Faunal Ecology and Conservation of the Great Indian Desert

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Editors

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Foreword

The Thar Desert, also known as the Great Indian Desert, is a large, arid region in the northwestern part of the Indian subcontinent. With an extent of 280,000 km^2, it is the 17th largest desert in the world. It lies mostly in the Indian state of Rajasthan, and extends into the southern portion of Haryana and Punjab and into northern Gujarat. The Thar Desert is bounded in the northwest by the Sutlej River, in the east by the Aravalli Range, in the south by a salt marsh known as the Rann of Kutch, and in the west by the Indus River.

In spite of the fact that climatic conditions are very harsh, this extremely hot region of the country exhibits a vivid and spectacular biodiversity. It is an important area biologically, at the confluence of very different habitats, namely grassland, sand dunes and rocky expanses as well as forested domains. Due to the diversified habitats, the vegetation and animal life in this arid region are very rich. Some wildlife species, fast disappearing from other parts of India, are found in large numbers in this desert, such as the Great Indian Bustard, Blackbuck, Indian Gazelle and Indian Wild Ass in the Rann of Kutch. The Desert National Park is an excellent example of the Thar Desert ecosystem, and its diverse fauna. The region is a haven for migratory and resident desert birds.

This publication on the *Faunal Ecology and Conservation of the Great Indian Desert* is thus a significant contribution to knowledge of desert ecosystems and their conservation worldwide. It is the outcome of concerted efforts by several experts in various fields. The authors of this publication have also taken care to present their information in a format that can serve as ready reference for researchers. The sixteen chapters on different aspects of the climate, fauna and conservation of the Great Indian Desert cover a wide range of desert inhabitants–from insects to mammals, including humans.

C. Sivaperuman, Q.H. Baqri, G. Ramaswamy and M. Naseema have fruitfully collaborated to produce this valuable volume. Their efforts are praiseworthy.

New Delhi, September 2008

G. Balachandhran
Additional Secretary and CEO
Food Safety and Standards Authority
Government of India
Ministry of Health and Family Welfare

Preface

The Great Indian Desert, or Thar Desert, is biogeographically the easternmost edge of the Saharan-Arabian desert zone, with an extent of 280,000 km^2. This hot desert in the north-western region of India is unique and the only habitat of its type on the Indian subcontinent. The Thar Desert is an important area biologically, being characterised by the juxtaposition of very different habitats, namely grassland, sand dunes and rocky expanses.

Before independence, the major portion of the Thar Desert was under the rule of the princely states of Jaisalmer, Jodhpur and Bikaner (now in Rajasthan). It was the desire of every ruler to bring water to these thirsty landscapes, so as to provide water for drinking as well as irrigation purposes. One of the first attempts to cultivate the desert was made by Maharaja Ganga Singh, the ruler of Bikaner State, channelling water from Sutlej via a canal later named the Gang Canal. The construction of this canal was initiated in 1920 and was commissioned on 26th October 1927; the construction work was completed in 1928. Its total length was initially 130 km, irrigating about 1.4 lakh ha only in Bikaner State.

After independence, a separate plan was drawn up by the Government of India to bring water to adjacent areas under cultivation, so as to meet the increased demands of a rapidly growing population. The work on this project was initiated in 1958 and the canal was named the Rajasthan Canal. The excavation commenced only in 1960 after signing of an agreement with the Government of Pakistan, the "Indus Water Treaty". Initially, the area covered four districts of Rajasthan State, namely Ganganagar, Bikaner, Hanumangarh and Jaisalmer. Later, this canal was renamed the Indira Gandhi Nahar Pariyojana (IGNP) after the (late) Prime Minister of India, Smt. Indira Gandhi. The IGNP is one of the largest and most expensive irrigation systems in dry lands in the world. Many urban and rural villages of the Bikaner, Churu, Ganganagar and Jodhpur districts obtain drinking water through the IGNP Canal. The IGNP is now considered a grand endeavour to bring water from the Himalayas to vast stretches of arid western Rajasthan.

The greater part of the main IGNP Canal is adversely influenced by strong winds and shifting sand dunes, which block the flow of water in the canal network. As countermeasure, the Government of Rajasthan has carried out afforestation on both

sides of the IGNP Canal, in corridors up to 100 m wide. Some of these plantations provide shelter to numerous mammals, viz. the wild boar, nilgai, jackal and desert fox. Many species of resident birds use these corridors during their flights, e.g. the common babbler, paradise flycatcher and green pigeon. The availability of canal water for irrigation has completely changed the pattern of kharif season crops in the IGNP command area. Groundnut *Arachis hypogea*, cotton *Gossypium* sp., paddy rice *Oryza sativa* and sugarcane *Saccharum officinarum* have replaced traditional crops such as moong *Phaseolus radiatus*, moth *Vigna acontifolia*, gaur *Cyamopsis tetragonoloba* and bajra *pennisetum typhoides*. Single-crop areas are being converted into double- and triple-crop areas. Sandy soil fields are now commonly used for two crops like bajra and gaur during the kharif season, and mustard, gram, wheat and barley during the rabi season, as well as vegetables.

This book is a result of detailed observations by reputed scientists working on the fauna of the Great Indian Desert, the faunal groups ranging from lower invertebrates (insects) to higher vertebrates (mammals). There are 16 chapters, and each contribution is made by an expert or professional in his/her particular field. The book offers novel information on various aspects of desert faunal ecology and conservation in the Great Indian Desert, with implications for similar ecosystems worldwide.

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Contents

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Chapter 1
The Thar of Rajasthan (India): Ecology and Conservation of a Desert Ecosystem

K.K. Sharma and S.P. Mehra

Abstract This paper highlights the Thar Desert and its ecosystem. The work reviews and presents the natural condition of the Thar Desert within Rajasthan State. The diversity of the vegetation and of higher animals is discussed on the basis of earlier works and surveys. Major problems and conservation issues are presented along with their possible solutions. Recommendations are made for the protection of this ecosystem.

1.1 Introduction

Among the six natural life-supporting ecosystem types of the earth, deserts occupy roughly one seventh of the land surface. Moisture is either absent or very low in deserts, and is dependent solely on the balance between precipitation and evaporation. Aridity results from evaporation being higher than precipitation. The tropics are the major belts in which deserts occur. The Hindi word for 'desert' is *marusthali* (region of death), stemming from the Sanskrit *mri*, 'to die', and *sthala*, 'arid or dry land'; in the dialect of those countries, the latter has become *thal*, the converse of the Greek *oasis*, denoting tracts which are particularly sterile (Tod 1920). Despite their inhospitable life conditions, deserts are characterized by often unique ecosystems, and the presence of an exclusive flora and fauna.

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1.1.1 The Great Indian Desert or Thar Desert

The Great Indian Desert, or Thar Desert, extends over about 0.32 million km^2 forming approx. 10% of the total geographic area of India. More than 60% of the desert lies in the State of Rajasthan, followed by 20% in Gujarat (Krishnan 1977). This desert forms the eastern extremity of the great arid and semi-arid belt of the world. It is one of the smallest deserts of the world but exhibits a wide variety of habitats and a high biodiversity, due to the juxtaposition of Palaearctic, Oriental and Saharan elements (Blanford 1901; Pocock 1939, 1941; Prakash 1963). It is the most densely populated desert of the world—the human population density is 84 per sq. km, compared to 3–9 per sq. km in other deserts (Baqri and Kankane 2001). Consequently, there is serious biotic pressure on its ecosystem and natural resources. Frequent droughts and a high livestock population contribute to the deterioration in ecosystem production and regeneration.

Owing to strong variations in climatic, edaphic, physiographic, topographic and geological characteristics, the State of Rajasthan shows a wide diversity of habitats. Indeed, there is much historical information highlighting the rich faunal resources of this state, formerly comprised of several princely states. Over time, however, ever increasing anthropogenic activities have been accompanied by changes in the traditional pattern of land use, resulting in substantial alterations of habitats. In more recent years, this has been due to the major impact associated with the construction of the Rajasthan Canal (Indira Gandhi Nahar Project, IGNP). Species most sensitive to these habitat alterations have become extinct; those better able to adapt have survived. Moreover, altered habitats have become an ideal home for many new species, leading to expanded distributional ranges.

1.2 Study Area

The State of Rajasthan lies between 23°04′–30°11′N and 69°29′–78°17′E, occupying 342,239 km^2 and 10.41% of the land area of the country. It is the largest state in India and the one with the highest proportion of land occupied by desert.

1.2.1 Physiography

Rajasthan State has four major physiographic regions, viz. the western desert (Thar Desert), the Aravalli hills, the eastern plains and the south-eastern plateau (Hadoti Plateau). About 62% of the state area consists of sandy plains, which is why it is known as the Desert State of India. The Aravalli (*a beam lying across*) hills running diagonally across the state form the geomorphic and climatic boundary of the desert in the east. The western part merges into the Pakistan desert.

The Aravalli Range is the major water divide in the state. The area in the east is well drained by several integrated drainage systems, whereas that in the west has only one, the Luni drainage system.

1.2.2 Climate

The climate is characterized by low rainfall with erratic distribution, extremes of diurnal and annual temperatures, low humidity and high wind velocity. The arid climate has marked variations in diurnal and seasonal ranges of temperature, characteristic of warm-dry continental climates. During summer (March to June), the maximum temperature generally varies between 40 and 45°C, with occasional highs reaching 51°C. Night temperatures decrease considerably, to 20–29°C. January is the coldest month. During winter (December to February), minimum temperatures may fall to −2°C at night. Occasional secondary Western disturbances, which cross mostly western, northern and eastern Rajasthan during the winter months, cause light rainfall and increased wind speeds which result in a wind-chill effect. The average annual rainfall ranges from less than 100 to 400 mm.

1.2.3 Divisions of the Thar

The Thar Desert can be subdivided into four sectors on the basis of rainfall and edaphic characteristics:

- the Luni basin, comprising Pali, Jalore, the south-eastern part of Barmer, the eastern part of Jodhpur, the western part of Ajmer, Sirohi, and the southern part of Nagaur;
- the northern drainage zone, comprising Sikar, Jhunjhunu and northern Nagaur;
- the agriculturally rich district of Sri Ganganagar and Hanumangarh adjoining Punjab and Haryana; and
- the true desert or *marusthali*, consisting of Jaisalmer in its entirety, northern Barmer, and the western parts of the Jodhpur, Bikaner and Churu districts.

1.3 Biotic Associations or Habitat Types and Vegetation

In the desert, the variety of biotic associations or habitats is very low. Blatter and Hallberg (1918–1921) recognized five formations. They defined each formation as a specific community of plants determined by certain soil characteristics. Krishna and Dave (1956) classified the Rajasthan Desert into three subregions according to climatological data and the occurrence of reptiles:

- *arid subregion*: rainfall 5″ (13 mm), north-western sector of Jaisalmer District
- *semi-arid subregion*: rainfall 5–10″ (13–25 mm), central desert
- *sub-humid subregion*: rainfall 10–15″ (25–38 mm), southeast Barmer, northeast Jodhpur, Ganganagar, Sikar and Jhunjhunu districts.

Prakash (1964) recognized the following associations and sub-associations in the Rajasthan Desert, based on the mammalian fauna:

- the sandy association: (1) sand dunes, (2) sand hills, (3) sandy plains and (4) artificial mines;
- the rocky association: (1) rocks, (2) lakes and surrounding gardens and (3) caves and tunnels;
- the ruderal association.

Furthermore, based on earlier work (Prakash 1963; Saxena 1972; Bhandari 1990), Prakash (1994a) recognized four major types of habitats in the Indian Desert, in terms of vegetation and fauna:

- aquatic habitats: rivers are mostly ephemeral. Canal, tanks and reservoirs are the primary aquatic habitats. The Rajasthan Canal has produced many new aquatic habitats in the form of small ponds and swampy areas. Blatter and Hallberg (1918–1921) described a number of species which were later classified by Shantisarup (1957) under three associations: *Eicchornia-Potamogeton, Hydrilla-Vallisnaria and Ceratophyllum-Vallisnaria*.
- sandy habitats: these occupy the largest proportion of the Thar Desert. Grasses are the predominant vegetation in these parts of the desert. *Lasiurus scindicus* occurs in the extreme desert where rainfall is below 150 mm annually. Mixed xeromorphic woodland is found in the vicinity of ephemeral rivers, and halophytic species on saline flats.
- hills and rocky outcrops: the Aravalli Range borders the Thar Desert on its eastern side, and isolated hills and rocky outcrops are scattered throughout this region. Smooth surfaces of hills are covered by a scrub community of mixed xeromorphic thorn forest (Satyanarayan 1963).
- ruderal habitats: Blatter and Hallberg (1918–1921) used the term ‘ruderal’ for the ecological association of vegetation near human settlements. This habitat type is associated with village complexes scattered throughout the desert—on rocky outcrops, sandy plains, sand dunes, saline flats and river banks, each with a distinct type of vegetation.

The major part of the Thar is occupied either by dry open grassland or by grassland interspersed with trees and thorny bushes (Gupta 1975). The vegetation falls under the category ‘thorn forest type’ or ‘scrub forest type’ (Mathur 1960; Champion and Seth 1968). The most common grass species of the Thar occur as a *Dicanthium-Lasiurus-Cenchrus* association (Dabadghao and Shankarnarayanan 1973). Most of the other vegetation consists of stunted, thorny or prickly shrubs and perennial herbs which are resistant to drought. Sand dunes form 58% of the desert. Stabilized dunes are covered mainly by *Capparis decidua, Calotropis procera, Calligonum*

polygonoides, Acacia senegal, Prosopis cineraria, Aerva javanica, Aristida adescensionis and other psammophytic species (Shetty 1994). Saline depressions—notably, Talchapar, Didwana, Pachpadra, Lunkaransar and Kuchaman—contain halophytic vegetation. The major grasses and sedges in these depressions are *Eleusine compressa, Eragrostis ciliaris* and *Dactyloctenium aegyptium*.

1.4 Protected Areas and Fauna

Protected areas in Rajasthan consist of two national parks and 25 wildlife sanctuaries along with 32 closed areas (Anon. 2003). Additionally, 24 sites are recognized as Important Bird Areas (Islam and Rahmani 2004).

The desert area of the state has two wildlife sanctuaries, viz. the Desert (Barmer, Jaisalmer) and Tal Chappar (Churu) sanctuaries (Anon 2003). The Desert Wildlife Sanctuary has an area of 3,162 km^2 and was established in 1981. In addition to the desert flora and fauna, the main purpose was to protect the Great Indian Bustard, *Ardeotis nigriceps*. Indeed, 70% of the country's population of this bird is found in this protected area (Rahmani 1986). It also holds significant populations of chinkara gazelles, *Gazella bennettii*, and of the sanda lizard, *Uromastyx hardwickii*. The Tal Chappar Wildlife Sanctuary has an area of 7.19 km^2 and is known for its population of blackbuck, *Antilope cervicapra*—in fact, it is commonly called the Tal Chappar Blackbuck Wildlife Sanctuary. There are 19 closed areas in this desert region (Table 1.1).

In the desert, one new site (Khichan, Jodhpur), the two sanctuaries (Desert and Tal Chappar) and one closed area (Diyatra, Bikaner) are recognized as International Birdlife Areas by the Bombay Natural History Society, Mumbai in the worldwide programme of Birdlife International. These are sites of high priority for avifaunal conservation (Islam and Rahmani 2004).

1.4.1 Faunal Diversity (Higher Vertebrate Groups)

The fauna of any area depends on the characteristics of the habitat. To avoid the high daytime temperatures of desert ecosystems, smaller animals commonly adopt nocturnal and subterranean life modes, also in the Thar Desert (Prakash 1964). Indeed, scarcity of water is a more acute problem than that of food. Many animals cover their water requirements via their food (vegetation or other animals; Prakash 1964). For instance, gerbils (*Tatera indica indica, Meriones hurrianae*), hare (*Lepus nigricollis dayanus*), squirrel (*Funambulus pennanti*) and porcupine (*Hystrix indica indica*) feed on seeds, roots and stems of desert plants. Larger animals usually remain in rather close proximity to water sources; thus, water becomes a key factor restricting their activities.

Table 1.1 Protected areas of desert regions in Rajasthan (extracted from Rajasthan Forest Department 2008)

Sl. no.	Name of protected area	District	Area (km^2)
	Wildlife (WL) sanctuaries		
1	Desert WL Sanctuary	Barmer, Jaisalmer	3,162.00
2	Tal Chappar WL Sanctuary	Churu	7.19
	Closed areas		
1	Bajju	Bikaner	210.00
2	Dachu	Jodhpur	661.18
3	Deshnok	Bikaner	25.17
4	Dhorimanna	Barmer	680.17
5	Diyatra	Bikaner	50.19
6	Doli	Jodhpur	42.76
7	Guda Vishnoi	Jodhpur	424.58
8	Jambeshwarji	Jodhpur	870.24
9	Jaroda	Nagaur	30.00
10	Jawai Dam	Pali	5.00
11	Jodvir	Bikaner	75.85
12	Lohavat	Jodhpur	1,242.31
13	Mukam	Bikaner	168.82
14	Ramdeora	Jaisalmer	3,000.00
15	Rotu	Nagaur	586.20
16	Sanchore	Jalore	1,813.12
17	Sanvatsar Kotsar	Churu	70.91
18	Sathin	Jodhpur	242.86
19	Ujala	Jaisalmer	3,000.00
	International Birdlife Areas (IBAs)		
1	Desert WL Sanctuary	Barmer, Jaisalmer	3,162.00
2	Tal Chappar WL Sanctuary	Churu	7.19
3	Diyatra	Bikaner	50.19
4	Khichan	Jodhpur	Undefined

Conservative estimates suggest that about 2,000 animal species are found in the Thar Desert. There are large numbers of mammals, birds and reptiles, including sand lizards, turtles and a variety of snakes. Indeed, the Thar contains a fascinating animal life associated with the sand dunes of its open scrub forest.

The mammalian fauna of the Thar is highly diverse—at least 68 species, which constitute about 18% of the total Indian mammalian fauna. Two major carnivores, the Asiatic lion *Panthera leo persica* and the Asiatic cheetah *Acinonyx jubatus venaticus*, have become extinct in Rajasthan during the last 100 years; the wild ass *Equus hemionus khur*, although suspected to have become extinct during the last four decades, has recently been sighted by Sangha (2003). The desert cat (*Felis sylvetris*), desert fox (*Vulpes vulpes pusilla*), wolf (*Canis lupus pallipes*), caracal (*Felis caracal*), wild boar (*Sus scrofa*), chinkara or Indian Desert gazelle (*Gazella bennettii*), blackbuck (*Antilope cervicapra*) and blue bull (*Boselaphus tragocamelus*) are some of the prominent mammalian species still found in the desert. However,

except for the chinkara and, in some areas, blackbuck, the status of all the larger mammals is not satisfactory. Some of these animals, such as the caracal, are highly endangered. Indeed, of the 68 mammalian species, 29 are listed in the India Wildlife (Protection) Act of 1972 and hence, need protection, though to a varying degree.

Rahmani (1997a, b) reported nearly 250 species of birds on the Rajasthan side of the Thar Desert. The most important threatened species is the great Indian bustard, one of the rarest bustards worldwide. Rahmani and Manakadan (1990) estimated that more than half of the great Indian bustards of India reside in Rajasthan, mainly in the Thar Desert. Of the 11 arid and semi-arid districts of Rajasthan (Chouhan 1988), the great Indian bustard is found in six, viz. Bikaner, Jodhpur, Jaisalmer, Barmer, Pali and Jalore (Rahmani 1986). Stoliczka's bushchat *Saxicola macrorhyncha* is another threatened bird in arid and semi-arid areas (Rahmani 1994, 1997c, d).

The Oriental white-backed vulture *Gyps bengalensis* and the long-billed vulture *G. indicus* were once common in the desert (Rhamani 1997c) but have declined at an alarming rate. In 2000, the long-billed vulture was sighted at three different localities in Pali District and, in 2005, more than 30 were sighted in Sirohi, along with five white-backed vultures (S.P. Mehra, pers. comm. 2006). More recently (January 2006), long-billed vultures were sighted in groups of 5–12 individuals at three different localities in Sirohi.

The pied tit *Parus nuchalis* is another threatened bird which has a wide distribution in the arid and semi-arid areas of Rajasthan (Tiwari 2001). The imperial sand grouse *Pterocles orientalis*, the houbara or Macqueen's bustard *Chlamydotis macqueeni*, the demoiselle crane *Grus virgo* and many other bird species are among the important migratory birds found in the desert.

Herpatofaunal studies show the richness of snakes and lizards in the Thar Desert. The sand dunes are inhabited by the scinid lizards *Mabuya macularia* and *M. aurata*. These form part of the diet of hedgehogs and foxes. The sand hills generally harbour the lizards *Mabuya* spp., *Varanus griseus, Stenodactylus orientalis, Gymnodactylus scaber*, and the nocturnal fatty-tailed lizard *Eublepharus macularis*. Snakes such as *Eryx johnii, Zemenis mucosus, Echis carinata, Bungarus sindanum* and *B. caeruleus* also find shelter in the sand hills. Along with all these, other snakes such as *Coluber diadema, Oligodon taeniolatus, Lycodon striatus, Psammophis schokeri* and *P. lethi* also inhabit the sandy plains of the desert. *Uromastix hardwickii* is common in the sandy plains, too. The crocodile *Crocodylus palustris* is found in small numbers in large, perennial bodies of water. The Indian flap-shell turtle *Lissemys punctata* is commonly sighted in well-drained areas of the desert, especially in the vicinity of the IGNP Canal.

Amphibians and fish usually require greater amounts of water for survival. Arid conditions are suitable only for a few desert-adapted amphibians, and these have not been extensively studied. Of 12 species so far reported for the State of Rajasthan, only *Duttaphrynus melanostictus, Bufo stomaticus, Microhyla ornata, Euphlyctis cyanophlyctis* and *Hoplobatrachus tigerinus* are commonly found under the semi-arid conditions of the desert. Ichthyofaunal studies have been conducted in parts of Rajasthan but very few in the arid land areas. More detailed assessments of the present status of fishes are needed for this region (Johal et al. 1993).

1.5 Threats and Conservation Issues

The degradation of the desert ecosystem is not the result of a single factor—rather, it is the result of cumulative influences, essentially all stemming from population explosion. The growing demand for sustenance by the increasing human population and their domestic animals, such as cattle, has resulted in overexploitation of limited resources.

1.5.1 Population Pressure

The human population in western Rajasthan has escalated tenfold in the last century (1901–2001). Indeed, the Thar is one of the most densely populated deserts worldwide, with more than 80 inhabitants per sq. km. Human settlements are increasing with the improvement in the drainage system of the desert. This is a serious cause of ecological stress, particularly for the plant life. Pasture and fallow lands are giving way to human habitations but the depletion of vegetation enhances soil erosion which, in turn, negatively affects the productivity of the desert for its human inhabitants.

1.5.2 Habitat Alteration Caused by the Indira Gandhi Canal and by Oil Exploration

Habitat alteration is the most important issue of concern for the Thar Desert. Tremendous changes in faunal composition are taking place due to the construction of the IGNP Canal. Desert animals are adapted to dry conditions and to shallow water reserves. The advent of the IGNP Canal has created many swampy areas as well as deeper water reservoirs. These have substantially modified also the traditional crop and grazing patterns. The northern part of the desert, such as the Ganganagar and Hanumangarh districts, are now rich croplands and many species, especially of birds, not seen there earlier are now commonly sighted near the canal area (Rahmani 1997a, b; Rahmani and Soni 1997). Boars (*Sus scrofa*) are rapidly invading the command area of the IGNP Canal (Prakash 1994b), as is the blue bull *Boselaphus tragocamelus*—the latter is becoming a serious menace to crops (Prakash 1995).

Recent exploration of rich oil deposits along with the projected construction of oil refineries in Barmer District will be accompanied by yet more changes in the desert. Clearing of the grasslands for oil exploration is underway, and the value of land in the vicinity has increased hundredfold. Many land owners in the Barmer region are selling their land—even that with good potential of agricultural production. This rapid and ongoing alteration will definitely disturb the fauna and affect diversity in the region.