Possible errors in historical dates: Error in correction from Julian to Gregorian calendars

We have studied five major historical events reported between 1630 and 1680 AD, where detailed references to the stars in the night sky are available. We show that the descriptions of the star patterns at that time are off by exactly ten days. For example, the solar eclipse reported in one example to occur on 20 March 1680 in fact occurred on 30 March 1680 according to the current (Gregorian) calendar. This is checked using a computer simulation package (SkyMap Pro 8) and Oppelzer's Canon of Eclipses[1]. We attribute this error in dating historical event(s) due to the switch-over from Julian to Gregorian calendars in the latter half of the 18th century.

Important events in Indian history are dated to an accuracy of a specific date that is calculated based on the documentation of a specific period(s) and historical references. However, it is often difficult to verify these dates by independent means since historical references do not often carry independent markers. However, documents on comparatively recent Indian history often give detailed description of astronomical events, which can be independently verified using modern software programs designed using data from high-precision astrometry satellites like *Hipparcos* and *Tycho*.

It is observed that while writing the history of Shivaji Maharaj, nearly all the evidences are written according to the Julian calendar. Due to many defects, this calendar was reformed by Pope Gregory in 1582 AD and it was announced that after 4 October the next date will not be 5 October but 15 October. Hence ten days were deleted from the Julian calendar, which is now named as the Gregorian calendar.

The Catholic community immediately accepted this change but the Protestants, including the British accepted it only after 170 years, that is on 2 September 1752 AD. They took the next day as 14 September 1752 AD. This has a difference of 11 days because in the 170 years the difference between the two calendars increased from 10 days to 11 days. As the Protestants were ruling many countries across the world, such countries continued to use the Julian calendar till that time. In India also all the history written by British historians is according to the Julian calendar up to 1752 AD.

Julius Caesar introduced the Julian calendar and put it in practice in 45 BC. The duration of a year in his calendar was 365.25 days as found by the Egyptians. It differs from both the sidereal period *Nakshatra varsha* of 365.2564 days used in India and the tropical year of seasons equal to 365.2422 days. The two differ because Vernal Equinox (ascending node of earth's orbit) moves backwards, that is towards the west due to the precession of the earth's axis of rotation around ecliptic poles at the rate of about 1 degree in 72 years. This produces a difference of 1 day in about 71 years in the Indian calendar, and of 1 day in 128 years in the Julian calendar.

In 325 AD, the sun used to enter Vernal Equinox on 21 March. In the Julian calendar therefore, it was declared that 21 March will be the Vernal Equinox day and it was related to the resurrection of Christ. However, the error due to precession was not taken into account while fixing this date. By the late 1500s the discrepancy became marked. In 1582 AD, i.e. in 1258 years, the sun started entering the Vernal Equinox ten days earlier ($1258 \times 0.0078 = 9.8$ days). So on 11 March the sun entered the Vernal Equinox point. To correct this problem, Pope Gregory cancelled ten days of that year and after 4 October 1582 the next day was declared as 15 October 1582. The period of Gregorian calendar is 365.2425 days. So, there is still a difference of 0.0003 days. In spite of this, for the next 3000 years the sun will enter Vernal Equinox near 21 March[2].

In the history of Shivaji Maharaj, historians have converted the moon's position (*Tithi*) into Julian dates. However, after the British left, India has continued to use the Gregorian calendar introduced by the British in 1752. So, from 1582 to 1752 AD the difference of 10 or 11 days is also reflected in the calculation of *Tithi*. As a result, by Julian calendar 20 March 1680 was new moon, but by Gregorian calendar it was on 30 March 1680. This is highlighted in the records of events associated with the life and times of Shivaji Maharaj. A difference of ten days is also noted in the eclipse of January 1665 and August 1673, in the dates of stone inscriptions of Karnataka[3].

According to historians[4], the date of birth of Shivaji Maharaj was in the month of *Falgun* and the *Tithi* was *Vadya Tritiya*. Bhavar, Baneda and Bikaner horoscopes of Shivaji Maharaj indicate that he was born on *Sinha Lagna*[5]. Time of birth mentioned in *Jedhe Shakavali* and *Shivabharata* volumes yields *Simha lagna* only. This is three days after the full moon day of the month of *Falgun*. This also means that the moon was near the *asterism Purva* or *Uttara Falguni* (in Leo) when it was full and after three days, it was in *Hasta* (Corvus) or *Chitra* (Spica) in Virgo *asterism*. Also, three

Table 1. Historical dates with astronomical details and comparison between stated and accurate dates

Event	Julian date	Gregorian date	*Tithi* (moon's phase)	*Nakshatra* (position)*
Birth	19 February 1630	1 March 1630	*Falgun Vadya* 3	*Hastha*
Pratapgad war	10 November 1659	20 November 1659	*Margashirsha Shuddha* 7**	*Shravan*
Rescue from Agra	17 August 1666	27 August 1666	*Shravan Vadya* 12	*Pushya*
Coronation	6 June 1674	16 June 1674	*Jyeshtha Shuddha* 13	*Anuradha*
Death	3 April 1680	13 April 1680	*Chaitra Poornima* (Full-moon day)	*Chitra*

*According to software program by G. M. Ballabh.
**This *Tithi* is correct, because in 1659 it could have occurred between 18 November and 18 December.

days after the full moon day, the moon must have risen 156 min (52 × 3) later than on full moon night. So the moonrise must be approximately at 9 p.m. At that time the rising zodiacal constellation was Virgo. But the birth time of Shivaji Maharaj was in the evening, after sunset. So at that time the earlier constellation Leo must be rising on the eastern horizon. In the history of Shivaji Maharaj, his birthday is mentioned as 19 February 1630. However, the above references do not match with the star patterns on this date as extrapolated back in the Gregorian calendar. They match very precisely on 1 March 1630 (ten days later).

Another and probably more accurate example is the partial solar eclipse visible from fort Raigad in the year 1680. In the various biographies of Shivaji Maharaj, it is mentioned that partial solar eclipse was visible on 20 March 1680. From the Gregorian calendar there were no chances of an eclipse on that day because the sun was in Pisces and moon was in Libra. But on 30 March 1680, an eclipse did occur. It was in the constellation of Pisces. From Raigad the eclipse started at 4 h 37 min in the evening. The sun was 30 degrees above the horizon. The mid-eclipse time was 5 h 41 min in the evening. The sun was only 15 degrees above the horizon. The eclipse ended at time 6 h 38 m in the evening when the sun was only 1.5 degrees above horizon[1]. This observation exactly matches with the documented history.

Table 1 gives many other events in the life of Shivaji Maharaj, which confirm our observations. All the *tithis* are taken from ref. 4.

We therefore conclude that the manner in which dates are calculated in the historical timescales has carried the error of Julian and Gregorian calendar dates. Hence care must be taken while calculating the English calendar dates of the past events from periods earlier than late eighteen century.

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Molecular identification of *Phytophthora nicotianae* isolates causing leaf rot of betelvine (*Piper betle* L.)

Betelvine (*Piper betle* L.) is an important cash crop in Asia, with trade worth Rs 700 crores in India alone[1]. One of the major limiting factors in yield is foot and leaf rot disease caused by *Phytophthora parasitica* var. *piperina*[2] that sometimes causes 100% losses. The importance of molecular diagnostics in the management of this crop has been emphasized by Johri *et al.*[3] because morphological identification is laborious and requires high level of expertise and could also lead to false determination. In this communication, we attempted a survey of betelvine conservatories for natural occurrence of the disease, isolation of pathogen, genomic DNA extraction, polymerase chain reaction (PCR), Southern hybridization and restriction fragment length polymorphism (RFLP) analysis of the PCR products to establish the identity at molecular level and the relationship/differentiation between Indian and other known isolates of *Phytophthora*.

The pathogen was isolated on PDA plates at 25 ± 2°C from naturally infected betelvine leaves showing typical concentric rings, and pathogenicity was established on *P. betel*. Genomic DNA of fungal isolates was extracted as described earlier by Kistler *et al.*[4], with slight modification. The extracted DNA was treated with RNAase (10 mg/ml), Proteinase K (10 mg/ml), reprecipitated and finally suspended in 20 µl TE. DNA obtained was quantified by taking OD at 260 nm using a spectrophotometer.

PCR reactions were performed using ITS4 and ITS6 universal primers described earlier[5]. ITS6 was a universal primer designed to improve the amplification of a part of rDNA of Oomycota; it amplifies a ~ 900 bp product in combination with ITS4 primers. PCR reaction mixture (50 µl) contained template (50–70 ng), Taq DNA polymerase (3 u/µl), buffer (10 X), dNTP (10 mM), $MgCl_2$ (25 mM), primer (25 pmol/µl each). The initial denaturation was done at 94°C for 3 min followed by 25 cycles with the conditions of 94°C for 1 min (denaturation), 52°C for 1 min (annealing), 72°C for 1.30 min (extension) and a final extension at 74°C for 5 min. PCR products obtained were analysed by electrophoresis on the 1.0% agarose gel. For Southern hybridization, DNA bands obtained on agarose gel were transferred to Hy-bond membrane (Amersham-Pharmacia, UK) and hybridized with radiolabelled probe, prepared by random primer extension method as described earlier[6], using genomic DNA of a known *P. infestans* obtained from SCRI, Dundee, UK. For RFLP analysis, the PCR amplicons obtained from DNA of the fungal isolates and DNA of *P. infestans* (Scottish isolate) were run on LMP agarose gel, eluted and digested by *Alu*I, *Msp*I, *Taq*I restriction enzymes separately as suggested[7,8]. The digested DNA samples were analysed by electrophoresis on 1.3% agarose gel.