

## Nature Watch

### Biological Invasion and Loss of Endemic Biodiversity in the Thar Desert

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The Thar desert situated in northwestern India was an undisturbed ecosystem fifty years ago. It was a vast range land with large expanses of grasses, the predominant species being *Lasiurus indicus* in areas below 150 mm rainfall as well as *Cenchrus ciliaris* and *C. setigerus* spread all over the arid region. Although tree diversity was low, the density of shrubs such as *Ziziphus nummularia*, *Capparis decidua*, and *Lepadenia pyrotechnica* was quite high by desert standards. The livestock population was low, 9.4 million (1951 census). As a consequence, the grazing stress on the vegetation was sustainable and the regeneration of all plant species was in consonance with the requirement of the grazing animals, both livestock and wild beasts.

Desert dwellers, 5.5 million in 1951, were dependent on rainfed agriculture, growing millets and pulses whose water requirement is relatively low. The economy of people was pastoral because of the unpredictable and erratic monsoonal pattern. Water was a precious and a rare commodity, hence rain water was rigorously harvested for human and livestock consumption. Wild animals also utilised the accumulated water for drinking.

The Thar desert harbours a spectacular diversity of biota possessing Saharan, Turanian and Oriental affinities (Box 1). The past history of wildlife inhabiting this arid zone has been well recorded by naturalists. Jerdon [1] mentioned that herds of about 200 wild ass, *Equus hemionus*, roamed the interdunal plains near Bikaner and Jaisalmer during the late nineteenth century. Adam [2] recorded the presence of the lion *Panthera leo*, in southern Jodhpur and Sirohi. Blanford [3] was of the view that the home of the caracal *Felis caracal* was the 'Rajputana' desert. Erskine [4] gave a vivid description of the abundance of

**Box 1. Zoogeography**

The Thar desert is situated in the unique biogeographical location in the Indian subcontinent. It extends up to the Sahara on its west through the deserts of the Middle East. On the east, it is bounded by the oldest Archaean Aravalli mountain range. The northeast merges with the geologically recent Gangetic plains. As a consequence of its geomorphological configuration, the Thar desert is a conglomeration of Saharan, Turanian, Oriental and Peninsular biological taxa. The genera *Gazella* and *Meriones* are spread from the Sahara to the Thar and further to the Gobi desert in the north. Since a fair number of species of these genera occur in northern Africa these are thought to have originated in the Sahara. However, the species *Meriones hurrianae* has an Irano-Tharian distribution. It does not occur east of the Aravallis. A number of mammals are endemic to the Orient such as the blackbuck *Antelope cervicapra*, the blue bull *Boselaphus tragocamelus*, the four-horned antelope *Tetracerus quadricornis* and they find their western limit in the Thar. A few taxa originated in the Peninsula (Deccan) such as *Chameleo zeylanicus*, *Bandicota bengalensis*, and *Golunda ellioti* have invaded the desert during the recent past. About four per cent of vertebrate fauna is macro-endemic and 14 percent micro-endemic to the Great Indian Desert.

the blackbuck *Antelope cervicapra*, Indian gazelle *Gazella bennetti*, wild boar *Sus scrofa* and the four-horned antelope *Tetracerus quadricornis* on the foot hills of the Aravallis facing the desert. During the 1950's, I have myself watched large herds of blackbuck and gazelles and very large flocks of the common sandgrouse *Pterocles exustus* and the great Indian bustard *Ardeotis nigriceps* throughout the arid environment. I have also watched a preponderance of houbara *Chlamydotis undulata* and imperial sandgrouse *Pterocles orientalis* which migrate to the western desert during the winters. During my field work, 1952-1964, I used to observe a variety of lizards and snakes even in the extreme desert. I had collected up to 12 saw-scaled vipers *Echis carinatus* during a 15 km long night walk. The diurnal toad agama *Phrynocephalus laungwalensis* was abundant on loose, bare, barchan (wind blown, shifting) sand dunes.

After the 1960s man's attention was diverted towards the Thar desert to exploit it as a future 'land-bank'! The human population escalated to about 18 million in about 40 years and the number of villages increased. As a consequence, cropping started even on marginal lands, thus drastically shrinking the area of grazing land which resulted in severe paucity of feed and

**Box 2. The Indira Gandhi Canal**

The brilliant idea of bringing in Himalayan water for drinking purposes into the desert was conceived during the 1950s by Kanwar Sain, the then Chairman of the National Water and Power Commission. The construction of the Indira Gandhi Canal started in 1958 and irrigation facilities were developed from 1961 onwards. The canal aims at ushering in a new era by converting the rainfed subsistence agriculture of farmers into irrigated commercial cropping. The canal emerges from Hari-Ka-Barrage in Punjab and through a 204 km long feeder canal passing through Haryana enters the Thar desert. The 545 km long main canal runs through the 100-250 mm rainfall zone of our northwestern districts of Rajasthan. The 8000 km long network of distributaries will convert 11 percent of the desert into arable land and producing food and fibre for humans. However this transformation will be at the cost of the vast grassland and its deserticolous inhabitants. Constructed at a cost of more than 1000 crore rupees, the canal has improved the quality of life of human desert dwellers, crop production has enhanced manifolds and the livestock survival has improved. But the over-exploitation of the good quality Himalayan water has several adverse effects also. The alluvial and inter-dunal plains have gypsiferous hard pen sediments, which are responsible for serious water logging and salinity-alkalinity problems. Moreover, natural surface drainage system is absent and the ground water is highly saline. Consequently, the water table is rising at an alarming rate, almost one meter per year. Silting of the canal due to shifting sand is a major problem. The change in land use pattern has tangible impact on biodiversity, with the deserticolous species being replaced by the invading mesic element. A number of human diseases such as malaria, and cutaneous leishmaniasis are emerging. These had never occurred earlier in the desert environment.

fodder for wild herbivores. In addition, an exponential rise in irrigation from bore wells and networks of canals, especially from the Indira Gandhi Canal, has occurred during the last 30 years (Box 2). The area under irrigated crop fields has increased from 3 lakh hectares to 40 lakh hectares. Moreover, the livestock population is also playing havoc in the arid zone. Paradoxically, along with the reduction in grazing area, the livestock numbers have registered an alarming increase, from 9.4 million in 1951 to 25 million at present. The grazing livestock animals are spread throughout the desert along with thousands of shepherds moving with their herds, thus leaving no habitat undisturbed for the survival of wild animals. The impact of grazing is so severe that only unpalatable annuals are available during the monsoon, which prompted the observation by Shankarnarayan [5] that the natural succession trend of vegetation has been reversed! All these ecological changes – transformation of desert grassland into irrigated crop fields, recent occurrence of large number of

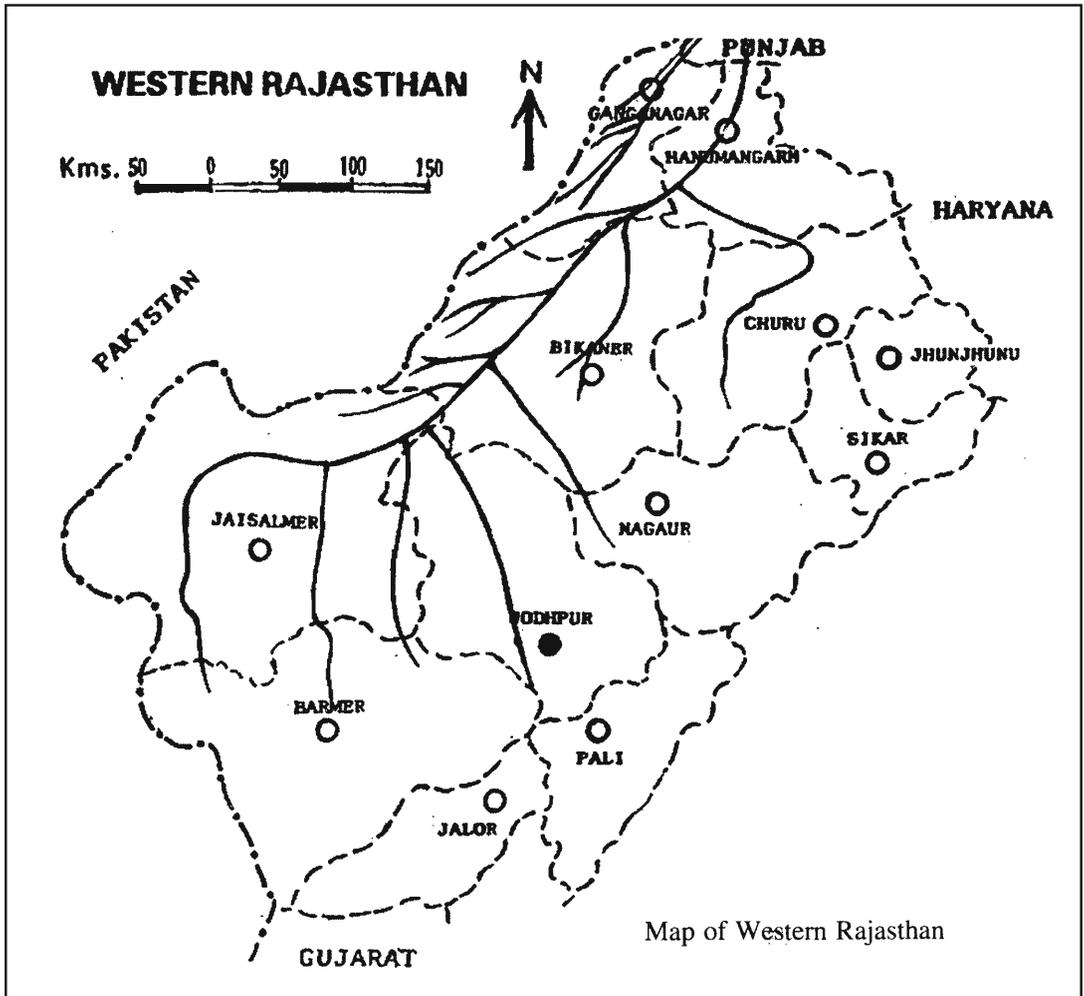


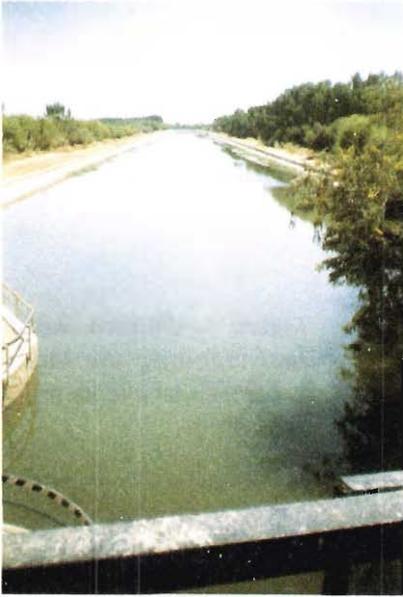
water bodies and availability of soil moisture throughout the year (instead of only during the monsoon period) – have resulted in invasion of mesic species into the desert and in loss of endemic deserticolous biodiversity, of both animals and plants which are not found anywhere else in the country.

### Invasion of the Desert

The invasion of biota is occurring through two geographical routes, from the north (Haryana and Punjab, along the Indira Gandhi canal) and from the south, along the western border of the Aravalli mountain range (Figure 1).

**Figure 1. Western Rajasthan showing the Indira Gandhi canal and its tributaries.**





**Figure 2.** The mighty Indira Gandhi Canal.  
(Photo: R N Bhargava)

Prior to land-use changes, the vegetation in the northern desert (Ganganagar district) was typically deserticolous and with the incoming of the unlined Gang canal, during 1927-1930 irrigated crops replaced the grasslands and the region was gradually infested by weeds invading from the Punjab. Irrigation from the Indira Gandhi (IG) canal (Figure 2) started during the 1960s in Suratgarh and Hanumangarh district, later up to Bikaner and now up to Mohangarh though the canal has extended up to Ramgarh. The main canal is about 545 km long and its tributaries are expected to extend into a 8000 km long network.

The water hyacinth, which never occurred in the region as there were no perennial water bodies, has intensively encroached the entire water surface of the canal to such an extent that it obstructs the flow of the canal water at certain points. The waterlogged areas are full of tall grasses such as *Arundo*, *Typha*, *Phragmites* and others. Saxena [6] has reported a large number of newly introduced weeds which are flourishing owing to high nutrient and moisture availability. About 40 weed species have invaded the desert through transport of soil and water, crop seed impurities and due to migration of birds and animals.

Insects very quickly intrude into new areas and with the presence of irrigated crops a large number of them such as the stem borer *Spenoptera gossypii* from cotton, *Heliothis* spp. from pulse crops, white grub *Adoretus bembinator* from sugarcane have been reported for the first time from the transformed regions. Vyas [7] recorded the occurrence of 18 new insect species, which were not found in the grasslands prior to irrigated cultivation. Moreover, 13 species that were minor pests have now assumed major pest status. These are the results of preliminary work by Vyas and more intensive studies will reveal the invasion of many more species. Riverine insect species like *Schizodactylus monstrosus* have been recently collected from the banks of the canal in the Mohangarh–Ramgarh sector.



Since the canals fetch water into the desert from the Ravi–Beas river system, many fishes from the Himalayan range have invaded the northwestern arid zone. Johal [8] has reported new records of nine Himalayan fish species in the IG canal and in water logged areas. With the expansion of IG canal tributaries, these fishes are expected to spread their distribution in the desert.

With the creation of new perennial water bodies in the northwestern desert, about 32 species of water-loving birds which never occurred in the region earlier have been reported by Rahmani [9] and he expects that about 70 more species will gradually occur in the IG canal region.

Before the establishment of irrigation in the northwestern desert, 80 percent of the rodent fauna throughout the desert was constituted by the gerbils *Gerbillus gleadowi*, *Tatera indica* and *Meriones hurrianae*. We have examined the impact of irrigation on the species composition of rodent pests and have found that the bandicoot *Bandicota bengalensis* and the metad *Millardia meltada* have invaded the crop fields almost totally replacing the gerbil population. However, the versatile Indian gerbil *T. indica* has adapted to burrow in the superior soil moisture regime and still inhabits the irrigated crop fields.

Bandicoot and metad are peninsular elements and Blanford [6] mentioned that they do not occur in the desert region. It is, however, conjectured that both species have migrated into the desert with the enhancement of mesic conditions made available to them by man by expanding irrigated agriculture. Moreover, the house mouse *Mus musculus* has ventured out of the residential premises and is abundantly found in sugarcane and wheat fields.

*Tatera indica* is the well-known reservoir of the plague bacillus *Yersinia pestis* and *B. bengalensis* is susceptible to the disease, its rate of positivity being 15.4 per cent. Occurrence of both these species in the same habitat is dangerous since if infected *Xenop-*

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*sylla cheopsis* or *X. astia* fleas shift from *T. indica* to *B. bengalensis* which comes in contact with *Rattus rattus* (common rat) an eruption of plague may occur. On the other hand, the shrew *Suncus murinus* is an uncommon insectivore in the desert while in the crop fields it is fairly common in Ganganagar district, and its susceptibility to the plague bacillus is being established.

The preferred habitat of the porcupine *Hystrix indica* is rocky formations, especially in the foothill slopes. But in recent years it inhabits slopes of tall sand dunes along the IG canal. At night, it raids the crop fields and inflicts considerable damage to crops. With the establishment of conducive habitat in the irrigated crop fields it must have migrated from Punjab, Haryana and possibly also from adjoining Pakistan. The wild boar *Sus scrofa cristatus* never occurred in low-rainfall desert but presently it is fairly common and it is conjectured that it is migrating from Pakistan. The blue bull *Boselaphus tragocamelus* can thrive without drinking water for two to three days and since water was not available, it was not found in Jaisalmer and Bikaner districts. But at present small herds are encroaching the IG canal irrigated fields (Figure 3). The status of the Indian gazelle *Gazella bennetti* is not clear. Since it can survive without drinking water, small herds were found in the region. Presently, however, their herd size has increased but they remain in the grasslands and attack the standing crops for feeding upon green forage.

It is thus clearly evident that the changes in the ecological scenario have augmented the species richness in the IG canal



**Figure 3. Fairly large herds of blue bull have intruded in the canal command area due to availability of drinking water.**

(Photo: R N Bhargava)

zone of the Thar desert.

The other route of invasion of biota into the desert is through the western slopes of the Aravalli mountain range facing the Thar. The painted partridge *Franco-linus pictus* occurs in this region in the Sirohi and Pali districts.

Three peninsular rodent species

have migrated into the desert through this route in recent years.

The metad *Millardia meltada*, the bush rat *Golunda ellioti* and the bandicoot *Bandicota bengalensis* were not trapped from this region during my surveys in 1952-54. In 1970, these three species were collected in low numbers, but during 1993-95 their frequency of occurrence was found to be abundant. These peninsular elements inhabit the irrigated crop fields. Another example of invasion of the desert by peninsular fauna was observed very recently. The Indian chameleon *Chameleo zeylanicus* (Figure 4) was captured from Bhopalgarh (26°55 N and 73°5 E) in the 250 mm rainfall desert. This beautiful lizard was not recorded by earlier workers and appears to be a new addition to desert fauna.



**Figure 4. A peninsular element, the chameleon has recently invaded the desert.**

### Biodiversity Loss

Vast grasslands of *Lasiurus indicus* occur in the northwestern desert, almost along the entire length of the IG canal. This grass grows over highly permeable soils receiving up to 200 mm rainfall. It does not survive in relatively higher rainfall zones. The changes in land-use pattern are serious threats for this grass, and it will ultimately vanish from the region where soil moisture is high and persists all the year round. A number of shrubs such as *Calligonum polygonoides*, *Haloxylon salicornicum*, *Dipterygium glaucum*, *Tribulus alatus* and the sedge *Cyperus conglomeratus*, which are adapted to survive only in extreme xeric conditions will also disappear by the time about 15 per cent of the desert is irrigated by IG canal tributaries. In the north-eastern region (Churu, Jhunjhunu and Sika districts) even the

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sand dunes are being irrigated by the tube (bore) well water and typical deserticolous vegetation is being replaced by newer weeds and plant species. It is expected that after a few years, canals bringing water from Sardar Sarovar dam will also alter the land-use pattern in the southern desert (Jalore district). Thus the entire endemic desert flora is facing a threat from irrigation since it will eventually be replaced by the invading mesic and water-loving species.

Since water consolidates the soil, imminent danger has emerged for the reptiles which inhabit extremely loose soil. The endemic, diurnal toad agama, *Phrynocephalus laungwalensis*, a cute little lizard with vivid colour spots on the dorsum, blue, green, yellow, crimson red and black, buries itself, when apprehended, in the loose sand by peculiar lateral wriggling movements of its body without the aid of its limbs. It is fairly abundant in western Jaisalmer district. Due to non-availability of loose soils, it will eventually disappear from the soils hardened due to irrigation. Another lizard, with atrophied limbs, almost swims with serpentine movements below the soil surface, hence its Persian name *Rig mahi* (sandfish)! This nocturnal lizard *Ophimorus tridactylus*, is plentiful over the barren sand dunes, preferring the barchans which are composed of extremely loose sand. The sand boa, *Eryx* spp., also buries and conceals its entire body under the sand and protrudes out only its head and waits to pounce on its prey – insects, lizards or small mammals. In stabilised soils, the boa will not be able to utilize this strategy. Further monitoring will reveal whether the boa evolves new methods of procuring food or whether it migrates out of the consolidated soil areas or disappears as the desert.

Some reptiles highly adapted to survive in extreme xeric environments, and exhibiting Saharan and Irano-Tharian affinities are likely to be affected by the transformation of desert grassland to irrigated crop fields. The lizards *Eumeces teaniolatus*, *Acanthodactylus cantoris*, *Cyrtodactylus kachhensis*, *Ablepharus grayanus*, *Stenodactylus orientalis*, *Ophisops jerdoni* and the snakes *Leptotyphlops macrorhynchus* and *Lytorhynchus paradoxus* are also



likely to disappear from the northwestern desert.

The impact of irrigation on the endemic avian fauna has not been so far fully studied. It has already augmented the avian richness in the desert but which of the grassland birds will shift their ecological niche or would perish is not known; perhaps the winter migratory birds will prefer the altered habitat. This needs to be monitored in the coming years.

The scope of biological invasion due to the fast changing ecological scenario in the Thar desert is enormous. But it will be at a great ecological cost due to the irretrievable loss of native biodiversity.

### Suggested Reading

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