The Number 71.$\overline{428571}$ in Hindu Cosmology

Enoch Haga
Pleasanton Unified School District (Retired)

Zimmer, in his 1962 book, Myths and Symbols in Indian Art and Civilization, speculates that the number 14, used to divide a kalpa into manvantaras, was chosen in an attempt to reconcile a mahayuga chronology with a tradition of flood heroes. Each manvantara was divided by 71 and an unspecified fraction to produce the mahayuga. The purpose of this research was to find this fraction and discover the reason for its use. The repeating cyclic fraction, 1/7, provides a plausible explanation for use of the number 71.$\overline{428571}$ (71 and 3/7) in cosmology; for 22/7 as a value for π; and for concepts of time and circle division related to breaths per minute. The discovery of cyclic decimal fractions by Vedic scholars likely contributed to cyclic theories of cosmology and specifically to the concept of infinity in mathematics.

In the vast and intricate structure of Hindu cosmology, there are some fascinating mathematical byways. One of these is the curious cosmic divisor 71 and a fraction. Since Zimmer (1962, p. 16) did not reveal the fraction itself, the author made the calculation in an attempt to discover the reason for its use.

This fraction, which, appended to its whole number is 71.$\overline{428571}$, or 71 and 3/7, provides a real bonanza for the mathematics teacher. There is fascinating material here for use in presenting fractions, reciprocals, prime numbers, π, and time and circle divisions related to breaths per minute.

Further, in this day when it is so important to find relationships between various fields of study, this number uniquely links ideas in biology (respiration), cosmogony, cosmology, mathematics (number theory and history), mythology, and philosophy and religion.

Search for the Fraction

The search for the missing fraction was begun by suspecting a link between breaths per minute and the lunar and solar calendars. In the Hindu scheme, which dates from Vedic times, about 1500 B.C., creation is a process that has gone on and will go on forever. When the gods breathe, worlds and universes are created and destroyed, both sequentially and simultaneously. The gods are personifications of Brahman, the Ultimate Principle. Two such gods are Indra and Brahma.

One thousand mahayugas of 4,320,000 sidereal years correspond to a single day in the life of a Brahma, a kalpa of 4.32 billion years—a period remarkably close to the estimated age of our planet, 4.5 billion years (Horgan, 1993).

Zimmer posed the problem by noting that each kalpa is divided into 14 Manu intervals (in Sanskrit, *manvantaras*), and by speculating that this strange division is the result of attempting to reconcile a mahayuga chronology with a tradition of periodic flooding. This is evidenced by the names of flood heroes assigned to the 14 manvantaras, each culminating in a deluge and each subdivided into 71 and a fraction mahayugas. Other than his flood-hero theory, Zimmer sheds no light on the reason for these two divisions, first by 14 and then by 71 and a fraction.

But because the names of these flood heroes may have followed rather than preceded the mathematics, perhaps there is an easier explanation. The fact that an Indra lives for 71 eons, and that 28 Indra lives equal a single day and night of Brahma seems to confirm this (Zimmer, 1962, p. 6). The divisor 14 may result from dividing an Indra life into nights and days, that is, from hypothesizing a "moon breath" of 14 per minute parallel to a "solar breath" of 15 per minute, or perhaps from simply dividing the kalpa by the manvantara.

Breathing Begets Time

As is true of other old civilizations, Hindu astronomy was based on a long experience of lunar, solar, and stellar observation. An attempt was made to take simultaneously into account both lunar and solar revolutions. The daily positions of the moon and the monthly positions of the sun were referred to the positions of constellations on the ecliptic (Filliozat, 1966 vol. 4, p. 621).

A rough estimate of the lunar period was 28 days, just as it is today. In attempting to work out a lunisolar compromise, Hindu mathematicians may have noted the ratio 30/28, or, 1.0$\overline{714285}$, in one of its various forms. The appearance of "714285" in these fractions was encouraging.

As may be confirmed in any medical reference, an adult human being at rest draws 13 to 17 breaths a

minute, the normal rate being 15. One breath occurs every four seconds. In the Hindu scheme, it happens that 360 breaths (prana), 15 per minute, corresponded to the duration of a 24-minute "hour." Since each day was divided into sixty 24-minute hours, there were 21,600 such periods in a 360-day year (Filliozat, 1966 vol. 4, p. 621).

In tabular form:

1 minute	= 15 breaths (prana)
	= 14 hypothesized lunar breaths
1 24-minute hour	= 360 breaths
1 day	= 21,600 breaths
	= 60 24-minute hours
	= 24 60-minute hours today
1 360-day solar year	= 21,600 24-minute hours
1 336-day lunar year	= 20,160 24-minute hours

It seems reasonable to conclude that breathing was deeply involved in ancient Hindu concepts of duration, perhaps contributing to the idea of 60 as a time multiple (e.g., 4×15, the number four being associated with completeness or wholeness [Zimmer, 1962, p. 13]) and a 360-degree circle (complete cycle). Notice also that 4×7 days coincide with a 28-day lunar month. When 360 is divided by 14 (hypothesized lunar breaths per minute), the result is $25.\overline{714285}$. The ratio 21600/20160 (hypothesized solar breaths to moon breaths), as does $25.\overline{714285}/24$, repeats the clue in the number $1.0\overline{714285}$.

Eureka! The Discovery Is Made

At this point, the division was performed by dividing the kalpa of 4,320,000,000 years by 14, and it was surprising to see the resulting manvantara of 308,571,428.571428 years, the number to be divided by 71 and the unknown fraction. Seeing this, the author remembered a passage in Beiler (1966, p. 76) on cyclic nonterminating decimals. Beiler points out that 7 is the first prime number whose reciprocal, 1/7, is a cyclic decimal:

1/7 = .142 857	4/7 = .571 428
2/7 = .285 714	5/7 = .714 285
3/7 = .428 571	6/7 = .857 142

(Beiler separated the cycle into two halves to show that one half could be generated from the other by subtracting from 9, as in 9-1 = 8.)

Here revealed is both the missing fraction and the reason for its existence. Multiply the mahayuga, 4,320,000 years, by $71.\overline{428571}$, or 71 and 3/7, and obtain the manvantara of $308,571,428.\overline{571428}$, whose fractional portion is 4/7. One notices that even part of the whole number portion begins the fractional cycle. The divisor, 71 and 3/7, exactly divides the manvantara, producing the mahayuga.

The arithmetic is summarized in the brief table below:

1 kalpa	= 4.32 billion years
	= 1000 mahayugas
	= 1 day in the life of Brahma
	= 14 manvantaras
	= 14 Indra lives
1 manvantara	= 71 3/7 mahayugas
	= years $308,571,428.\overline{571428}$
1 mahayuga	= 4.32 million years

The cyclic nature of fractions like 1/7, with their magical qualities, may have conjured up in the Vedic mind notions of vast cosmic cycles. Somewhere nearby may lie the mystical significance of the number 7 itself. Since the ultimate cycle is a circle, it seems reasonable that these same fractions may help unravel the origin of 22/7, or $3.\overline{142857}$, as a good approximation of π. These decimal fractions, it was seen, cycled on forever, always returning, yet proceeding. Infinity is added to eternity. Perhaps, it is here that the genius and sweeping intelligence of Ramanujan, the famed 20th-century number theorist, had its beginning.

Multiplication of the mahayuga by 1,000 produces the kalpa. A similar multiplication of the ratio 30/28 by 1,000, followed by a subtraction of 1,000, may have been used to produce the integer and repeating decimal $71.\overline{428571}$. The author doesn't pretend to know the actual algorithms followed by the ancient mathematicians, but some were recently published (Abram, 1993).

Brahma lives only for 100 Brahma years, including days and nights, after which all universes are destroyed (Zimmer, 1962, p. 6). After another 100 Brahma years of latency, another staggering cycle of 311,040,000,000,000 human years (one kalpa x 2 [day and night] x 360 days x 100 years) is renewed (Zimmer, 1962, p. 19).

Conclusion

The repeating cyclic fraction 1/7 provides a plausible explanation for use of the number $71.\overline{428571}$, or 71 and 3/7, in Hindu cosmology. Also, it sheds light on the origin of cyclic theories of cosmology as well as

concepts of eternity and infinity. As a bonus, this fraction possibly helps explain the origin of 22/7 as a value for π and concepts of time and circle division related to breaths per minute.

References

Abram, T. (1993). An ancient Indian algorithm for multiplication. *ComMuniCator, 17* (4), 24-25.

Beiler, A. H. (1966). *Recreations in the theory of numbers*. New York: Dover.

Filliozat, J. L. A. (1966). Calendar, V. Hindu calendar. In *Encyclopaedia Britannica*, (Vol. 4, pp. 621-622). Chicago: Encyclopaedia Britannica, Inc.

Filliozat, J. L. A. (1966). Chronology, II. Hindu. In *Encyclopaedia Britannica* (Vol. 5, pp. 721-722). Chicago: Encyclopaedia Britannica, Inc.

Haga, E. J. (1994). Cycling through the cosmos. In *Exploring prime numbers on your PC* (pp. 79-81). Livermore: Enoch Haga Publisher.

Horgan, J. (1993). Off to an early start. *Scientific American, 269* (2), 24.

Zimmer, H. & Campbell, J. (Ed). (1962). *Myths and symbols in Indian art and civilization*. New York: Torchbooks, Bollingen.

Note: Enoch Haga's address is 983 Venus Way, Livermore, CA 94550-6345.

Although Professor Bear and Humpty Dumpty Had Long Been Colleagues, Professor Bear Could Not Resist the Temptation

To Discuss the Physics of the Situation.