

4. These conditions all reversed would produce a maximum of glaciation in the north temperate and polar regions such as evidently existed at the beginning of the Post Tertiary period.

It is probably within the power of physical astronomy to calculate the epochs at which these maxima and minima have occurred. It is, however, a problem of considerable difficulty, involving, as it does, the rate of precession of the equinoxes, the proper motion of the apsides, and the secular change in the obliquity of the ecliptic, none of which data are perfectly constant. According to recent determinations, the equinox completes a revolution in 25,868 years. The apsides move forward to meet the equinox, so that perihelion has the same longitude once in 21,066 years. The obliquity of the ecliptic returns to the same value in about 100,000 years.

M. Adhémar has based an explanation of the occurrence of glacial periods upon the climatic effects of the precession of the equinoxes alone. As the earth's axis is inclined to the ecliptic, the hemisphere which has its winter in aphelion is not only farther from the sun than the other hemisphere during its winter, but also experiences a winter having about eight days longer duration. The excess in the duration of its winter is partly caused by the slower motion of the earth on that side of the equinoxes which embraces the upper apsis, and partly also by the greater length of the path on that side. This hemisphere is therefore subjected to an excess of cold. For reverse reasons, the other hemisphere enjoys more than the mean warmth.

In consequence, however, of the gyration of the axis in a period which Adhémar takes at 21,000 years, it follows that at the end of 10,500 years the hemisphere which had been turned away from the sun at aphelion becomes turned toward him. In other words, the climatic inequalities of the two hemispheres become reversed. That hemisphere which for 10,500 years had been subjected to excessive glaciation, now enjoys excessive warmth, and that which had enjoyed excessive warmth is visited by excessive cold. There are, therefore, two great seasons for each hemisphere during the progress of the *Annus Magnus*, or Great Year. The summer has a duration of 10,500 years, and the winter an equal duration.

One thing farther should be remarked in connection with the accumulation of masses of ice and snow about either pole, from whatever cause the accumulation proceeds. Such an accumulation must necessarily change the position of the centre of gravity of the earth-mass. That centre must move toward the pole thus burdened. The fluent waters upon the earth's surface, free to adjust themselves in equilibrium about the centre of gravity, must change their distribution as the place of the centre of gravity changes. During the glaciation of the southern hemisphere, the waters will accumulate about the south pole; and during the glaciation of the northern hemisphere, they must accumulate about the north pole. These alternating accumulations of the waters are adequate,