nerated in the Southern Ocean, the tide which is produced under the more immediate influence of the new or full moon cannot, at most places, be that which takes place on the day of new or full moon ; and in reading the preceding sketch of the phenomena, these must not be confounded. The latter, however, is that which has commonly been ob­served for the purpose of determining the establishment; but it often differs materially from the former, and in the tide-records anomalies frequently occur which seem refer­able to this difference. It has already been mentioned, that the agreement between the empirical laws of the tides and the equilibrium theory is much improved, by referring the tides to a transit anterior to their occurrence by two or three days. To illustrate this, Mr Lubbock denotes the successive transits of the moon at intervals of about twelve hours) by the letters A, B, C, D, E, F ; F being the transit which immediately precedes, by about two hours, the high water at London : and he finds that the laws of the tides at London and Liverpool agree best with theory when they are referred to the transit B. The tide which reaches London at two hours after the transit F, was at Plymouth about six hours after the transit E ; and as from transit B to transit E is about thirty-eight hours, if we refer the Plymouth tides to B, we take a transit about forty-four hours before the tide. Transits A and C are about fifty- six and thirty-two hours anterior to the tide. Nearly the same may be said of Bristol. The general result is, that the transit B gives the best tables.

We cannot, however, in this way completely reconcile observation and theory, even as regards the semimenstrual inequality. From Mr Lubbock’s researches on the Liver­pool tides (Phil. Trans. 1836, p. 57), it appears, that while the transit A very nearly reconciles the theoretical and observed times, we must take a still earlier transit if we would obtain the like agreement in the heights. Nor does that selection of a transit which best represents the semi- menstrual inequality bring about an agreement with theory in the parallax and declination corrections. Hence, al­though there appear to be in the actual laws of the tides inequalities *corresponding* to all those which arise from the supposition of the equilibrium tide of an anterior epoch transmitted along the ocean to our shores, we cannot so assume the epochs to produce all the inequalities at once even for the same place. The epoch is of one value for the times, of another for the heights ; different for the parallax correction, and again for the effect of declination.

The relation between a change in the epoch and the semimenstrual inequalities may be examined as follows. The successive lunar transits occur at intervals of about twelve hours twenty-four minutes of solar time. The semimenstrual inequality, both of interval and of height, is referred to the solar time of the moon’s transit. The height is the same whether it be referred to the transit E immediately preceding, or to the transit B a day and a half sooner. If the moon moved uniformly in her orbit, the inequality of the interval between the tide and tran­sit would be the same, whether the tide were referred to the transit E, or any anterior one, as B ; for the inter­val is increased by the constant quantity twelve hours twenty-four minutes nearly for every transit that we go back. But though the inequality of the interval for any given tide would be the same, it would not occupy the same place in the table or curve, since it would be referred to a different hour of the transit. For example, if the mean interval of transit and tide at Bristol referred to E be 7h∙, and if, when the moon’s transit is 2h∙, the tide be at 8h∙, the interval is 6h., and therefore in this case the inequality is minus one hour. If now we refer this tide to the tran­sit B a day and a half sooner, the interval of the transit and tide will be 6h. + 36h. + 72m., and the mean interval will be 7h∙ + 36h. + 72m.; and therefore, as before, the

inequality is minus one hour. But the moon’s transit E taking place at 2h∙ solar time, the transits D, C, B will take place at 1h. 36m., 1h∙ 12m∙, 0h∙ 48m∙ respectively; and therefore the inequality of minus one hour, which was re­ferred to the transit happening at 2h∙ when transit E was used, is referred to the transit at 0h∙ 48m∙ when we em­ploy the anterior epoch B. Thus, by referring to an an­terior epoch, the whole semimenstrual inequality is shifted backward through twenty-four minutes of lunar transit, for every step of one transit backwards. This is the mean result, supposing the moon's motion uniform, and neglect­ing all other inequalities ; on which suppositions nothing would be gained or lost in accuracy by the change of the epoch. But in the actual case, this mean result is modi­fied by the influence of the other inequalities, which make one transit a better epoch than another.

The tide which comes to the shores of narrow and long seas is not immediately produced by the luminaries, but is derived from the tide in the main ocean. Its circumstances are governed by those of the primary tide from which it is derived ; and whatever interval may elapse during its trans­fer, it is regulated by the position which the sun and moon had at the time when they determined the primary tide. Now this time may have been one, two, or more days before the tide reaches the place where it is observed. Thus the tide on the shores of North America and Spain, conform­ably with its being supposed to be generated in the South­ern Ocean, and sent up the Atlantic, seems to correspond to the configuration of the sun and moon at a day and a half previous. The tide in the port of London appears to be two days and a half old when it arrives. The time spent in the transfer of the tide is very different in different parts of the world, and has not yet been ascertained for many places. But it affects the determination of the establishment from observations, in a manner which may be thus explained. If the tide at London be determined by the position of the sun and moon two and a half days before it occurs, the moon must then have been more to the west of the sun by an angle of two hours (her motion in *A*R in two and a half days) than she is when the tide arrives. Hence the tide which happens on the day of full moon, corresponds to the period when the moon was in *A*R, two hours west of the point opposite to the sun, or ten hours east of the sun. Therefore, by the preceding small table, the tide is thirty-one minutes later than the mean interval between the tide and moon’s transit. The tide at London takes place nearly at two o’clock on the days of new and full moon ; and there­fore 1h∙ 29m∙ is the corrected establishment for London.

The establishment is usually defined to mean the hour of high water at new and full moon. Mr Whewell calls this the vulgar establishment. Observations of tides have most commonly been made with the view of determining this vulgar establishment, which it now appears is not a corresponding quantity at different places. The mean of all the lunitidal intervals for a half lunation, he calls the corrected establishment. Hence the vulgar establishment seems to be greater than the other by a quantity depend­ing on what Mr Whewell calls the age of the tide ; namely, the length of time which has elapsed since its real or theo­retical origin. This is also what Mr Lubbock, following Ber­noulli, calls the *retard.* It is considered as the principal rea­son why the greatest tides do not occur on the days of new and full moon, nor the least at the quadratures, but one, two, or more days after. Both Mr Lubbock and Mr Whewell frequently use the term epoch in the same sense as the age of the tide, or at least as the time during which any parti­cular inequality has been transferred from the Southern Ocean to the place of observation.

The doctrine of the age of the tide, as thus laid down, not unfrequently leads to inconsistencies, some of which are only apparent, being referable to the mixture and inter-