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Review: Dr. Nansen's Scientific Results

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Cape Flora in the years 1894-97, were of small intensity; they were always of a whitish tint, and, beginning at the north-east, extended in the form of arcs and curtains towards the south-west.

Animal life was not abundant. The most common form was the polar bear, of which forty specimens were shot. Several of the birds already recorded in Franz Josef Land were observed. Ross's gull, hardly ever seen in Franz Josef Land, is also absent from Rudolf island, though occurring in large numbers on the neighbouring Hvidtland. Of plants thirty-nine species were collected, belonging to six genera of phanerogams and six of cryptogams.

The geology of the island, as far as can be judged from the brief remarks of the Duke of the Abruzzi to the Italian Geographical Society, is precisely similar to that of the more southern islands investigated by Dr. Koettlitz. There is the same basalt forming the mass of the island, and silicified wood was found near Cape Germania. A granite pebble on the same cape is an indication that the island was once submerged like the other islands; and a reindeer's horn at a height of more than 150 feet above sea-level and about 600 yards from the shore may, perhaps, have rested on a raised beach, as similar remains do on the coasts within the range of Dr. Koettlitz's examination.

It seems most probable, then, that the scientific results of this expedition other than geographical will simply confirm the conclusions previously arrived at, and render somewhat more complete our knowledge of the meteorology and magnetic variations in Franz Josef Land. The principal object of the expedition was to reach the pole or, at least, a higher latitude than had before been attained. In this it was successful, Captain Cagni having beaten even Nansen's record, and Italians are justly proud of their first achievement in arctic exploration.

DR. NANSEN'S SCIENTIFIC RESULTS.*

THE two substantial volumes of the scientific results of the drift of the *Fram* and Dr. Nansen's adventurous journey over the ice, which have recently been published, give very full details of certain parts of the work, some aspects of which it may not be out of place to consider. We propose to refer specially to Prof. Geelmuyden's discussion of the astronomical observations, not only because of the able and thorough manner in which the author has handled his subject, but also because of the discrepancies between the positions fixed by observations, as finally calculated, from those provisionally accepted on the return of the expeditions. Our object is merely to

* 'The Norwegian North Polar Expedition, 1893-96.' Scientific results, edited by Fridtjof Nansen. Vols. i. and ii. Published by the Fridtjof Nansen Fund for the Advancement of Science. Christiania and London, 1900-1901.

place before those of our readers who may have been puzzled by the contradictory statements, a brief explanation which we trust will set the facts in their proper light. To begin with, we must deprecate the practice which has prevailed for many years of claiming credit for attaining a higher latitude than any predecessor, on account of a few minutes of arc in the calculated position. It is necessary to remember that a degree of accuracy which may be demanded in an examination or striven for in navigating a vessel in open water, is absolutely unattainable in polar regions, where the personal difficulties of observing in a very low temperature are combined with the unknown and unascertainable variations in refraction, the very low altitude of the sun, and the impossibility during the long polar day of seeing distinctly any other heavenly body.

In Dr. Nansen's case he out-distanced the best of his predecessors, not by miles, but by whole degrees of approach to the pole, and it is absurd to suppose, as some people actually appear to have done, that he attached any importance to the precise number of minutes by which he exceeded 86° . The great merit of his scientific work lies in quite another direction. It consists in the fact that by an exhaustive discussion of the observations of previous travellers he deduced the existence of a current or drift of water and ice across the north polar area, from the Siberian towards the Greenland coast, that he designed a practicable means of testing this theory, and that he proved it to be correct.

We question whether any practical traveller or geographer would find anything to excite surprise in the differences between the positions as first announced and as subsequently determined by the calculations of an experienced astronomer. The positions assigned to points of observation in the text and map of 'Farthest North,' and in other early publications, were only what they were expressly and repeatedly stated to be, of a provisional nature intended to give a rough general idea of the expedition, which would serve until more accurate computations became available. The public insisted on the very earliest information, and have no right to complain of the provisional nature of the first reports of scientific results. The complete discussion of the multifarious and complicated observations (astronomical, magnetic, meteorological, geological, oceanographical, etc.) could only be undertaken by specialists, whose labours would necessarily extend over many years, and, in fact, much of it is still uncompleted.

The discussion of the numerous astronomical observations has, however, now been finished under the supervision of Prof. Geelmuyden, and published in the second volume of the scientific results, with two new and excellent charts showing the routes of the *Fram* and those of Dr. Nansen and Lieut. Johansen. These final results, of course, differ from the preliminary and provisional values assigned in 'Farthest North,' and the differences are, as is not surprising, most conspicuous in the

results of the observations made for longitude during the first months of the sledge journey.

The provisional results had to be based chiefly on calculations made during the journey, with such rough corrections as appeared to be necessary after obtaining the correction of the watches (which had stopped on the journey) from Mr. Jackson at Cape Flora. There was no time after arriving at Cape Flora, still less immediately after returning home, to recalculate all the observations, and as a matter of fact Dr. Nansen was only able to compute some of the observations made in and near Franz Josef Land.

The result of Prof. Geelmuyden's work is to show the following facts:—

(1) The error in the assumed Greenwich time adopted after the regrettable stoppage of both Dr. Nansen's watches on April 13, 1895, is shown to be smaller than Dr. Nansen believed it to be on his return home. He estimated it in 'Farthest North' at 26 minutes (corresponding to $6^{\circ} 30'$ of longitude), while it now appears to have been only 15 minutes (corresponding to $3^{\circ} 56'$). This seems no very improbable mistake (deplorable as the occasion of it unquestionably was), as it means merely that, possibly on account of drifting of the ice, the travellers had been carried about 16 miles to the eastward of the position indicated by their carefully kept dead-reckoning.*

(2) The rate of Dr. Nansen's watch is shown to have been considerably greater than he assumed it to be from observations made before leaving the *Fram*. Thus the error in the assumed Greenwich time was always increasing during the month's journey, until it was as much as 29 minutes at the place where the winter hut was built, the position of which was fairly well determined by two different methods. The difference of the position worked out by Dr. Nansen in 1896 did not, we believe, differ by more than 2 miles from that determined by Mr. Armitage of the Jackson-Harmsworth expedition.

(3) A somewhat important result of Prof. Geelmuyden's discussion

* A few mistakes occur in the original longitudes calculated during the journey and quoted from the diary in 'Farthest North.' Thus on May 9, 1895, the longitude was given as $64^{\circ} 20'$ E., but it should have been $63^{\circ} 24'$ E., according to the correction for the watches assumed at the time, and Geelmuyden shows that the true longitude was probably about $67^{\circ} 47'$ E. On May 27, 1895, Dr. Nansen informs us that the longitude of $61^{\circ} 27'$ E. was given by a slip of the pen for $59^{\circ} 7'$ E., which it should have been with the assumed watch correction; Geelmuyden finds that the actual longitude was about $63^{\circ} 52'$ E. This is 30 miles east of the position where Payer placed his Petermann Land, which the Duke of the Abruzzi's expedition has now proved to be non-existent. In the maps published in 'Farthest North,' but not drawn by Dr. Nansen personally, there are several errors, such as placing the farthest north point in 90° E. instead of 95° E., the position which is repeatedly mentioned in the text, and which Prof. Geelmuyden has now shown was really $96^{\circ} 30'$ E. The text of 'Farthest North' contained several mistakes which did not occur in the Norwegian version, which must be looked upon as the authentic original of the book.

of the astronomical observations is, in his own words, that "there is another difficulty which for a certain period of the expedition is more serious than the stopping of the watches." This is that during April and May, 1895, nearly all the altitudes were measured with the sextant from the natural horizon. Two sets of observations made on April 2, 1895, one with an artificial, the other with the natural, horizon, seem upon closer examination to prove that in the special meteorological conditions (with temperature below -22° Fahr.) the natural horizon was lifted perhaps 8' or 9', on account of irregular refraction, corresponding to a difference of nearly 10 minutes of time in the watch-error. This fact necessarily introduces considerable uncertainty into the determination of longitude, on the sledge journey in March, April, and May, 1895. It should serve as a warning to future arctic or antarctic explorers never to make use of the natural horizon when a theodolite or an artificial horizon can be employed. The sextant and natural horizon are, of course, the most convenient for use, and decidedly the least unpleasant at temperatures of from -30° to -40° . Still, the additional trouble and even the risk of frost-bitten fingers should not be considered in the case where, as in those high latitudes, an error of 1' of arc involves an error of 1 minute of time in the watch-rate. On the other hand, of course it must not be forgotten that in latitude 86° even an error of several degrees in longitude is comparatively unimportant, as 1° of longitude is equal to only 4 miles of distance, and even in 84° N. 1° of longitude does not exceed 6 miles. Thus the least accurate observations on Dr. Nansen's expedition were precisely those where the error corresponded to the least distance on the ground. The observations taken later on approaching Franz Josef Land were fairly accurate, as they were to some extent taken with the theodolite. As these observations supply data for controlling the error of the watches the latitudes and longitudes of the latter part of the sledge-journey may be looked upon as fairly accurate, as they are reproduced in the sketch-map of Franz Josef Land made at Cape Flora and published in 'Farthest North.'

It is pointed out that since the meteorological conditions on April 7, 1895, were almost the same as on April 2, it is probable that the latitude of the last meridian altitude taken towards the north should not be $86^{\circ} 13' \text{ N.}$ (or $86^{\circ} 12' 5$, as Prof. Geelmuyden makes it), but only $86^{\circ} 4' \text{ N.}$ As Dr. Nansen walked some distance northwards after the observation was taken, his extreme latitude may be placed at a minimum of $86^{\circ} 5' \text{ N.}$ instead of $86^{\circ} 14' \text{ N.}$

We believe that Dr. Nansen most fully accepts all the corrections of his preliminary results, and we consider that he is to be congratulated on the manner in which Prof. Geelmuyden's searching criticism has established the substantial accuracy of what, though undoubtedly an important part of his work, is after all only subsidiary to the great objects he had in view.