be proceeded with except it be step by step; each portion must be made good before the next is attempted, and if the aphorism—

> "By many blows that work is done
> Which cannot be achieved by one,"

be kept steadily in view, and the main object not allowed to sleep, progress must result. Had the Association continued its grant, even if reduced to £100 *per annum*, it is more than probable that, by this time, four more areas of the map would have been completed, and a larger number of objects catalogued, and, as regards observations, we have reason to believe that by pursuing a course similar to that adopted by the last lunar Committee, a large number might be obtained capable of yielding important results. If these views be correct, it appears that the proximate effect of the withdrawal of the Association from the work has tended to retard it. Nevertheless, so far as the grants have been judiciously applied, the Association has been true to its designation; it has advanced the science of Selenography. In the second place, because the Association has withdrawn, and the work has been proportionately retarded, are we to come to the conclusion that it will languish and die out? By no means,—languish it may, but if there be energetic and devoted Selenographers, and they are upon the increase, the study of lunar physics will assuredly not die out. Observers will not be content with the works of Schröter, Gruithuisen, Lohrmann, Madler, Smidt, and Bulard, but will seek in some way to bring their own work before the public, to place their observations on record, and to secure an examination and discussion of them, that their labours may not be lost, but that posterity may reap the benefit, should they not meet with a favourable reception at the hands of living astronomers.

HISTORICAL ECLIPSES.

Mr. J. R. Hind, writing from Mr. Bishop's Observatory, Twickenham, furnishes us (*The Times*) with the following interesting sketch of the Eclipses recorded in History:—

"It is well understood that the historical eclipses, especially those of the sun, have an important bearing upon our knowledge of the elements of the moon's motion, as affording the means of testing the accuracy of those elements when carried back to very remote times. I send you a brief account of some results I have deduced in a systematic examination of these eclipses, making only such a selection therefrom as may possibly possess interest for the general reader. I shall omit any reference to the purely astronomical conclusions to which I have been led, which would be out of place in your columns, and, indeed, would extend this communication beyond reasonable limits. It may, however, be desirable to state that I have employed the last value of the secular acceleration of the moon's mean motion given by Professor Hansen, of Gotha, the author of the latest lunar tables, and have combined other important elements as determined by him with the results of M. Leverrier's tables of the sun. From recent investigations, it appears by no means improbable that we may have to rely wholly upon the ancient eclipses in fixing the true amount of acceleration in the motion of our satellite.

"I shall follow the chronological order in the subjoined remarks upon some of the better known eclipses of history. These form a part only of the phenomena I have rigorously examined upon the same system of calculation.

"1. The Nineveh Eclipse of B.C. 763, June 15.—The discovery of the record of this eclipse on one of the Nineveh tablets in the British Museum was announced by Sir Henry Rawlinson in the *Athenæum* of May 18, 1867, to which I refer for details of its bearing on the sacred and profane history of the period. In the actual state of our knowledge it is the *terminus a quo* for researches on the historical eclipses, and I believe I am correct in saying its value in an astronomical point of view is greater than that attaching to the famous eclipse predicted by Thales to the Ionians, as mentioned by Herodotus. The underlining of the inscription appears to indicate a phenomenon of unusual character or that the eclipse was total in or near Nineveh. Adopting for the position of the city the longitude and latitude deduced by the Astronomer-Royal for the pyramid of Nimrud, I find the calculated southern limit of totality would pass a few miles south of Nineveh, leaving a very large partial eclipse at that city. Very trifling corrections in the lunar elements employed would suffice to bring the total eclipse over it. In this longitude the duration of totality on the central line would be 4m. 20s., the middle of the eclipse at half-past 9 local time.

"2. The Eclipse of B C. 689, January 11.—The idea that the retrogression of the shadow on 'the dial of Ahaz' during the illness of Hezekiah may have been connected with a solar eclipse has given rise to much discussion, and several writers have endeavoured to point out how the occurrence might thus be explained. Of the eclipse to which attention has been directed the above has perhaps appeared the more probable. It was an annular eclipse, and at Jerusalem the sun would present the form of a luminous ring for $7\frac{1}{2}$ minutes, the middle at 10h. 18m. In Babylon it would have the same appearance for seven minutes. It seems hardly probable that the eclipse could have occurred much latter in the day, though more than one author has considered the circumstance essential for the explanation of the retrograde motion of the shadow on the ancient form of sun-dial by an eclipse. I must leave the reader to judge how far the expression "wonder done in the land" may relate to such a phenomenon, which is, of course, a very rare one in a particular locality.

"3. The Eclipse of Thales, B.C. 585, May 28.—This eclipse, which, as Herodotus informs us, terminated the six years' war between the Medes and Lydians under Cyaxares and Alyattes, when during a battle, 'day was suddenly turned into night,' has greatly exercised the chronologist and the astronomer, and although, misled by imperfect tables of the lunar motions, they have fixed upon other eclipses from time to time, it has been known for some years past that the date distinctly assigned by Pliny (the fourth year of the 48th Olympiad) is the correct one. My new calculation throws the shadow precisely over the tract of country where with the greatest probability it has been supposed the contending armies were situated, and in addition it indicates a circumstance which I believe has not resulted from any previous calculation, and which may not be without its chronological import—viz., that the eclipse was total in Nineveh for between three and four minutes shortly before sunset. The date of the final destruction of Nineveh is closely connected with the eclipse of Thales.

"4. The Eclipse of Xerxes, B.C. 473, February 17.—Much difficulty has been experienced by chronologists with an eclipse which occurred,

according to Herodotus, in the early spring, when Xerxes was setting out from Sardis on his expedition against Greece. It is certain that there was no such phenomenon in the year B.C. 480, to which this event is usually referred, and in examining the eclipses about this period, I found only one that can apply. There is no doubt that the sun was very largely eclipsed at Sardis on the morning of February 17th, B.C. 478. A direct calculation for this place shows that more than 94-100ths of the sun's diameter would be covered, the greatest phase ten minutes after 11, local time. The eclipse was annular, and Sardis appears to have been just outside the annulus. One other eclipse only was visible in eastern Europe about this year, it occurred B.C. 479, October 2, and has been considered to be the one which occurred at the time Cleombrotus consulted the oracles at Sparta. Its magnitude there is found to have been about 6-10ths, the greatest eclipse at oh. 50min. If the eclipse of B.C. 478 be truly the one recorded by the historian, the date of the battle of Salamis will require to be brought down two years.

"5. The Eclipse of Agathocles, B.C. 310, August 15 (Diodorus, Justin). On the morning after the fleet of Agathocles sailed from Syracuse for Africa, the historians tell us the sun was eclipsed to such a degree (*tantum fit solis deliquium*) that the stars appeared everywhere as at night. Though Agathocles could hardly have been more than 100 miles from Syracuse, it is uncertain in which direction he had sailed, or whether he was rounding Sicily on the north or south side, and this circumstance detracts from the scientific value of the record. My calculation throws a central line near the African coast, so that the fleet, if sailing southwards, would be near the northern limit of totality.

"6. The Eclipse on the Passage of the Rubicon by Cæsar (Dion), B.C. 51, March 7.—This would appear to have been a very notable phenomenon on the Rubicon and in Northern Italy generally. The eclipse was annular, and the annular phase continued 6min. 30sec. At Rome there would be a partial eclipse, about three-fourths of the sun's diameter being covered. A line drawn from 9 deg. 24 min. E. and 43 deg. 26 min. N. to 14 deg. 39 min. E. and 46 deg. 15 min. N. will define the course of the central eclipse across Italy, and the ring-formed appearance of the sun would extend to about 1 deg. 35 min. north and south of this line. The Rubicon would be placed about midway between the central line and the southern limit. Near Ariminum the middle of the eclipse occurred at oh. 50m. By some writers (including the Abbè du Fresnoy, in his valuable 'Tablettes Chronologiques,') the eclipse is dated B.C. 50; the above, however, is the correct year.

"A great eclipse has been referred in the year B.C. 43 or 44, soon after the death of Julius Cæsar, and it is instanced by Baron de Zach and M. Arago as the first annular eclipse upon record. Calculation shows that there could not have been an eclipse, annular or otherwise, visible in Italy in either of these years, nor, indeed, for several years before or after. The phenomenon alluded to, was, no doubt, of a meteorological character, and this would appear from the passage in Suetonius, one of the authors quoted upon the subject.

"7. The Eclipse of Herod (Josephus).—The lunar eclipse, which I take to be the one recorded by the Jewish historian during Herod's last illness, occurred B.C. 1, January 9. On this occasion the moon passed nearly centrally through the earth's shadow, entering it at 11h. 23m. p.m. mean time at Jerusalem, and emerging at 2h. 57m. a.m. on the 10th; the total eclipse continued 1h. 39m. This is the date recognised by Calvisius, and recently supported by Mr. Bosanquet. An eclipse in B.C. 4, on the night between March 12–13, which other chronologists have

supposed to be the one referred to, was partial only, and did not commence till 1 a.m.; little more than half the moon's diameter was immersed in the earth's shadow at greatest phase.

"8. The Eclipse of Phlegon in the 202d Olympiad (Eusebius), A.D. 29, November 24.—Total on a line crossing the Black Sea, rather west of Odessa, to Sinope, thence, near the site of Nineveh, to the Persian Gulf. At Jerusalem a partial eclipse; about 11.10 a.m. eight-tenths of the sun's diameter would be covered; at Heliopolis (Baalbec) also partial—nine-tenths. At a point on the central line near Sinope the totality would continue $1\frac{1}{2}$ minutes. Humboldt mentions that this eclipse had been calculated by Wurm, but I have not met with his results. It is the only solar eclipse that could have been visible in Jerusalem during the period usually fixed for the ministry of Christ.

"The moon was eclipsed on the generally received date of the Crucifixion, A.D. 33, April 3. I find she had emerged from the earth's dark shadow a quarter of an hour before she rose at Jerusalem (6 36 p.m.), but the penumbra continued upon her disc for an hour afterwards.

"9. The Eclipse of 113, May 31.—Kepler, after endeavouring to ascertain the date of a total eclipse mentioned by Plutarch as having 'recently occurred about noon,' when the darkness was like that of night, and stars were seen in all directions, states he had found none which accorded better with the description than the above. On submitting it to calculation on the modern elements, the central line appears to have passed too far north—over central Germany. I have not succeeded in discovering the date of this eclipse, though I have accurately examined several at the close of the first and beginning of the second century.

"10. The Eclipse of 418, July 19.—Very large at Constantinople, according to Philostorgius, who relates that at the eighth hour of the day the sun was so far eclipsed that the stars appeared, and a comet which had not been previously perceived became visible during the obscurity, and was watched for more than four months afterwards. According to my calculation the central line passed somewhat to the south of Constantinople, where ninety-five hundredths of the sun's diameter would be covered. At a very short distance below that point the eclipse would be total. This is the second occasion upon which the discovery of a comet during a total, or nearly total, eclipse of the sun is recorded in history.

"11. The Eclipse of 671, December 7, on the attempted removal of the pulpit of Mahomet from Medina.—Professor Ockley, in his "History of the Saracens," mentions on the authority of several Arabian writers a a large solar eclipse which occurred about the 52nd year of the Hegira. The Caliph Moawiyah having formed the intention of removing the Prophet's pulpit from Medina to his residence at Damascus, his people proceeded to do so, 'when immediately, to their great surprise and astonishment, the sun was eclipsed to that degree that the stars appeared.' Baron de Zach refers the eclipse to 674, October 4, but in this he is certainly mistaken—I believe through a wrong assumption as regards the moon's latitude. The correct date would appear to be 671, December 7. The eclipse of this day was annular on the central line. At Medina the greatest phase occurred at 10h. 43m., when 85-000ths of the sun's diameter would be obscured. In the clear skies of that part of the world such a degree of eclipse might be sufficient to bring out the brighter planets or stars. No larger eclipse, visible at Medina, occurred about this epoch.

"12. The Eclipse of 840, May 5.—Among the causes which are said to have brought on the '*maladie de langueur*' that terminated the life of

Louis de Debonnaire was 'the fright which a total eclipse of the sun had occasioned him.' It is related that the King was taken ill at Worms, and having been removed to Ingelheim, near Mayence; he died there on the 20th of June. I find the northern limit of totality in this eclipse passed about 100 miles south of Worms, and on the central line in this longitude the total eclipse continued 5m 25s., an unusually long interval for the latitude of central Europe. The middle occurred at 1.15 p.m., with the sun at an altitude of 57 deg. The phenomenon under such circumstances must have been a very imposing one, and well calculated in those days to inspire alarm.

"I have already described in your columns the track of the total eclipse of 1140, March 20 (William of Malmesbury) across this country, and merely refer to it now to add, that if any one of your readers is aware of its having been recorded as total in London, he might be doing an astronomical service by making the fact generally known.

"13. The Eclipse of 1133, August 2 (Willliam of Malmesbury), a great solar eclipse, considered as foreboding evil to Henry I. of England.—The central line traversed Scotland from Ross to Forfar, and the eclipse was, of course, large in every part of the country. It would be total in Northumberland. In the centre of Forfarshire totality continued 4m. 20s. Berwick-upon-Tweed was about 20 miles within the south limit.

"During the existence of the kingdom of Jerusalem there is mention of an eclipse which would appear to have been total in the city or its immediate neighbourhood, and has been variously dated from the election of Godfrey of Bouillon in 1097. I am inclined to think it must be to the eclipse of August, 1133, that the record applies, though previous or subsequent events may have been mixed up with it by the historian. Continuing the calculation of the track of total eclipse after leaving this island, I find it would enter Palestine near Jaffa, and pass over Jerusalem and Hebron, where the sun would be hidden $4\frac{1}{4}$ minutes about 3 p.m., and from Nablous on the north to Ascalon on the south the country would be in darkness for nearly the same interval. The magnitude of the eclipse of 1187, September 4, was rather more than 9-10ths at Jerusalem, the central line passing between eight and nine degrees to the north; in the eclipse of 1191, June 23, the magnitude was about 7-10ths.

"14. The Eclipse of 1433, June 7, long remembered in Scotland as 'the black hour.'—It was a remarkable eclipse, the moon being nearly in perigee and the sun not far from apogee. The central line traversed the country in a south-easterly direction, from Ross to Forfar, passing near Inverness and Dundee. Maclaurin mentions that in his time a manuscript account of this eclipse was preserved in the University of Edinburgh, wherein the darkness is said to have come on about 3 p.m., and to have been very profound. By direction calculation for Edinburgh I find the total eclipse commenced at 3h. 3m. and continued 3m 41s. At Inverness totality continued 4m. 32s. The after-course of this eclipse was north of Frankfort on the Main and Munich, over the Dardanelles, south of Aleppo, and thence nearly parallel to the course of the Euphrates to the north-east border of Arabia. The totality was observed in the Turkish dominions according to Calvisius.

"15. The Eclipse of 1598, February 25.—Maclaurin says the memory of this eclipse was preserved among the people of Scotland, and 'that day they termed Black Saturday.' He adds:—'There is a tradition that some persons in the north lost their way in the time of this eclipse, and perished in the snow'—a statement the probability of which our experience of recent phenomena by no means tends to support. The central

eclipse may be described as having passed about five miles south of Stranraer to the Bass Rock, a little south of Edinburgh, or, more precisely over Dalkeith. Totality came on at Edinburgh at 10h. 15m., and continued 1m. 30s. The duration was the same at Douglas, Isle Man. From the rapid motion of the moon in declination the course of the central line was a quickly-ascending one, in latitude on the earth's surface, the total eclipse passing off within the Arctic circle. Kepler must refer to another eclipse which was observed by Jessenius at Torgau on the Elbe, though he gives the above date.

"16. The Eclipse of 1652, April 8, to which reference is also made by Maclaurin as 'still famous among the populace of Scotland, and known among them by the appellation of Mirk Monday.' The central line passed over the south-east of Ireland, near Wexford and Wicklow, arrived on the shores of Scotland near Burrow Head, Wigtonshire, and running within a few miles from Edinburgh, Montrose, and Aberdeen, left the island at Peterhead. Greenock and Elgin would be situate near the north limit, and the Cheviots and Berwick upon the south limit of totality. The eclipse was observed at Carrickfergus, Ireland, by Dr. Wyberd. I find by direct calculation for this place that it was only just within the north limit of totality, which would commence at 10h. 8m. 30s., and continue 44s. This short duration may partly explain a curious remark of Dr. Wyberd, that when the sun was reduced to 'a very slender crescent of light, the moon all at once threw herself within the margin of the solar disc with such agility that she seemed to revolve like an upper millstone, affording a pleasant spectacle of rotatory motion.' Wyberd's further description clearly applies to the corona.

"I believe it has been generally supposed that the last total eclipse of the sun visible in England was that of 1715, May 3, so wel recorded by Hally in the 'Philosophical Transactions' of the Royal Society, and I was under this impression myself until, on calculating the elements of the eclipse of 1724 (May 22), observed at Paris, and by the French King at the Trianon, I discovered that before reaching France the belt of totality must have traversed the south-west of England, and it now appears that the totality did not pass by us unrecorded.

"I am indebted to the Astronomer Royal for referring me to an account by Dr. Stukeley, who observed the eclipse from Salisbury Plain. The duration of totality in that locality would be rather less than three minutes. The eclipse of 1724 is therefore the last that has been total in England, and as I have shown in a previous communication, there will be no other till August 11, 1999, and that will be confined to the south-west corner of the country."

To this the following reply appeared:

To the Editor of the *Times*.

Sir,—I should be glad to offer a few remarks on the very interesting communication of Mr. Hind on historical eclipses. I will endeavour to be as brief as the importance of the subject will permit.

In regard to events in history it is desirable to lay down some rule as to the respective provinces of historical testimony and science.

In regard to the time, the magnitude, and other circumstances of an eclipse, we must bow at once to the authority of men like Sir G. Airy and Mr. Hind. Dr. Hincks, indeed, asserts that in the mathematical

expression on which their calculations are founded there are some coefficients which admit of variation when the calculation relates to very distant epochs. But I do not presume to attribute any weight to this, as I am unable to test it. I accept the determination of all these points as calculated by these great astronomers. But there I feel their absolute authority ends. Their testimony is only one part of the case, and the other evidence must be examined.

In two cases I entirely demur to the conclusions drawn from the evidence of eclipses by Mr. Hind in his valuable Memoir.

These are (1) the eclipse of Thales, and (2) the eclipse of Xerxes.

1. The eclipse of Thales, May 28, B.C. 585. Both Sir G. Airy and Mr. Hind consider that this was the eclipse which terminated the war between the Medes and the Lydians. Now, Herodotus, who was born more than a century after this eclipse, is the original authority on which the connexion between this eclipse and Thales and the Lydo-Median war has descended to us. But Herodotus declares it to have occurred in the reign of Cyaxares, who died in B-C. 594, as all historical evidence and the authority of Herodotus himself leads us to believe. The question is largely discussed in *Clinton, F.H.*, vol. 1, p. 418. It may be added, however, that some ancient authorities state that it was in the reign of Astyages, the successor of Cyaxares. But, as Clinton shows, many circumstances concur in leading to the belief that this war terminated before B.C. 600. Able astronomers have fixed on two eclipses—B.C. 610 and B.C. 603, as the eclipse of the battle. Thales is said to have predicted the eclipse which closed the war. Some authorities would bring down the reign of Cyaxares beyond B.C. 585, by which they subvert all the most careful chronology, which is established on very strong evidence. But this is surely unphilosophical. A tradition first reported 120 years at least after the event connects the close of the war and the prediction of the eclipse by Thales with each other. Another later tradition connects the prediction of the eclipse with the eclipse of B.C. 585. The authority of Herodotus is explicit against a war between the Lydians and the Medes at so late a period. Therefore, if we connect the battle and the eclipse of B.C. 585 he entirely contradicts himself. Does not this teach us to examine the evidence on which these events are connected? A tradition passing through 120 years and many months, might easily be confused. Suppose the eclipse of B.C. 603 to have been the battle eclipse, and Thales, by the *Saros*,* to have predicted that of B.C. 585, is it not easy to see how this tradition might have arisen, and the two eclipses become confused? The answer usually given to this suggestion is, that only a total eclipse could produce so great a moral effect, and that Herodotus says "day suddenly became night." He says the same thing of another eclipse which was not total, except the word "suddenly." But there he adds, "the sun left the heavens." Surely there is not evidence enough in this tradition to overturn all established chronology, which is contradicted also by the author who reports it. We know little what the moral effect of a large eclipse might be in those ages.

2. The eclipse of Xerxes. Mr. Hind appears disposed to bring down the date of the battle of Salamis two years, on the evidence of an eclipse seen by Xerxes on his way from Sardis to Greece. There was no eclipse in B.C. 480, but a large one in B.C. 478. But there was also an eclipse in B.C. 482, and if we suppose him on his way from Susa to Sardis this might be the eclipse. His Magi predicted from it his conquest of Greece.

* *Saros*. This is the period of 223 lunations, for 18 years, 10 days, and 8 hours, by which the Babylonians calculated eclipses by their observations.

So that it could not be after his defeat; and the date of the battle of Salamis is too well known to admit of a reduction of two years. We must, therefore, believe that there is some error in the tradition, if we deny that any eclipse but that of B.C. 478 is to be accepted. It will be seen at once that a contemporary report of an eclipse stands on a very different footing from a tradition reported half a century afterwards.

These considerations are very important in regard to the evidence on which we accept accounts of historical events. Eclipses are very useful correctives when we can depend on their connexion with the events with which they are associated by tradition; but when that tradition is of a doubtful kind they must be subjected to the laws of historical evidence, as well as of scientific accuracy.

I remain, Sir, yours, &c., IGNOTUS.

THE METEOR COMET OF AUGUST.

To the Editor of the *Times*.

Sir,—The remarkable discovery made in 1866 by Signor Schiaparelli, director of the Observatory of Milan, that the August meteors move round the sun in an orbit almost identical with that of a large comet which became visible in July, 1862, has given occasion to several sensational announcements founded upon the close approach of the comet to the earth's orbit, at the point where it passes from the north to the south side of the plane of the ecliptic, at which point the earth arrives about the 10th of August, when for many years past (indeed, since Professor Quetelet's announcement of the periodicity to the Belgian Academy of Sciences in 1836) we have been accustomed to look for an unusual display of shooting stars. A few remarks may not be inopportune at the present time.

The second comet of 1862, as it is usnally termed, was first detected by Mr. Tuttle, now of the United States Navy, at the Observatory of Harvard College, Massachusetts, on the 18th of July, in the constellation Camelopardus, and was subsequently independently discovered at Florence, Rome, and Copenhagen. It presented a very conspicuous appearance in Corona Borealis and vicinity in the latter part of August, exhibiting a tail variously estimated, according to clearness of atmosphere, at from 25° to 30° in length. It was last seen in Europe, at Athens, on the 26th of September; but was followed at the Royal Observatory, Cape of Good Hope, till the 25th of October, when it was lost to view in the southern constellation Ara. A few weeks after the discovery of the comet it became evident that its path deviated sensibly from a parobola, the curve in which, for facility of computation, it is usual to suppose these bodies to be moving, and many comets show no appreciable deviation from this curve, even during a long period of visibility. Various elliptic orbits were assigned, but the last and most complete determination of the elements is by Professor Oppolzer, of Vienna, one of the most accomplished calculators of the present day. He finds the period of revolution to be 121½ years, and it is certain that this period must be very close upon the true one.

Now, it follows from Professor Oppolzer's definitive calculation of the elements, that in 1862 the orbit of the comet intersected the plane of the earth's annual path at a point which was situate only 430,000 miles from our track—a circumstance sufficient, under certain conditions, to have brought about a collision (so to call it) between the two bodies. In order, however, that this should be possible, the comet must have arrived