

ture) under climate change also remains unattended so far¹². It is paradoxically surprising that while India is being projected among the worst-hit countries by climate change owing to its devastating impact on agriculture, the response of soil science in India is far below expectations. Knowledge of the possible changes in soil fertility and nutrient availability is required for a holistic assessment of climate-change impacts on agricultural sustainability, and also for evolving an integrated strategy for climate-change adaptation in India. To this end, the soil science community in India needs to assume greater responsibility by recognizing and responding to the challenges posed by climate change, so that food

security for more than one-sixth of humanity can be ensured in the future.

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A new conservation policy needed for reintroduction of Bengal tiger-white

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The conservation value of the Bengal tiger-white which is chinchilla albinistic has been discounted on the notion that the whole population has descended from a single white male caught in the jungles of Rewa, Madhya Pradesh, in 1951, which was later named Mohan¹. But empirical facts prove otherwise. Although it is true that the Rewa strain of white tigers originated from Mohan, subsequently another strain of white tigers was born in 1980 to orange-coloured Bengal tigers at Nandankanan Zoo, Bhubaneswar, Orissa, which have their ancestry from a different forest area^{2–4}. The multiplicity of sightings of the Bengal tiger-white in a vast area ranging from central India to Assam also point in the same direction.

Between 1920 and 1930, fifteen Bengal tigers-white were killed in the forests of Bihar⁵. The Tiger Species Survival Plan devised by the Association of Zoos and Aquariums has condemned the breeding of white tigers on the allegation that they are of mixed ancestry; hybridized with other subspecies and are of unknown lineage. Although this is true of offsprings that have originated from a cross between the Bengal tiger-white and the Siberian tiger which are found in the US, it has no application to the Bengal tigers-white kept in Indian zoos.

Incessant inbreeding for several generations leads to the expression of deleterious

traits in animals^{6,7}. This can be observed among Asiatic lions⁸, Bengal tigers and Bengal tigers-white. But there are, in Indian zoos, several healthy Bengal tigers-white born to heterozygous recessive Bengal tiger parents which are only carriers of the white trait. The genes that are responsible for deleterious traits and deformities are not directly linked to white pigmentation. The only exception to the above is Strabismus or crossed eye, which is known to have a direct link to the gene causing white colour. But this has been observed outside India mainly among white tigers with mixed Bengal and Siberian ancestry but for one exception of a Bengal tigress-white, Rewati in Washington DC^{9,10}. A few isolated cases of arched back, clubbed feet and still birth have been reported from the Delhi zoo during the 1960–1970s (ref. 11). But in the recent past, there have not been reports from Indian zoos of any such occurrences exclusively in the case of Bengal tigers-white. It cannot, therefore, be categorically asserted that the above abnormalities were due to white pigmentation. Abnormalities can also arise due to lack of proper diet, maintenance or inbreeding.

Analysis of data from the Central Zoo Authority of India shows that the mortality rate among Bengal tigers-white (6.73%) in all Indian zoos put together is lower than that of Bengal tigers (8.19%)

for the five-year period (2004–2009). Likewise, the birth rate among Bengal tigers-white (12.74%) is much higher than that of Bengal tigers (4.93%) for the same five-year period. The comparison between the respective mortality rates and birth rates of the Bengal tigers-white and Bengal tigers shows a better survival edge for the former. The contention that the low mortality rate and high birth rate among Bengal tigers-white in zoos can be attributed to the special treatment given to them in respect of their diet and enrichment is not justified according to the enquiries made with zoos in India.

Historically speaking, the genes responsible for white colour are represented by 0.001% of the population. However, in 2008–2009, a closing stock of 264 Bengal tigers and 100 Bengal tigers-white were accounted for in Indian zoos. The disproportionate growth in numbers of the latter points to the relentless inbreeding resorted to among homozygous recessive individuals for selectively multiplying the white animals (Figure 1). The present practice in some Indian zoos is to mate two homozygous recessive white individuals to get all progeny white. This progressively increasing process will eventually lead to inbreeding depression and loss of genetic variability. Such breeding with immediate kin flies in the face of guidelines issued by the International Union for Conserva-



Figure 1. Kinship in confinement: chance for inbreeding – Hyderabad Zoo.

tion of Nature (IUCN) and the Central Zoo Authority of India as well.

Animals have a natural tendency towards the avoidance of inbreeding, and if let free into the wild, a healthy and vigorous population is most likely as a result of hybridization with cousins, the orange-coloured Bengal tigers. This is the reason why captive breeding programmes contemplate out-crossing white tigers with distantly related healthy, orange individuals as is being done in Nandankanan Zoo. However, it is advisable to showcase in zoos, a couple of healthy white individuals as representatives of the Bengal tiger-white, which is a mutation caused in nature without any human interference. The fact that the Bengal tiger-white was not able to survive and multiply to the desired level in the wild was mainly because of hunting, poaching and superstitions. However, proper surveillance and sensitization programmes can surmount these problems.

As has been tried out in several cases, reintroduction programmes will help improve the situation. The Golden Lion Tamarin (*Leontopithecus rosalia*), Père David's Deer (*Elaphurus davidianus*) and Przewalski's Horse (*Equus ferus przewalskii*) have been re-introduced into the wild through captive breeding programmes. In India, captive bred Pygmy Hog (*Porcula salvania*) has been introduced again into the Sonai Rupai Wildlife Sanctuary and Gorumara National Park, Assam, and Bengal tigers into the Sariska Tiger Reserve, Rajasthan. There

is a proposal to introduce the African cheetah into suitable wild locales in western India even as the recently extinct Indian cheetah is more affined to the Iranian variety. There is another proposal on the anvil to introduce lions from the Delhi and Hyderabad zoos into the Kuno sanctuary, Madhya Pradesh on account of Gujarat's reluctance to part with lions caught from the wild and kept in zoos there. Likewise, healthy individuals from among captive Bengal tigers-white can be reintroduced into an isolated tiger population in a reserve forest area of the Bandhavgarh National Park adjoining the district of Rewa or that of Orissa in a phased manner on an experimental basis, conforming with the guidelines issued in this respect by IUCN/Species Survival Commission (SSC) Re-introduction Specialist Group. There had already been plans for reintroduction of the white tiger to the reserve forests of Rewa¹². Such a programme may take only three to four generations to get the Bengal tiger-white wild.

Misgivings expressed about undetected illnesses likely to be contracted from the Bengal tiger-white in zoos by the wild tiger population at large are unfounded. There is also the assumption that the reintroduction of the Bengal tiger-white into the wild will cause a skewed effect by the prevalence of the mutant gene, out of all proportion, due to the limited number of founders. This is not likely as reproductive opportunity and success are not equally distributed among members of the founder group

and natural sexual selection will take place among the population, regulating the effect of the newly introduced genes.

Beneficial traits like the ability to reproduce and maintain good health among the Bengal tigers-white can contribute to the natural gene pool of tigers. These genes are conserved even in captivity and have, therefore, an inherent right to survive in the wild. The desideratum is to chalk out a new conservation policy with regard to reintroducing the Bengal tiger-white into the wild.

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