

## THE YEAR ZERO.

THE questions collaterally involved in "the last year of the century" controversy possess a scope and interest quite independent of the seeming triviality of the main problem, and the considerations which F. Pietzker recently advanced in the *Naturwissenschaftliche Wochenschrift* may be found worthy of notice from both a scientific and an educational point of view.

While almost perfect harmony prevails among chronologists as to the main point at issue, namely that the year 1900 really belongs to the nineteenth century and not to the twentieth, a more serious controversy has arisen, which affects the general correctness of our method of reckoning time backwards and forwards from the beginning of the Christian Era. By the common method of computation the year just preceding the beginning of the Christian Era is denoted by  $-1$ . The astronomers see in this practice an ambiguity, and by them this year is denoted by  $0$ .

The difficulties which arise here are apparent. In introducing a year numbered  $0$  there is no more reason for adopting the year preceding Christ's birth than there is for adopting that succeeding his birth; in fact, the latter would seem preferable, although then the nineteenth century would cease with the year 1899 and not with the year 1900; just as the twelfth number of Volume XII of *The Open Court*, which began with No. 500, was called No. 511. In order to avoid this inconsequence it has been suggested that since the date of Christ's birth did not coincide with the ending of the year, the year zero should be defined as that in which the date of Christ's birth actually fell. If this view were accepted, the year zero would not be the first year before our era, but would be the first year of that era itself, and we should then again be compelled to adopt a method of reckoning which is quite opposed to that accepted by astronomers.

But the matter has been still more complicated by certain ac-

cidental and arbitrary circumstances which accompanied the introduction of our chronology.

The originator of the Christian Era, Dionysius the Little, a Roman abbot who lived in Italy during the sixth century, selected as the starting-point of his enumeration, the first day of January of the 754th year of the so-called Varronic Era of the Romans; that is, of the year in the last weeks of which according to his belief Christ was born. This year was made "the year one" because it was nearest to the date of the Annunciation (the twenty-fifth of March), from which date it had been the practice of the ancient fathers to reckon the Incarnation of our Lord. The Dionysian Era was not universally accepted until the ninth century, and during the interval which elapsed between its suggestion and adoption the date of the beginning of the year oscillated between the twenty-fifth of March and the twenty-fifth of September. But the inconveniences which arose from so undecided a state of affairs speedily made themselves felt, and the New Year's day of Caesar, the first of January, was at last definitively adopted.

We see thus that we do not reckon time from the birth of Christ, but from a point in the old chronology indirectly related to the date of Christ's birth. In fact, however, it is quite indifferent whether we regard the first of January after Christ's birth or the day of the Annunciation selected by Dionysius, as the beginning of our era, because our entire chronological system is, owing to the uncertainty of the date of Christ's birth, in error by several years.

Regard it how we will, the method is fraught with inconveniences, but these inconveniences are inherent in the nature of the question and would not be removed by the introduction of a year zero. A few practical examples will render the case clear.

It is asserted by the astronomers that we are compelled by the accepted method to resort to a double manner of computing time in many instances. In computing the interval of time which has elapsed between two given dates, we employ a different rule when the years have the same signs from what we should if they had different signs. For example, if we had to determine the age of Frederick the Great in years, we have only to subtract the year of his birth, 1712, from that of his death, 1786, to obtain his age, which was 74 years. If we desired to determine the age of Augustus, however, we should not be permitted to subtract the year of his birth (-63) directly from the year of his death (+14), for in that case we should obtain 77 years as the length of his life, which was actu-

ally only 76 years; but we should have to reduce the first number by 1, and employ the equation :

$$14 - (-62) = 76.$$

And this diminution of the number of years prior to Christ's birth by 1 is precisely what is effected, say the astronomers, by the introduction of the year zero.

But here again the astronomers have reckoned without their host. The object which they wish to attain would be reached in quite the same manner, and would be historically more justified in the Dionysian view, if the positive years were decreased by 1, and the reckoning took the form :

$$13 - (-63) = 76.$$

But the argument involves a gross breach of logic. By this method, which operates with whole years, the result would never accord with the actual facts unless the points of time with which the comparison is conducted were situated exactly at corresponding places in the years compared. But in the case of Frederick the Great this is not the fact. If the fractional parts of the year be taken into account, the length of his life will be found to be 74 years and 7 months nearly, which by the accepted rules of computation would be counted as 75 years. If Frederick the Great had been born in the first minute of the year 1712 and had died in the last minute of the year 1786, his life would reckon up 75 years exactly; whereas, if he had been born in the last moment of the year 1712 and had died in the first moment of the year 1786, the length of his life would be 73 years only. In other words, the reckoning with whole years as units may involve an uncertainty of two full years, and it would seem incredible that a scientific rule should ever become established upon so inexact and crude a practice.

The method of computing time with whole years could be employed only if there were no smaller divisions of time than full years. In the case of quantities which increase interruptedly and always by the same finite amount, that is to say in the case of discrete quantities not admitting of subdivision, it is quite proper to select one of these elements as the starting-point and to give to it the number 0; but this procedure would lose all justification whatsoever and would be absolutely unmeaning, if it were applied to a set of quantities which change continuously and which are therefore composed of minor quantities smaller than the element designated zero. Even now in the method of reckoning adopted by

astronomers, errors and contradictions arise whenever months and days are considered instead of whole years; but the embarrassments are still more increased in calculations connected with the year zero. According to Dionysius, we have one starting-point of time only, from which we count both backwards and forwards. If we introduce a year zero, we have two starting-points: (1) the end of this year for the time after the birth of Christ, and (2) the beginning of this year for the time before the birth of Christ. From which one of these points events falling within the year zero itself would have to be reckoned is quite indeterminable; and by this very fact alone the reasons for the introduction of the zero year fall to the ground.

The whole matter of reckoning time is in fact in no wise distinguishable from the reckoning of temperatures with the thermometer. We have no "zero-degree" on the thermometer, but only a zero-point, and alterations of temperature are always determined by the same arithmetical rule, whether the quantities entering into the computation are degrees with positive or degrees with negative signs. In like manner, the number of years which Frederick the Great lived may be determined from the following computation:

$$(1785 \text{ years, } 7 \text{ months, } 17 \text{ days}) - (1711 \text{ years, no months, } 24 \text{ days}) \\ = 74 \text{ years, } 6 \text{ months, and } 23 \text{ days;}$$

and that of Augustus may be determined by the following:

$$(13 \text{ years, } 7 \text{ months, } 19 \text{ days}) - [-(62 \text{ years, } 3 \text{ months, } 7 \text{ days})] \\ = 75 \text{ years, } 10 \text{ months, and } 26 \text{ days.}$$

In *both* instances we reckon with the number of years decreased by 1; that is, with the number of *whole* years involved in the problem, in the minuend as well as the subtrahend. The *signs* prefixed to the number of the years give rise to no difference in the computation.

It remains to notice another inconvenience inevitably associated with our chronology. The selection of an initial point from which time is computed is necessarily arbitrary and artificial. It does not fairly square with the events which have happened *previously* to the zero-point selected. The negative sign of the intervals of time prior to this epoch represents the point of view of a future generation; the people who lived during these "negative periods" naturally counted their years forward, and we have adopted their method of computation to the extent of employing

the same day of the month for the fixing of dates within a negative year. To be logical, we ought to count the years prior to Christ's birth, not from their beginning but from their end, as being nearer to the zero-point of our system. That we do not do so is illogical, but it is quite intelligible. The inconvenience which follows from this fact is very slight, particularly as it can be removed by an easy calculation, and it is certainly not sufficient to justify in the slightest the introduction of a year zero, which would increase and not diminish the contradictions now involved in our practical methods of reckoning time.