

BEHAVIOURAL AND TETRATOGENIC EFFECTS OF SOLAR ECLIPSE

N. SETHI¹, M.S. (U.S.A.), Diplomate American Board of Pathology

The earliest recorded solar eclipse was on October 22, 2137 BC as mentioned in the Chinese 'Slue Ching'. The Chaldean astronomer in about 400 BC discovered that eclipses occur in regular succession at an interval of about 18 years, the cycle being called the Chaldean Saros. The exact interval is 223 lunations or 6585.3 days. Out of a total of 65 eclipses in 19th century only 4 total solar eclipses were seen over India, i.e. on December 21, 1843, August 18, 1868, December 12, 1871 and January 22, 1998. The first one passed over South India, the second over Masulipatnam, the third across the Madras Presidency and the last over Central India. Prior to the eclipse of February 16, 1980, there were sixty total solar eclipses during the present century, of which 3 were visible in India. The present one (Feb. 16, 1980) was observed between 2.00-5.00 p.m. in different parts of India. Here at Lucknow, where the work has been carried out, it began at 2.39 p.m. reached its greatest phase at 3.51 p.m. and deejlpsed at 4.55 p.m. It covered 70% of the sun's surface.

Each of the total solar eclipses have been considered significant mainly because of the following new discoveries in science :

- (1) Recognition of helium as a new element (August 18, 1868).
- (2) Tracing of Fraunhofer lines, especially those of sodium.
- (3) Continuous emission shortward of the Balmer limit (Jan. 22, 1898).
- (4) Einstein's theory was first confirmed, (May 29, 1912).

And since the probability of emission of non-ionizing radiation is high and is likely to affect the cognitive as well as

emotional functions, it occurred to us to observe its effect on pregnant animals (rats and rabbits) for the predicted period of the eclipse and follow those up to the completion of gestation period. This paper, therefore reports :

- (1) The changes in behaviour of rodents during the eclipse.
- (2) The effect on the foetus when pregnant mothers were exposed.
- (3) The effect on the postnatal development of the fetuses born to above mothers.

MATERIAL AND METHOD

Rats : Charles Foster rats about 90 days old and weighing 170 ± 10 g were used. The animals were kept in air conditioned quarters ($22 \pm 2^\circ\text{C}$), 60% relative humidity), illuminated 12/24 hours from 6 a.m. to 6 p.m. and supplied with food and water *ad libitum*. The regularity of the estrous cycle was checked daily by vaginal smears. Proestrous females were caged with males of the same strain at 6.00 p.m. and occurrence of copulation was established the following morning at 10 a.m. by checking the presence of sperms in the vaginal smears. Assuring a copulation time between 6 p.m. and midnight this then was day 0.5 of gestation, and in the course of paper reference to day 20 gestation will mean day 20.5. Thereafter the pregnant rats were weighed and caged individually. Thirty females were divided at random in three groups of ten animals. Selection of these animals was dependent on positive copulation, so that day 6 of gestation fell on February 16, 1980, the predicted day of solar eclipse. Animals of groups II and III were brought out in the open under

¹ Scientist, CDRI, Lucknow.

direct sun-rays and kept there from 2.00 p.m. to 5.00 p.m. for two days prior to the day of eclipse. Enough quantity of water and food was assured and observations were recorded regarding any gross behavioural change. On day 6 of gestation, i.e. the day eclipse only group III animals were kept in the open under similar conditions as of previous two days. Group I animals were not disturbed from their original place and thus comprised the normal control group, and group II of blank control group. From day 7—day 20 gestation all animals were kept under identical conditions and observations were recorded for behavioural change, eating habits, morbidity and mortality. On day 20 of gestation final body weight of animal was recorded and all were delivered by Caesarian section between 10.00 a.m. and 1.00 p.m. All mothers were checked for implantation and resorption sites and number of live and stillborn foetuses. Each female was weighed and examined for nongenital distance and other gross defects. One-third of the foetuses were fixed in Bouin's Solution and examined for visual abnormalities by the sectioning method of Wilson and Waskani (1964). The remaining foetuses were cleared in a 1% Kon solution and stained by Dawson's Alizarin Red technique for visualisation of osseous defects.

Rabbits : Thirty mated albino rabbits were used in this study. All of them had positive copulation on February 8, 1980, assuring to have day 8 of gestation on the predicted day of solar eclipse. These were divided in three groups of ten each. Then three groups I, II, III were treated similar to rats as follows :

- Group I .. Normal control
 Group II .. Blank control
 and Group III .. Experimental group.

The experiment was carried out as described above for rats.

OBSERVATION AND RESULTS

Animals when were exposed to direct sunrays during pre-eclipse days became less active after an initial phase of hyperactivity lasting for about 30 minutes. They consumed no food but water intake was normal. However during the eclipse time the two species behaved differently. Rats became very active and stayed so till the end. Rabbits on the other hand became progressively lethargic, consumed a lot of water, but no food. Their ears started drooping down and then was watery discharge from the eyes. This condition of the rabbits lasted for 72 hours post eclipse period. However the rats resumed their normal behaviour and eating habits within 12 hours post eclipse. On Caesarian-delivery 9 of 10 rats of group III showed resorption of the embryos with no live birth. The remaining one had a better with five foetuses all being still births (Table I). Animals

TABLE-I—Effect of solar eclipse on rabbit foetus
 Experimental Groups

Parameters	I (Standard control)	II (Blank control)	III (Experi- mental)
1. Total No. of animals used	10	10	10
2. Sun-exposure	Nil	Pre-eclipse	Pre-eclipse + during eclipse
3. Maternal toxicity	Nil	Nil	Nil
4. Maternal gain in body wt. (Kg)	1.2	.980	0.570
5. Implants total per animal	48 4.8	56 5.6	50 5.0
6. Resorptions total %	4 8.33	18 32.1	46 92
7. Live births total %	44 83	38 68	8
8. Still births total %	—	—	—
9. Foetal weight (g)	42.8	38.4	40

of Group II showed increased resorption and smaller foetuses as compared to the normal control.

Table I and II summarise the different parameters and highlighted the following :

- (1) Resorption rate is very high in animals which were exposed to sun-rays.
- (2) It is still higher in those animals, which were exposed to solar-eclipse in addition to direct sunrays.
- (3) Both species showed similar response.

TABLE-II—Experimental Groups

Parameter	I (Standard control)	II (Blank control)	III (Experi- mental)
1. Total No. of animals used	10	10	10
2. Sun-exposure	nil	pre-eclipse	Pre-eclipse and during eclipse
3. Maternal toxicity	nil	nil	nil
4. Maternal gain in body wt. (g) \pm S.I)	60 \pm 8.42	50 \pm 7.33	46 \pm 9.46
5. Implants total per-animal	88 8.8	84 8.4	90 9.0
6. Resorptions total %	7 9	22 28.5	25 94
7. Live births total %	81 90.9	62 71.4	3 3.33
8. Still births total %	—	—	—
9. Foetal weight (g) \pm S.I)	4.5 \pm 0.02	3.8 \pm 0.06	2.20

Rabbits (Table II) 9 of 10 rabbits of group III showed complete resorption with no live foetus and the remaining animal had a litter of 4 live foetuses. The external examination of these foetuses showed no evidence of any external deformity. Animals of group II showed 32% resorption as compared to 8.33% in the standard control group.

The effect of sun as well as solar-eclipse was obvious in both species of animals and

similar results were observed. The number of live-births was reduced when the animals were exposed to sun-rays alone. It became more marked when in addition those animals were exposed to the sun-rays during solar eclipse time as well.

For a discussion of birth defects one does not know to determine aetiology of birth defects. Cumulative evidence indicates that hereditary and environmental factors both play an important role. The inherited genes can be expected to modify or prevent the development of genetically determined structure by exogenous factors. Drugs and physical agents are some of the very important exogenous factors. Physical agents including ionised radiation make a substantial contribution towards production of mongolism, hence fluoroscopy and radiotherapy is avoided in a pregnant mother. During the solar eclipse the probability of emission of non-ionizing radiations is high and little is known as to the pathophysiological changes produced by these. In our experiment the striking observation is of foetal death indicating embryotoxicity. An increase in the foetal death is always observed in the assessment of teratogens because of interplay with malformation. A comparatively higher rate of resorption seen in our blank control as compared to the standard control may be due to the effect of other physical agents such as heat, light, noise and change of environment, etc.

The same work if carried out at places, along the totality path (from Ankola-Puri) of the eclipse may have generated some more interesting data and dose-relationship. The present report thus serves to delineate some evidence about the legendatry 'tales' of solar eclipse are not without foundation.

ACKNOWLEDGEMENT

Thanks are due to Mr. S. K. Mathur, Mr. S. K. Khan, for their dedication in carrying out the study.