebergs. In the southern seas, bergs several kilometres in length, and rising to a height of 60 metres (200 feet), have been frequently met with; ice-islands rising to as much as 500 metres (1640 feet) have been reported, but this is obviously a gross exaggeration. Erroneous views about the antarctic icebergs are very widely held.* Heim, for example, states that they are of marine origin, formed by successive thickenings of the ice-pack.

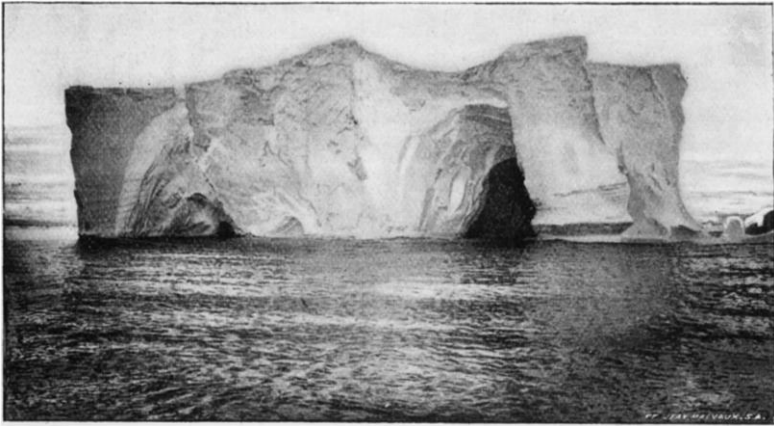


FIG. 6.—TABULAR ICEBERG WITH GROTTOS.

(Photo by Cook.)

In the seas navigated by the *Belgica*, we have seen as many as a hundred and ten icebergs at once, distributed all round the horizon. Forty per cent. of these would be of the characteristic tabular form, while the remainder resembled arctic bergs, or some form derived from the tabular. Large icebergs were rare; heights of 50 metres (164 feet) were quite exceptional, and the tabular bergs averaged only 30 to 40 metres (98 to 131 feet). The tabular icebergs are covered over with *névé*, and only show the alternate blue and white bands at the base. I only once had an opportunity of examining this stratification, in an iceberg which was enclosed in the pack, and displaced so that the strata dipped at a considerable angle. Both the blue and white bands were formed of glacier ice with the characteristic grained structure; the strata were not sharply separated from one another, the only difference between blue

* A. Heim, 'Gletscherkunde,' p. 270.

and white being that the ice in the latter was more porous, enclosing a large number of air-bubbles; the ice in both was compact. The supposition that tabular bergs are formed of sea-ice is entirely wrong. The mode of formation of the sea-ice shows that its thickness constantly tends to a limit, supposed by Weyprecht * to be 7 metres (23 feet) at a maximum, however low the mean winter temperature, and however great the number of years. I think Weyprecht's limit is too great for the antarctic regions. In any case, the continental origin of the antarctic icebergs is indisputable, for the bed of the Antarctic ocean is covered with terrigenous deposits and erratic blocks laid down by the melting of the ice, and these materials are transported to great distances from the glaciers from which they are derived.

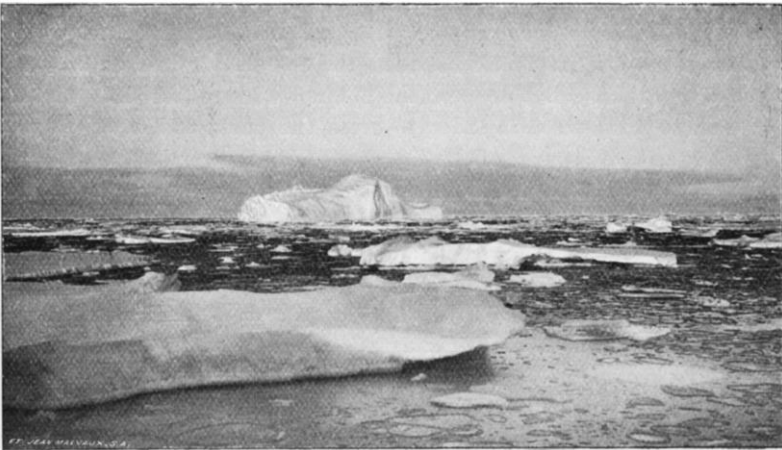


FIG. 7.—THE EDGE OF THE PACK.
(Photo by Cook.)

The majority of the great antarctic glaciers have a sufficiently gentle slope to produce icebergs of tabular form. It is probable, however, that most of the ice-tables do not come from these glaciers, but from the wide ice-cap which form the inland ice covering the low-lying land situated farther south. Both our soundings † and those of Ross have shown that the continental inland ice does not extend (on the continental shelf) beyond the isobath of 400 metres (1312 feet), and this may be taken as the maximum total thickness of the icebergs coming from the pole in the whole antarctic area of the Pacific. If one-eighth of the tabular icebergs appear above the surface, we get 50 metres (164 feet) as the limiting height of the bergs detached from the great ice-

* K. Weyprecht, 'Die Metamorphosen des Polareises,' p. 139.

† H. Arctowski, "The Bathymetrical Relations of the Antarctic Regions" (*Geog Journ.*, July, 1899).

barrier known to extend from Victoria Land to long. 170° W., and which doubtless continues eastwards to the land to south and west of Alexander Land.

7. *Attempts to penetrate the Pack.*—As soon as the *Belgica* entered the Pacific ocean, the surveys of the strait discovered being completed, and the season already well advanced, Commander de Gerlache was impatient to push his way as far south as possible. He hoped to attain a high latitude, being convinced of the existence of an open navigable sea, like those discovered by Weddell and Ross, beyond the zone of the pack. We could have explored the coast of Graham Land, and we could have effected a landing on one of the Biscoe islands, which would have added materially to our knowledge of the geology of the antarctic lands. As we were in sight of Alexander Land, it would also have been easy to ascertain if this land is continuous with Graham Land; in other words, whether the apparent break between the two is a strait or only the entrance to a fjord. But de Gerlache did not wish to lose time, and set his course to south-west, in order to cross the pack, which we entered. We were already south of Bellingshausen's route, and unexplored regions lay before us to west and south. In the light of the experience gained since, it is apparent that it would have been better to have followed the edge of the pack, and to have entered the ice much further to the west; but those things cannot be foreseen, and we made our first attempt in long. 80° W. The ice was very thick, and after a few miles' navigation in the pack further progress was hopeless, and we had to turn back.

A second attempt proved equally vain. In long. 81° W., we did not reach the 70th parallel. In long. 85° , however, the edge of the pack was more to the south, and on February 27 we reached lat. 70° S. without difficulty, the ice being navigable, and, aided by a gale, we made rapid progress. Here the pack was distributed in bands of ice but little compressed, and having free spaces of varying width between, through which the *Belgica*, driven by the wind, could break a passage. Finally we came to the close pack, which was quite impenetrable. With powerful machinery we could no doubt have proceeded further, but the *Belgica* became altogether immovable in lat. $71^{\circ} 30'$ S., on March 2, 1898. This latitude was never exceeded later by more than a few minutes.

No serious attempt was made to escape from our imprisonment. Wintering in the antarctic regions was part of the programme of the expedition, and it was just as well to do so where we were, in the moving pack, as to force a way out and return to a land station. Besides, in the explored land regions, we had only seen one place where wintering was practicable—at the twelfth landing in Lemaire channel.

The first days of our sojourn in the ice were very trying. Everyone naturally asked himself how long we were to remain, whether we were one day to escape and return home safe and sound, or whether

the pressure of the ice would crush our vessel, with consequences no one could foresee; every one regretted the work unfinished, and feared for the loss of the materials and observations already collected. But we became accustomed to our surroundings very quickly. On March 6, Amundsen, Cook, and I left the ship, and, going from one floe to another by jumping the narrow open channels between, made our first excursion. The weather was fine, and it was a pleasure to risk a visit to an iceberg, which, like ourselves, was a prisoner in the pack. The floes were small, and constantly moving, so that the recurring risk of jumping short and falling into the water added a spice of adventure to our journey. But all went well, and a very agreeable day gave us confidence in ourselves and hope that we should not lack means of amusement.

The seals and penguins were our very good comrades from the



FIG. 8.—ATTEMPT TO PENETRATE THE PACK.

(Photo by Arctowski.)

beginning; they took the greatest interest in all our affairs. The penguins, particularly the small ones (*Pygoscelis Adelix*), seemed to us remarkably intelligent, and we took great interest in watching them. They had an almost human appearance when walking across the snow, and, indeed, they had many human attributes, especially in their social customs.

We often met companies of six or eight or more penguins promenading on the pack in the sunshine. When they saw us they generally exhibited curiosity, and approached to get a nearer view. I do not know if these birds have the instinct of the naturalist, and take a lively interest, doubtless purely philosophic from their point of view, in everything new which presents itself, or if the object of their investigations is entirely practical, but they certainly came near

us with a distinct purpose of making examination. But if we had the misfortune to excite much curiosity, they became aggressive. One would first come close to us and reconnoitre, and then, on his order, the others would advance with a menacing air, and the battle began—a battle in which we sometimes had trouble to demonstrate effectively our superior strength. On one occasion we were able to observe that the penguins are musical amateurs. Unfortunately, we could not ascertain if they are equally able to appreciate "talent and classical music," for we had no *virtuoso* amongst us, nor indeed any musician, although we all, without exception, played numerous melodies and even operatic airs on the ship's barrel organ. But in any case—and the thing is worth noting—one of the sailors delighted to exercise himself upon the trumpet, and the penguins came from great distances to listen to him—no doubt to learn something new.

Often, very often, these brave penguins amused us, and when we were tired of preserved foods, specially with the Australian rabbits, they afforded us real succour, after we learned that the flesh of penguin is excellent eating. It is to be imagined that our existence in the pack was not of the gayest, however. Far from being ideal, the life of the polar explorer is often sad and monotonous. In the region where we were storms are frequent, and failing storms, fogs and snow-drift often rendered excursions impossible, and sometimes we were unable to walk about even close to the ship. Then at times the ice would open up, and the floes press against each other and break into fragments. These squeezes were most uncomfortable to watch when in the immediate neighbourhood of the ship, and hearing the grinding of the ice, the groans of the ship, and the trembling of the rigging as she rose and fell again, we experienced sickly sensations which may be imagined—we realized the gulf which separated us from the abysses of the ocean, and we longed for the land.

The *Belgica* was only once seriously nipped during the autumn months; but she held out, and the ice, which broke under the pressure on the starboard bow, went under the hull. The pack took a long time to consolidate. Whenever the wind fell the floes united, and the snow-drift over the surface of the ice helped to transform it into an unbroken plain. But as soon as the wind sprang up, the ice gave way again. Thus it was only with the cold, as it became more and more intense, that the floes consolidated. The ruptures grew further and further apart, and our situation became gradually more secure. Ultimately the *Belgica* was fixed in the middle of a field of ice, to which she was attached as if built in it; this we called "our floe." After this it was only from afar that we heard the noise of the ice after the wind had ceased to howl in the rigging, and the ice was yielding to pressure. And often in the silence of the night, lying in my berth, I put my ear to the wall and listened to hear what was happening a long way off.

8. *Investigations.*—I observed the *aurora australis* for the first time on March 14, when I witnessed a remarkably fine display, which impressed me greatly. The play of light was extremely varied, exceptionally so in this particular case, and the phenomenon presented a most imposing spectacle. The horizon amongst the ice was entirely free; we had the whole vault of heaven before us. I will not again describe the scene, but will refer those who are interested to my preliminary notices, and to the special memoir on auroræ published in the reports of the *Belgica* Expedition.* As the last-named publication is still in the press, I may give some notes on our scientific work generally. As soon as we had definitely resolved to winter in the antarctic, we had to organize an observing station. This station was not fixed. Our floe turned so as to displace the bow of the ship, but only slightly, and ultimately the direction remained—in spite of the drift—almost constant. The icebergs visible on the horizon had a motion scarcely different from our own; we kept them in sight nearly the whole time. During the drift the floes usually moved *en bloc* over a wide space, but occasionally they changed their positions (after a strong drift), so that one occupied an entirely different place relatively to its neighbours. This was at least the case as shown by the icebergs, which were fixed in the floes in the same way as the *Belgica*.

Lecoite made frequent astronomical determinations of position, and deduced therefrom the direction of drift. For this purpose a wooden hut was erected on the port side of the ship, quite close to it, and electric communication was established so that Dobrowolski could note the chronometer on board, while Lecoite himself observed the stars in the artificial horizon. During his observations in "his observatory" Lecoite was certainly sheltered, but as he often remained there without moving, he generally returned on board with his fingers half frozen. We were always eager to hear the result of the calculations. On May 31 Lecoite announced lat. $71^{\circ} 36'$ S., the highest we attained during our drift. Sometimes we moved northward with southerly or south-westerly winds—this we heard with joy; but with change of wind we would again go towards the pole, or eastward or westward, and so we wandered from place to place, sometimes back in our old position, sometimes far to the westward. Apparently we remained immobile, for everything round us followed the same course; we always took our dreary scenery with us. The drift of the *Belgica* with the ice is the longest experienced by any vessel; the chart shows that the movement of the pack was guided by an obstacle to the east and south of us, and the existence of land in those directions is further indicated by our soundings. Depths diminished to the south and east, and my

* H. Arętowski, "Aurores australes" ('Rapports scientifiques sur les résultats du voyage du S.Y. *Belgica*').

bathymetrical chart, published in the *Geographical Journal*, shows that during nearly all the time we were on a continental plateau. The pack in which we were may be regarded as a coastal pack, no doubt of great extent, but different in every respect (especially with regard to its movements) from the pack of northern polar regions. It is possible that in some years the pack becomes detached like that in the Ross sea, but the observations of Cook and Bellingshausen, as well as our own, in 1898 and 1899, indicate that this must be exceptional. I am of opinion that the great Graham Land peninsula forms an anticyclonic region, so that, far from driving the ice towards the ocean, the prevailing north-easterly winds of the summer months send it southward; but in the Ross and Weddell seas the same anticyclonic winds produce the opposite effect, because, as they come from south-east, they are diverted towards the north, Victoria Land being, in all likelihood, equally a region of high pressure. The forthcoming English expedition should decide this question.

On board the *Belgica* I took every opportunity of making soundings; the soundings were usually accompanied by observations of temperature, and the collection of samples of water for the estimation of density.

Racovitza made frequent use of the vertical net for the collection of plankton; and, thanks to the drift, he was also able to explore the bottom. He employed the trawl, with swabs, and was but little satisfied because these cumbrous appliances were brought up, after much labour, filled with pebbles which only went to enrich my geological collection, about which he cared little! The antarctic plateau is entirely covered with boulders, brought by the icebergs from distant land, and the sediments are for the most part terrigenous. But Racovitza's take did not consist exclusively of pebbles; he obtained good hauls of animals entirely new to science, and, as everything was carefully preserved, he has brought back a collection of great value. His treasures are now in the hands of competent specialists, and will furnish an important contribution to biogeography.

Our lamented Danco, who had constructed an observatory on the pack, did his best to obtain reliable observations of the magnetic elements, under the unfavourable conditions.

The hourly meteorological observations carried on by Dobrowolski and myself formed our principal occupation. When it snowed, the snow-crystals were examined and described; when there were clouds (particularly cirrus), Dobrowolski attempted to follow all their transformations, and especially to ascertain the direction of movement; and any optical phenomena were studied with the greatest care. Thus the days passed, not too quickly sometimes, in constant and assiduous labour.

9. *The Wintering*.—On May 17 we saw the sun for the last time. According to calculation, the centre of the sun was 40' below the horizon

at noon on that date, and it was, therefore, because of refraction that we were able to observe half the disc, travelling along the horizon, for over an hour. For reasons which I am unable to explain, the appearance presented by the sun was very variable; at one moment it seemed flattened, almost square, at another notched and jagged. Such anomalies in the refraction of objects on the horizon are often observed in the polar regions.

From this day, we were not to see the sun again for two months. At the beginning we did not dread the prospect of this long polar night before us, but before the sun had been gone many days one of us became very ill. Danco lacked the constitution to hold out, and on June 5 he died. It is useless to dwell on sad recollections. He was loved on board the *Belgica*, and this loss, following on the death of the sailor Wiencke, who was washed overboard by a wave in Bransfield strait, made a deep impression on us. In the obscurity of the midday twilight we carried Danco's body to a hole which had been cut in the ice, and committed it to the deep. A bitter wind was blowing, as with bared heads, each of us silent and sad, we left him there . . . and the floe drifted on.

In the antarctic regions, thanks doubtless to the detestable climate, the disastrous effects of the polar night are far more marked than in the north. There is a general lowering of the system, and the heart acts feebly. Several of us developed serious symptoms, and without daily care on the part of the doctor, others would not have survived the period of darkness, though it was relatively short. One part of Cook's treatment was very effective and ingenious. Those who were most affected by deficient circulation were made to stand in a half-naked condition close to the red-hot stove, for several hours daily. In this way the action of the solar radiation was in part replaced by rays of artificial heat—in a manner admittedly primitive, but none the less beneficial.

Life on board during the polar night was of great interest from a psychological point of view. One finds one's self in conditions of existence altogether abnormal, and crowded against one's fellows in an uncomfortably narrow space. Some became nervous, excitable, and sleepless, with the imagination continually wandering and dreaming. I was one of these. Others, more happily constituted, became chronically tired and indifferent; these slept much. But everybody was content to spend twelve hours a day, or more, in bed. One of the crew developed maniacal tendencies; another, in more evil case, was brought home insane. Since the return of the expedition, one of our best men, Knutsen, has died, doubtless from heart disease contracted in the antarctic.

On board the *Belgica* we tried to amuse ourselves, during the dark days of winter, as best we could. We read much, but our library was

inadequate. Personally, I should greatly have liked an encyclopædia, and some Polish tales; a single volume of Sienkiewicz, which I happened to have with me, was read and re-read with great pleasure. We spent our evenings playing cards, and although I have always had a great aversion to cards, and indeed to games in general, I confess to pleasant hours spent at whist. We had to play for something, and as we had no money, we gave notes of hand (which we had not the remotest intention of honouring) for sums of 100 to 10,000 francs, and risked the most hazardous combinations. Sometimes the bank held



FIG. 9.—THE "BELGICA" DURING THE WINTER NIGHT.
(Photo by moonlight, Cook.)

100,000, or even a million; we amused ourselves like children in making and losing fortunes.

Personally, I retain many pleasant recollections of the polar night, for I made meteorological observations after all the others had gone to bed; and, in the profound silence that reigned on board, alone in my laboratory, I rejoiced in the solitude. Between the hourly observations I was able to read a great deal, and to profit by the perfect tranquillity, so difficult to obtain under ordinary conditions.

The sun reappeared on July 23. With its return our torpor disappeared, and gave place to general activity. Our usual work was resumed, and we were again able to venture on the ice. Lecointe, Cook, and Amundsen even risked a long expedition, taking with them provisions for fifteen days, a fur sleeping-bag for three, and a tent.



FIG. 10.—FORMATION OF "RASSOL FLOWERS" ON THE NEW ICE IN AN OPENING PRODUCED DURING THE DRIFT OF THE PACK.

(Photo by Cook.)

They stayed out for a week, but did not make much progress, for, after a strong breeze, several channels formed in the ice-field, and they had the greatest difficulty in regaining the ship in safety. We had no kayaks, and the practical result of this little expedition was to show that without them all attempts to traverse long distances on the pack must be futile. It was also made evident that it is impossible to go far from the floe on which an expedition is encamped without running grave risks of being unable to find a way back. For this reason I do not appreciate the opinion of a German critic, who has expressed surprise that we did not try to attain a high latitude on the pack, by following a direct route to the pole. The great problem is to find the position of the ship when it is time to return to it. If we had left the *Belgica* on August 10, in lat. $70^{\circ} 50' S.$, long. $86^{\circ} 30' W.$, we should have had to find her again, one month later, on September 10, in lat. $69^{\circ} 50' S.$, long. $82^{\circ} 40' W.$, and I greatly doubt if my German critic, even with the most favourable hypotheses, could have accomplished this *tour de force*.

With the return of the sun we made an effort to discontinue our régime of preserved food, and to live entirely on fresh "beef-steaks" of seal and penguin. It is extraordinary how the change pleased us. We ate nothing afterwards on the *Belgica* but the delicious "penguin beef-steak," which has not, it is true, much resemblance in flavour to the ordinary beef-steak, but is none the worse for that.

10. *The Icepack*.—The expeditions on the ice were not made exclusively

with the intention of filling our larder, for in most cases it was not necessary to go for hours along the edge of the waterways to get penguin and seals; as a rule, we got more than were needed. But the exercise did us a great deal of good, and we willingly undertook long excursions.

Whenever the weather was not foggy we could easily discern the aspects of the pack, and I gladly profited by some fine days to photograph the varied forms presented by the surface of the frozen sea. The rigid crust of the frozen ocean well deserves special study from a geographical standpoint. The numerous descriptions of the pack-ice of north polar regions, which have been left to us by the older voyagers, and especially those of Weyprecht, lead me to suppose that the antarctic ice differs from it in several respects. The characteristic feature of the southern pack is the thick layer of snow which lies on it all the year round. Except for the young ice, which forms in the open channels, is broken up by every movement caused by the wind, and often presents a bare glassy surface, the floes resemble an immense plain covered by a thick mantle of snow. The weight of this snow is so great that the ice is often depressed below the water-level, and the base of the snow is transformed into blue, granular, compact ice, very different in its physical properties (composition, structure, etc.) from the ordinary ice produced by the freezing of sea-water. The fallen snow is changed into *névé* under the influence of solar radiation and frequent changes of air temperature. Under the action of wind, freshly fallen snow is drifted



FIG. 11.—INFLECTIONS OF THE ICE PRODUCED BY PRESSURE; FORMATION OF ICE-HUMMOCKS.

(Photo by Arctowski.)

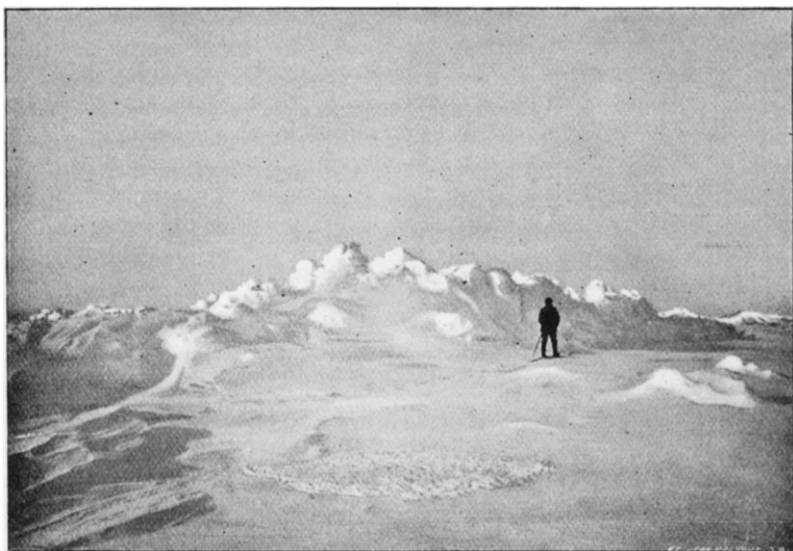


FIG. 12.—AN OLD PRESSURE-RIDGE IN THE PACK.
(Photo by Cook.)

over the ice-field like sand across a desert, and whenever an obstacle like a hummock is met with, small dunes, or ripple-marks, or long trails, clearly indicate the direction of the wind. The kumatology of snow was specially interesting in the region of "pressure hillocks," and I have taken many photographs illustrating the description which I shall give of these varied phenomena in a special memoir of the *Belgica* reports. I have spoken of regions of "pressure hillocks." I may explain that after the polar night and later, during the summer, the rigid surface of the Antarctic ocean became markedly different in appearance from when we first entered it. The small floes joined together, so that the independent units became larger and larger, till they were sometimes several miles in diameter. From the crow's nest of the *Belgica* we could see the whole of our floe, and the neighbouring floes pressing hard on it and on each other, all of them fringed with hummocks. These little elevations were regions of true folding and faulting, and of great interest on closer study. Miniature mountain chains, they had all the characters of the great ranges of the earth, for all the traits of a mountain range were present, except those due to running water and volcanic action; a "structural surface" altered only by a leveling agent *par excellence*, drifted snow. I will not commit myself to a maze of description; I only wish to point out one analogy. The distribution of gravity on the surface of the continents presents many strange anomalies. Amongst these, modern research seems to have disentangled one general principle—that the value of

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gravity (reduced to sea-level) is less in a mountainous region than in contiguous plains. It seems as if there were empty spaces under the mountains, as if where the crust is crushed and squeezed so as to form ridges on the surface, the denser magma is found at a greater depth than elsewhere. This principle goes by the name of *Isostasy*. The isostasy of fold-ranges compels us to admit that the masses of the crust which have been compressed along a line, forming a chain of mountains on the surface, are equally depressed into the dense magma of the interior, so that a corresponding chain, composed of relatively light material, faces towards the Earth's centre. It seemed interesting to test this hypothesis for the miniature ice-ranges which were formed along a line perpendicular to the direction of pressure, and to ascertain the conditions of equilibrium of the hummocks. I therefore measured the thickness of the ice in different places, and made a series of borings (with a small geological boring tool) along a line perpendicular to the alignment of one of the hummocks. The result is important, for I found under the hummock a symmetrical protuberance much larger than that emerging above the surface of the sea. The hummock was therefore in perfect equilibrium, the ice accumulated below displacing a volume of water sufficient to keep the little range perfectly stable, and therefore to make it permanent. The greatest thickness I measured in this particular case was 9 metres (29.5 feet); but as this was in a hummock which raised itself scarcely 2 metres ($6\frac{1}{2}$ feet) above the sea surface, I am led to suppose that in the regions where the ice is greatly crushed and dislocated the maximum thickness may be 15 metres (49.2 feet), or even more. Such, however, must be regarded as exceptional cases, due to pressure. In normal circumstances the field-ice may be taken as about



FIG. 13.—ASPECT OF NEW HUMMOCK PRODUCED BY THE COMPRESSION OF TWO FLOES.
(Photo by Aręłowski.)

2 metres ($6\frac{1}{2}$ feet), or, in the case of ice several years old, not more than 3 to 4 metres (10 to 13 feet) in thickness. The freezing action clearly tends to a limit which cannot be surpassed, however low the temperature. This is the invariable result of measurements in the arctic regions, and it is entirely supported by our measurements during our wintering in the antarctic.

11. *Summer in the Ice.*—The greatest cold we experienced occurred in September; on the 8th the thermometer sank to -43° C. (-45.4° Fahr.), an extreme temperature when one considers that we were very far from land, and only in 71° S. lat. We took advantage of the sunshine when it came, following the example of the seals, who lay motion-



FIG. 14.—DRIFTED SNOW BURYING OLD HUMMOCKS.

(Photo by Arctowski.)

less on the ice for hours together enjoying sun-baths. When there was no wind we felt warm at a temperature of -15° C. (5° Fahr.), and even -25° C. (-13° Fahr.), which is easy to understand, as evidently the temperature of the air did not indicate all the heat we felt, and we had only to go into the shadow to feel the difference.

In the antarctic there are strong equinoctial storms, which follow close upon one another. The storms which preceded the establishment of the summer régime were accompanied by tremendous snow-drifts, and as the *Belgica* presented an obstacle to these, large quantities of snow accumulated, and at length almost buried her. It became necessary to extricate her, and the work had to be done quickly, as she threatened to sink gradually, dragged down by the enclosing ice. But we succeeded in clearing all the snow and ice down to sea-level, and the ship raised herself out of the ice in which she had been nipped. Future expeditions may profit by our experience; at the beginning

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of favourable weather the ice should be entirely cleared away from the ship, so as to leave her free to move if the pack opens.

12. *Leaving the Pack.*—Until December we had every confidence that the sun would melt the ice and break up the floes to such an extent that we could make our escape easily. But when December had passed, and the sun made his daily tour of the horizon without melting anything, we felt ourselves deceived. The lanes certainly opened more freely, and although the thermometer fell to -14° C. ($6\cdot8^{\circ}$ Fahr.), the young ice ceased to form. Everything seemed to promise that the *Belgica* would soon be in an open channel, and making her way gradually to the edge of the pack. But our big floe would not give way; there we remained, at the mercy of fate, helpless in the middle of an ice-field several miles in circumference. We had to keep up our courage, although our provisions were coming to an end, and rather than face a second winter we should have to leave the ship. We would not have died of hunger, for penguins were plentiful, but we should have had to prepare seal-oil for lighting purposes, and as our coal would have run short, we would have had to depend on seal-fat for heating. In effect, we should have had to lead the life of Eskimo, and after the experience of one winter in the ice, we had enough of it. So we resolved to attack our floe with the explosives with which the expedition was provided. We carried a large supply of tonite, but experiments at low temperatures had previously shown us that the effect of this explosive on the ice was practically *nil*. Bombs laid on the surface produced no effect at all. We obtained better results afterwards with mines, laid in the ice, and these led us to make experiments on a larger scale. A hole was bored through the ice about 500 metres (1640 feet) ahead of the *Belgica*, and in this we placed a barrel of dynamite, about 3 metres (9·8 feet) below the surface. Several long fuses were lighted, and while they burned we removed ourselves as far away as possible, believing that the explosion was about to blow a good part of our floe into fragments. Nothing of the sort happened. The spectacle was imposing: a terrific report was heard, a sheaf of pulverized ice and water rose to a height of 50 metres (160 feet), but there was no fracture, not even a crack in the ice. We had to give up all idea of explosives.

After doing some work in a direction leading the shortest way out of the pack, we perceived that this route was hopeless, for we should have had to cut through three lines of hummocks, where the ice was very thick. But a closer examination of our floe fortunately revealed an old fracture, close astern of the ship, on which the ice was only from $1\frac{1}{2}$ to 2 metres (4·9 to 6·6 feet) in thickness. Along this we cut a channel 700 metres (2297 feet) long, and wide enough to allow the passage of the ship. The task was long and arduous, but as it was a matter of life or death to us, and as it was equally urgent that the results of our scientific work should not be lost, it was no use hesitating, and the work went on cheerily, day and night, for a whole month. As we

had only three saws, we could not all work together, so we divided into two parties, one working by day, the other by night. We had no want of light, for the work was done during January and February.

The method ultimately employed was very simple. Starting from the edge of our floe (AC, Fig. 15), two lines AB and CD were cut; then EF, and the triangle AEF was detached and pushed out of the way. Next the line GH was cut, and the quadrilateral ECHG removed; then EK,

and another polygon was free. Thus we got rid of the ice piece by piece, and as each slab had to be pushed out, the channel already cut was kept open.

The work was almost completed when a storm came upon us. Strong pressure was brought to bear on the pack, and the unfinished part of our canal gave way. Then the *Belgica* was nipped between two large floes, and as the swell from the ocean reached us B

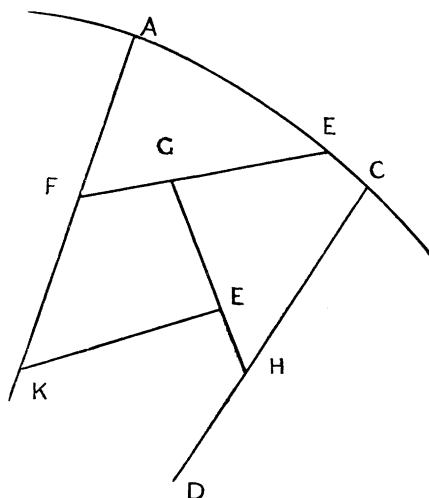


FIG. 15.

from outside, these crushed and left the vessel alternately with every wave. We had three days of anguish, three days in which we could not tell what a moment would bring forth, for the shocks followed one another without ceasing, and the *Belgica* might yield to the pressure at any moment. But it turned out otherwise. The sea went down, and after some more labour, aided by a free use of our tonite, the *Belgica* was finally delivered on February 14, 1899.

We made rapid progress through the ice, northwards this time, for a whole day; but then, on the edge of the pack, our way was completely barred by a number of small floes, packed close together. We were drifting rapidly to the west, and ahead of us innumerable icebergs were passing; it seemed as if the pack were surrounded by a belt of bergs, through which we must pass. It was only after a long month's waiting, tossed about all the time by the ocean swell, that we got a chance to escape to the open sea, towards which the water-sky to the northward had all the time been showing us the way.

The *Belgica* left the pack on March 14, and on the 28th we were back in Punta Arenas.

Conclusion.—I do not think this short account of our adventures should discourage future voyagers in the antarctic pack-ice, but rather the contrary. The *Belgica* Expedition has shown that a small vessel, provided with only a small auxiliary engine, can enter and remain

in the pack with every confidence; and further, that one can get out again and return home safe and sound. But the important fact established by this first wintering in the antarctic is that the new method of exploration, first tried by Nansen in the *Fram*, can afford excellent scientific results. The value of the results of the *Fram* Expedition has been indicated by the two volumes of the report already published, and I can affirm that the scientific results of the Belgian Antarctic Expedition, of which the report is in the press, will form a really valuable addition to our knowledge of the antarctic regions, notwithstanding the comparatively limited resources at the disposal of the commander and the scientific staff. Again, I repeat that the new method of exploration of polar regions is extremely fruitful, and that its application should be widely extended.

Before the reading of the paper, the PRESIDENT said: We welcome here this evening one of the principal members of the scientific staff of the Belgian Antarctic Expedition, which, as you will remember, wintered in the antarctic pack in the years 1898-99. We have every reason to admire the work that has been done by this scientific expedition under great difficulties. The funds which were collected for that expedition were very small, very small indeed. I remember going over the ship in August, 1896, with Captain Gerlache, and thinking how very small the accommodation would be for purposes of a polar voyage; but M. de Gerlache found numerous volunteers, men of distinction in science, to accompany him, and Mr. Arctowski, who was constant in his observations throughout the winter, and who also made a number of very valuable observations on the land that they discovered, is now with us this evening. I am sure we shall all be extremely interested in what he has to tell us, and in the views which he will be able to give us on the screen, and we shall give him a very warm welcome at the end of his address. I now call upon Mr. Arctowski to read his paper.

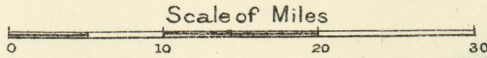
After the reading of the paper the following discussion took place:—

Dr. W. T. BLANFORD: I am sure that everybody will have listened with very great interest to the accounts Mr. Arctowski has given us of the antarctic regions. But whilst we have listened with very great pleasure to his description of adventures, the points in his accounts which will, I think, attract most attention relate to scientific observations. The additions to geographical knowledge appear at first not to be very great: an additional sound has been found, a number of small islands have been mapped and named, and there it may at first seem that the geographical part of the discovery terminates. I can only say that I think more important geographical observations have been made than those which are connected with the additions to our maps, valuable as these are, and although the subjects were necessarily, in the abridged account to which we have just listened, passed over very lightly, there are two points to which I should like to call attention. In the first place, Mr. Arctowski has made some most valuable observations on the older glacial action in the southern hemisphere, and the most important of these are perhaps at Terra del Fuego, where Mr. Arctowski has shown very clearly that the glacial conditions at no very distant geological date were greater than they are now. He has found moraines and other evidences of glaciers where no glaciers now exist; he has shown that exactly the same phenomena occur near Cape Horn which are so striking in parts of Europe. Now, I cannot say that no observations of ancient glacial evidence have been made in South America before, because I have heard of some; but they were rather opposed to Mr. Whymper's very important observations

SKETCH OF DANCO LAND THE BELGICA STRAIT AND PALMER ARCHIPELAGO

AND PALMER ARCHIPELAGO

Surveyed by
CAPT. G. LECOINTE.
1898.



Track of the 'Belgica'

64

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