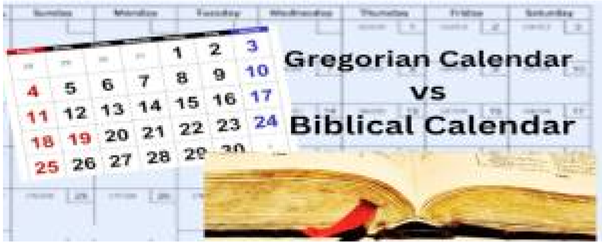
The Approaching End of the Age – Part IV. Section III. Soli-Lunar Cycles, And Their Relation to the Chronology of History. Chapter II.



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DIFFICULTY OF HARMONIZING SOLAR AND LUNAR MEASURES.

IT might have been supposed, that as solar and lunar revolutions were to be employed by man, as measures of time, God would have made them so harmonize, as that some definite number of the lesser, would be *exactly* commensurate with one of the greater, and a definite number of these again, with one of the greatest. We might have supposed for instance that thirty revolutions of the earth on its axis, would have occupied precisely the same time as one revolution of the moon in her orbit, and twelve such revolutions of the moon, precisely the same time, as one revolution of the earth in its orbit.

This arrangement would have made the month *exactly* thirty days, and the year *exactly* twelve months. Had it been selected by the Creator, the great natural chronometer in the heavens, would have acted, as do our little artificial time-pieces; its hands would, so to speak, have kept pace together, the second, minute, and hour hands, returning simultaneously to their common starting-point, at the close of every major revolution, and setting out again on a new round, in identically the same order as at first. New and full moon would have fallen invariably on the same day of the month, and of the year; and the endless variety we now experience in this respect would have been replaced by perfect uniformity.

Such a plan would have been, in some respects, convenient to mankind, and would have made the arrangement of the calendar an exceedingly simple matter, instead of as it is, a most complex and difficult one. But it would have been adapted to the measurements of short periods of time only, and would have afforded no standards for longer intervals.

The arrangement actually adopted on the other hand, while it creates some difficulty in the exact and uniform adjustment of *days* and *months*, to *years*, gives rise to an infinite variety of cycles, or circles of change and harmony, which enable the soli-lunar clock to measure out the revolutions of ages, by standards, varying in length from three years to over a thousand years.

Of these cycles we shall have much to say presently; and it must be distinctly borne in mind, that it is not in connection with them alone, that we employ soli-lunar reckoning, but that our ordinary computation of time is *soli-lunar*. Our calendar is neither purely solar—regulated by the sun alone; nor is it wholly lunar—regulated by the moon alone; but it is soli-lunar—regulated by both, adapted to the motions of both sun and moon.

As this soli-lunar reckoning of time is fundamental to our present investigation, it will not be out of place to dwell a little more fully on the subject of

THE CALENDAR AND ITS HISTORY.

It is evident that one of the first cares of every civilized or even partially civilized society, must always have been to establish some uniform method of reckoning time. Without such a standard of reference, the administration of public affairs would be impossible, and even the regulation of the common concerns of every-day life. For the adjustment of civil and religious ceremonies and institutions, for the fixing of the proper periods for seed-time and harvest, and for the transmission to later generations, of the dates of events worthy of remembrance, a well-regulated calendar is a matter of the utmost importance.

A moment’s reflection will show the difficulty which must attend every attempt to construct a calendar, practically adapted to the wants of mankind, out of elements so inharmonious as the natural day, month, and year.

The *day*, measured by the revolutions of the earth on her axis, and marked by the apparent diurnal revolution of the entire heavens,—contains twenty-four hours, and is the fundamental measure of time.

The *month*, or interval between one new moon and another, occasioned by the moon’s revolution in her orbit, contains 29 days 12 hours 44 minutes and 3 seconds.

The *year*, or apparent course of the sun round the earth, from any given point in his orbit, to the same point again, occupies 12 months 10 days 21 hours, or 365 days 5 hours 48 minutes and 49 seconds.

How many days make a month? How many months make a year? In either case the answer involves *a fraction*, and the fraction involves more practical difficulty, than can be easily conceived by the uninitiated.

Before observations were as accurate and information as full, or experience as great, as they now are, it is easy to understand that the ancients would grapple boldly with a difficulty which to them may have appeared slight. Twenty-nine or 30 days to the month, and 12 months to the year, was a fair approximation to actual facts, and would be supposed to be sufficiently near the mark. But the very purposes aimed at in the use of a calendar, would quickly be defeated by the employment of so inaccurate a one as this. It would for a time agree pretty well with the course of the moon; but each year it would get more and more out of harmony with the true course of the sun, by eleven days. Now as the seasons are regulated by the course of the sun, it is evident that practical confusions, and irregularities of a most embarrassing kind, would quickly arise. For supposing it to have been settled at any time, that the new year should begin in the spring, sixteen years afterwards, new year’s day would fall in the autumn, and in thirty-three years it would have worked its way all through the seasons, back to spring again.

Intercalation, or the insertion of days at certain junctures, was the remedy employed to meet this difficulty; but it was an uncertain, awkward, and imperfect remedy. About the time of the Christian era, it was felt that a reformation of the calendar was urgently needed. Julius Caesar, calling to his aid the most eminent mathematicians of his time, attempted the task. A careful consideration of the elements of the problem proved, that no satisfactory solution could be found which did not make she sun’s annual course the principal measure and adapt to *it* the months and days. He therefore made the year to consist of 365 days for three years successively, and of 366 every fourth year, in order to take in the odd six hours.

This reformation was made B.C. 45, in the year of Rome 708 The beginning of the year was fixed to the 1st of January; and the months were made to consist of 30 and 31 days alternately, with the exception of February, which in ordinary years had only 28 days, but in the fourth year, when the new day arising from the odd six hours was added to it, 29 days.

This Julian calendar, though superior to any that had preceded it, was still far from perfect, for the odd six hours is not actually six full hours, but 5 hours 48 minutes and 49 seconds as we have said: so that the year of the Julian calendar exceeded the true solar year by 11 minutes and 11 seconds.

This difference amounts in 130 years to an entire day, and in process of time throws the whole seasons again out of course. In the 16th century the vernal equinox, which had by the Council of Nice in A.D. 325 been fixed to the 21st of March was found to happen instead on the 11th of that month, the error having, in the intervening period, accumulated to the extent of ten days.

The present and prospective inconvenience of this state of things was represented to the Councils of Constance and Lateran, by Cardinals Ailli and Cusa, and attempts to remedy it were proposed and discussed. Pope Sixtus IV., in the year 1474, called to Rome the celebrated mathematician Regiomontanus, and bestowed on him the Archbishopric of Ratisbon, that through his aid he might accomplish the required fresh reformation of the calendar. The premature death of the mathematical archbishop, disappointed however the project, and nothing was done for another century. Then Pope Gregory XIII, after consulting mathematicians, and obtaining the consent of the various princes of Christendom, to a plan submitted to him by the astronomer Luilius, called a council of the most learned prelates to consider the question, and having with their concurrence decided it, he published a brief in March, 1582, abrogating the Julian reckoning, and substituting for it the Gregorian calendar which we now employ.

By this alteration, or “new style,” the ten days which the civil year had gained on the true solar year, were deducted from the month of October of the year 1582, the equinox being thus brought back to the 21st of March, as it had been settled by the Nicene Council; and in order to prevent a recurrence of the irregularity, it was ordered, that instead of *every* 100th year being a leap year, as by the old style, only every 400th year should be such, and the rest be considered as common years. As a day had been gained by the former method every hundred and thirty years, or about three days in four hundred years, the omission of three leap years every four centuries, would evidently nearly rectify the defect. A much more difficult matter was to adjust the lunar to the solar year, and to settle the time for the observance of Easter and other moveable feasts.

It was ordered by the Council of Nice, that Easter should be celebrated on the first Sunday after the first full-moon, next following the vernal equinox. In order that this rule might be properly observed, it was needful to know the days when the full moon would happen, in any given year. This however it was extremely difficult to ascertain: for the nineteen-years' cycle discovered by the Greek philosopher Meton, which nearly harmonizes the movements of sun and moon, and brings the days of new and full moons back to the same days of the year, was found to be too long by an hour and thirty-two minutes (Julian year measure). After sixteen Metonic or lunar cycles the true phases of the moon would precede those shown in the calendar by a whole day.

At the time of the Gregorian reformation, the error occasioned by this means amounted to four days; had the old calendar still been followed, it would in time have announced full moon, at the time of change, and Easter would consequently have been celebrated at a period, exactly opposite to that commanded by the Church. By an ingenious device, Luilius, the astronomer employed by Gregory XIII. in this intricate business, succeeded in arranging a plan by which the period of the new moon may be ascertained for any month of any year.

He rejected the “Golden numbers” formerly employed for the purpose, and made use of Epacts in their stead.

The Epact is the moon's age at the end of the year. If for example the new moon occurs in a given year on new year's day, we should say there was no epact that year. But as twelve lunations (or lunar months) are completed in 354 days and the year is over 365 days, it is evident that on the second new year's day, the moon would already be eleven days old, while by the third, she would be twenty-two, or have twenty-two days' epact, and by the fourth *thirty-three*. But as the time of the entire lunation is never more than 29 days and a half, the epact cannot possibly exceed thirty. In the latter case, therefore. thirty must be subtracted, and at the beginning of the fourth year the epact would only be *three*. By observing this rule through a period of 19 years, the epacts would stand in the following order:—0, 11, 22, 3, 14, 25, 6, 17, 28, 9, 20, 1, 12, 23, 4, 15, 26, 7, 18.

As in sixteen lunar cycles, or 304 years, the slight error of that cycle amounts to an entire day, these numbers have then to be increased by unity, and for the second period of 304 years will stand in the order, 1, 12, 23, 4, 15, 26, 7, 18, 29, 10, etc.

Gregory XIII. ordered all ecclesiastics under his jurisdiction to conform to the new method of reckoning, and exhorted all Christian princes to adopt it in their dominions. The Catholic nations did so at once, the Protestant nations refused to for a time. But the difference between the “old” and new style, as the Julian and Gregorian accounts were called, occasioned so much confusion in the commercial affairs of the different states of Europe, that by degrees popular prejudice against the change was overcome even in Protestant countries, and in 1752, the new style was by Act of Parliament adopted even in England. A century having elapsed, instead of cancelling ten days as the Pope had done, *eleven* days were ordered to be left out of the month of September, and accordingly on the second of that month the old style ceased, and the next day instead of being called the third, was called the fourteenth. Russia still retains the old style. (**Note:** Russia switched from the Julian calendar to the Gregorian calendar in 1918. Right after Jan.31, 1918 came Feb.14! The Russians lost two weeks of time.)

This Gregorian calendar is practically correct for a very long period; it is not absolutely so, and it would probably be impossible to arrange a calendar that should be theoretically perfect for all time, but it is so accurately adjusted to actual solar and lunar movements, as to be free from the error of a day in some thousands of years. A better plan had been previously proposed which seems to have been unknown to Gregory XIII. Herschel says: “A rule proposed by Omar, a Persian astronomer of the court of Gelaleddin Melek Schah, in A.D. 1079 (or more than five centuries before the reformation of Gregory) deserves notice. It consists in interpolating a day, as in the Julian system, every fourth year, only postponing to the 33rd year the intercalation, which on that system would be made on the 32nd. This is equivalent to omitting the Julian intercalation altogether in each 128th year (retaining all the others). To produce an accumulated error of a day on this system, would require a lapse of 5000 years. So that the Persian astronomer’s rule is *not only far more simple but materially more exact than the Gregorian*.”

(To be continued.)