ART. IX.—*On the Cause of the Annual Inundation of the Nile;*
by WILLIAM FERREL.

It is remarkable that the source of the Nile, and the cause of its annual inundation, notwithstanding its historic importance, have remained unknown even to the present time. Several expeditions in modern times have ascended the White Nile, which is the principal branch of the Nile, with a view of discovering its source; but the furthest point yet reached, it seems, is in latitude $3^{\circ} 50'$ north, and longitude 31° east. The late discovery by Captain Speke of lake Nyanza, having its southern limit in latitude $2^{\circ} 30'$ south, and longitude $33^{\circ} 30'$ east, and said by the natives to extend in a northern direction 300 miles, renders it probable that it is the source of the Nile, but it is by no means certain.

Of the theories which have been advanced to account for the annual inundation of the Nile, the last, I believe, is that set forth by Sir R. I. Murchison in his annual address before the Royal Geographical Society in 1859.¹ Taking it for granted that lake Nyanza is the source of the Nile, this theory attributes its annual inundation to the abundant discharge of water from this lake during the rainy season; but it seems to me that this theory is not tenable. According to Captain Speke the rainy season only a little south of this lake, is from November to March, and consequently cannot vary much from this period at the lake; but

¹ See this Journal, *Geographical Notices*, vol. xxviii, p. 411.

the water in the lower part of the Nile, does not begin to rise until the latter part of June. Hence the water would be about seven months in flowing from this lake to the lower part of the Nile, notwithstanding this lake is about 4000 feet above the level of the sea. This would give a velocity for the flow of the water considerably less than one mile per hour, which is far less than the velocity of rivers generally, especially at the times of inundation.

In order to account for the Nile's inundations, it is necessary to understand the causes of the rainy seasons, and the laws which govern them, in the region of the sources of the Nile, and its principal tributaries. Although we know but little of these from direct observations in the region itself, yet I think we may have a pretty correct idea of them from the observation of the laws which prevail generally at other places in the same latitude. It is well known that there is a belt surrounding the earth near the equator where the northeast and southeast trade winds meet, in which an enormous amount of rain falls daily. In the regions of the trade winds on each side of this belt, which embraces nearly one half the surface of the globe, very little rain falls; but the vapor is carried to the latitude where the trades meet, where the ascending currents carry it up to a point where it is condensed, and hence nearly all the rain which would otherwise fall over the whole regions of the trade winds, falls in a narrow belt only a few degrees wide. This belt is not stationary, but vibrates with the seasons nearly 1000 miles in latitude, having its most northern position in mid-summer, and its most southern in mid-winter, of the northern hemisphere. In the Atlantic ocean the middle of this belt, when farthest north, is about the latitude of 12° , and when farthest south, it is a little south of the equator, and it is about 8° wide. Hence in the latitudes occupied by the belt, when in its extreme positions, there is one rainy season annually, continuing about five months at places near the inner limits of this belt when in its extreme positions. The width of this rainy belt, the range of vibration, and the amount of rain which falls, may be considerably modified by the continents, and especially by high mountain ranges, but still there can be no very material change in the seasons, or the laws which regulate them. Hence in South America when the rainy belt occupies its most northern position about the first of August, the watershed of the Orinoco receives an immense amount of rain, and an inundation takes place, which, near the mouth of the river, is at its maximum in September. In like manner, when this belt occupies its most southern position about the first of February, all the tributaries which flow into the north side of the Amazon becoming flooded by the immense amount of rain, an inundation follows in that river, which is at its maximum toward the mouth

about the last of March, or about two months after the middle of the rainy season.

The annual inundation of the Nile, it seems to me, can be very satisfactorily accounted for in the same manner. Wherever the source of this river may be, it can have little effect in causing the inundation, for it must be a very small part of all the tributaries which make up the Nile; and it is to the sources of the principal tributaries that we must look for the cause of the inundation. We have seen that at the southern part of lake Nyanza the rainy season is from November to April, as it should be, if there is a vibrating rainy season there, as observed at other places near the equator, and hence we have reason to conclude that in mid-summer of the northern hemisphere it prevails 12° or 15° north of the equator. The extreme northern position of the north side of the rainy belt doubtless coincides with the southern limit of the great African desert, and the deserts of Arabia, which, but for the narrow strip rendered fertile by the irrigation of the Nile, would be one continuous desert, caused by the absence of rains in the belt of the trade winds. The rainy belt, therefore, from May to November, must be between the parallels of about 5° and 17° north latitude. If now we examine a map of this region, it is seen that the great water-shed drained by the Blue Nile, and its tributaries, embracing nearly all of Abyssinia, and also several important tributaries of the White Nile, is situated principally between these latitudes. Hence the immense amount of rain falling in this region during the rainy season, must cause an inundation of the Nile, just as it does of the Orinoco or of the Amazon. From what has been stated, the middle of the rainy season here, must be about the first of August, and the greatest height of the lower parts of the Nile is about the first of October, so that the flood would have about two months to descend. From what we know of the usual velocity of the currents of other rivers generally, this would be just about the time required.

The rainy belt from November to May is perhaps mostly south of the equator, and the source of the Nile or some of its tributaries must extend into this belt during this season, else the Nile, flowing more than 1000 miles through a rainless region, from which it does not receive a single tributary, however small, could not be supplied with water. This is an argument in favor of the hypothesis that the Nile has its source in lake Nyanza; but I think the water-shed of that lake, would not be more than sufficient to supply the Nile at low water, and that if ever the Geography and Meteorology of this region shall be well understood, the cause of the inundation of the Nile, will be found in latitudes farther north, as stated above.

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