B.K. Sharma
Seema Kulshreshtha
Asad R. Rahmani *Editors*

Faunal Heritage of Rajasthan, India

General Background and Ecology of Vertebrates

Volume 1

Springer

Faunal Heritage of Rajasthan, India

General Background and Ecology of Vertebrates

B.K. Sharma · Seema Kulshreshtha
Asad R. Rahmani
Editors

Faunal Heritage of Rajasthan, India

General Background and Ecology of Vertebrates

Springer

Editors
Dr. B.K. Sharma
Associate Professor & Head
Department of Zoology
RL Saharia Government PG College
Kaladera (Jaipur), Rajasthan, India

Dr. Seema Kulshreshtha
Associate Professor & Head
Department of Zoology
Government Shakambhar PG College
Sambhar Lake (Jaipur), Rajasthan, India

Dr. Asad R. Rahmani
Director
Bombay Natural History Society
Mumbai, Maharashtra, India

ISBN 978-1-4614-0799-7 ISBN 978-1-4614-0800-0 (eBook)
DOI 10.1007/978-1-4614-0800-0
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2012954287

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

यज्ञवत् भूमंडलम् धत्त समृगवनकाननम्।
तावत् तिष्ठति मेदिन्याम् संततिः पुत्रपोत्रिकी।।

So long as the earth bears woods and forests full of wild animals
Will it continue to support the progeny of man.

- Atharva Veda

*The **Atharvaveda** (Sanskrit:* अथर्ववेदः, *Atharvaveda), a tatpurusha compound of atharvan, an ancient Rishi, and veda (meaning "knowledge") is a sacred text of Hinduism and one of the four Vedas, often called the "fourth Veda". The other three Vedas are the Rigveda, the Yajurveda and the Samaveda. The Atharvaveda is a collection of spells and incantations, apotropaic charms and speculative hymns.*

To my father (Late) Prof. J.K. Sharma, an epitome of valor, self esteem and versatility whose untimely and hapless demise left me speechless but his presence still dwells in my convictions and strength and to my mother, Mrs. Prabha Shalini, whose blessings continue to support my endeavors.

–Dr. B.K. Sharma
Chief Editor

Foreword

The contents of this diligently edited work enrapture me. They have an intimate link not only with my core subject of Zoology but also other areas of my interest as Secretary of the Zoological Society of London (ZSL) responsible for London and Whipsnade Zoos, the Institute of Zoology and our worldwide conservation programs. Fauna have always attracted me as an avid observer, interpreter, and reader; the present volume wonderfully describes and analyzes the vertebrate faunal abundance of Rajasthan, currently the largest state of the Indian republic.

Being home to the most exotic biological diversity, splendid ecosystems and colorful cultural heritage, Rajasthan has fascinated researchers, conservationists, academics, travelers, and tourists from around the globe. I am particularly impressed with the fact that through this well-researched work, the editors have achieved an extraordinary accomplishment not only in further unveiling the well-known Thar or Great Indian Desert but also putting in the spotlight the much lesser known yet ravishing wilderness, communities, lush green landscapes, and wetlands of Rajasthan. More than 600 illustrations are a direct testimony to this. These two volumes are an assemblage of what is bound to become some of the most sought after chapters and brilliantly

synthesized scientific information available. The content of this monumental yet modern faunal treatise will surely make it a distinguished contribution to knowledge in the area of faunal ecology and conservation. The first book (Volume-1) entitled "*Faunal Heritage of Rajasthan, India: General Background and Ecology of Vertebrates*" in its 24 chapters covers a spectrum of vertebrate fauna of the region. Individual chapters dedicated to threatened faunal species are of special significance in the contemporary setting. The second book (Volume-2) entitled "*Faunal Heritage of Rajasthan, India: Conservation and Management of Vertebrates*" aptly describes the conservation- and management-related aspects spread over 20 chapters.

This publication will be highly appreciated since there is no comparable account currently available. I am delighted to find that the physiographic and biodiversity profile of Rajasthan, conservation strategies covering a vision on the future of the fauna of Rajasthan, and information that fills significant gaps in research each find a bold presence in these superbly edited volumes. In addition, separate chapters on ecotourism, community conservation, and wildlife trade covered in Volume-2 will be useful resources, introducing concurrent themes for researchers interested in this part of the world. The editors have effectively revised the image of the Thar from that of merely a desert to a more vivid landscape housing some of the most resplendent and majestically unique fauna and flora.

The opening chapters of the first volume provide a well-focused introduction to Rajasthan as a vivacious state of India. The historical, sociocultural, mythological, and anthropological aspects of faunal conservation and the tribes of Rajasthan together with the fossil records set the scene for the book. I am certain that this work will serve not only zoologists, wildlife biologists, conservationists and natural scientists, and social scientists but also the general reader. Students, teachers, and active researchers on wildlife and conservation biology will find these volumes particularly valuable as an important reference and textbook. Although, there are many lacunae in our knowledge about faunal ecology and its conservation, this formidable twin volume set will surely help in bridging the gaps, while enabling conservationists and policy makers to arrive at a consensus regarding future strategies in Rajasthan. The editors have superbly compiled the latest information on both the ecology of Rajasthan and the conservation of the region's myriad vertebrates.

Today, when mankind has encroached, exploited, and decimated the natural habitats of our planet, and we find ourselves in the midst of impending environmental calamities, these volumes will spur a sense of responsibility towards nature; they deserve to create mass awareness about sustainable development, conservation, and management of our forests, wildlife, and natural resources.

I extend my hearty congratulations on the publication of *Faunal Heritage of Rajasthan, India* as two separate yet closely linked volumes. I further take this opportunity to congratulate wholeheartedly the dynamic chief editor Dr. B.K. Sharma, for it was he who conceived, carried forward, and delivered this massive work. I wish him further good fortune in his academic and professional endeavors.

March 21, 2011

Paul H. Harvey CBE, FRS
Professor & Head
Department of Zoology, University of Oxford
Tinbergen Building, South Parks Road
Oxford OX1 3PS, United Kingdom

Preface

The Indian landmass, a cache of the top 12 mega-biodiversity regions of the world, proudly owns the famous *desert state* of Rajputana (old name) or Rajasthan with a human population of 68,621,012 (Census of India—2011). Endowed with diverse physiographic features, Rajasthan is often addressed as the state of *Maru* (desert), *Meru* (mountain), and *Mal* (plains). Best known as an exotic state of India where tradition and glory meet in a riot of colors against the backdrop of desert and greenery, Rajasthan has an unusual diversity of people, customs, cultures, costumes, music, manners, dialects, cuisine, and physiography. There is a haunting air of palpable romance about this famous abode of kings that never ceases to intrigue and enchant. The state owes much of its charisma to its enduring traditional way of life. So rich is the history of the land that every other village has its own tales of valor and sacrifice, the winds sing them and the sand shift to spread them further beyond. The panoramic outlook of the state is simply amazing with lofty hills of Aravallis and the golden sand dunes of the Great Indian or Thar Desert. In fact, no other region in the country is a conglomeration of so many paradoxes. Rajasthan is a land of superlatives where everything is breathtakingly fascinating. The state harbors a wealth of mesmerizing palaces and invincible forts of the erstwhile rulers and Maharajas, magnificent heritage *havelies* (palatial houses of olden times) and monuments, beauty of sorts, and natural resources. The vibrant and colorful attires, traditions, fairs, festivals, and pilgrimage sites attract a large number of national and international tourists. Rajasthan leaves a person truly spellbound with its glorious past, mysterious desert, art and craft, and rich cultural heritage. Located in the western part of the country, the state has been the hub of historical, cultural, archeological, and social activity. The triumph of Rajasthan's Rajput military architecture shone recently on the global stage with UNESCO granting six hill forts (Amber, Chittorgarh, Gangron, Jaisalmer, Kumbhalgarh, and Ranthambore) from the state World Heritage status in an unprecedented acknowledgement at the 37th meeting of the World Heritage Committee held at Phnom Penh, Cambodia on June 21, 2013.

Embracing 5.50 % of the total population of India, the state of Rajasthan presents an irregular rhomboid or kite shape in India's political map at 23°30" North latitude and 78°11" East longitude. Divided into 33 districts, the state covers an area of

342,239 km^2 (826 km × 869 km) which is equivalent to 10.41 % of the total area of the country. The 1,070 km long boundary forms the international border between India and Pakistan and touches four districts of Rajasthan, namely, Barmer, Jaisalmer, Bikaner, and Sri Ganganagar. Other states around Rajasthan are Punjab and Haryana in the north, Uttar Pradesh in the southeast and Gujarat in northwest. It is interesting to note that the size of Rajasthan is more than double of that of England. Physiographically, the state is bordered by the plains of the Sutlej–Beas Rivers in the northeast, the Ganga–Yamuna Rivers in the east, the Malwa Plateau in the southeast and the Gujarat Plain in the south. Out of the seven mountain ranges of the country, Aravalli and Vindhyas run across Rajasthan. In addition, Rajasthan also has the Indo-gangetic Plains. In spite of considerable aridity, unfavorable climatic conditions, and a limited forest cover, Rajasthan has an unmatched broad ecological spectrum with many biodiversity-rich areas. A wide variety of ecosystems, climatic and topographical conditions, and an intricate network of biological diversity and the tribes depending on them make Rajasthan a spectacular geographical region of the world.

Besides, there are a number of potential ecotourism sites boasting dense forests and scenic waterfalls still unexploited by the rapid pace of civilization. Hadoti region and Abu Hills of southwestern Rajasthan, for example, attract thousands of native and international tourists, naturalists, and researchers. Rajasthan has extensive wetlands too. In addition, the traditionally conserved *Orans* and *Gauchars* or Common Property Reserves and the age-old water conservation structures are also indicative of the wise use of the limited natural resources since ancient times.

This largest state of India can be divided into four major physiographic regions: (a) 640 km long Great Indian or Thar Desert with barren hills and rocky and sandy plains extending over an area of 175,000 km^2 in the west, (b) the forested Aravalli Hills covering the central districts while running from Khetri in the northeast to Khedbramha in the southwest over a length of 550 km and dividing the state obliquely into arid western part and semiarid semihumid eastern part, (c) The Eastern Plains covering the northeastern districts with rich alluvial soil and further named as the lowlands of the Chambal Plain, the Banas Plain, and the middle Mahi or Chhappan Plain, and (d) the southeastern Hadoti Plateau covering the southeastern districts which forms the Archaean Shield of the Deccan Peninsula and is divided into Vindhyan Scarpments and Deccan Lava Plateau. The desert occupies 61.1 % of geographical area followed by 23.3 % of the area covered by the Eastern Plains, 9.56 % by the forests (mainly confined to Aravalli and Vindhyan Hills) and 7.1 % by the vegetation. The average rainfall in Rajasthan is 54.78 mm. The climatic profile of Rajasthan can be seen as a transition between two major climatic regions of India, the semiarid east and the arid west. Water resources of the state include Chambal, Banas, and Mahi Rivers, their tributaries, and the fresh water and salt lakes, while Shekhawati, Marwar, Mewar, Wangar, Hadoti, Bangad, and Mewat present the cultural divisions. Forests of the state are divided into four broad types, namely, tropical thorn forests, tropical dry deciduous forests, central Indian subtropical forests, and mixed miscellaneous forests. The habitat variation in Rajasthan can be witnessed not only in the desert but also in the grasslands, dense forests,

Malwa Plateau, wetlands (both fluvial and nonfluvial), agricultural fields, ravines of Chambal River System and even the rocks, ruins, and civil structures. In the state of Rajasthan, aridity increases from east to west and south to north. The southern and southeastern parts of the state are richer in forest and biodiversity. A layer of soil of varying depth is present on the slopes of mountains of southern Aravallis, which makes it suitable for growing many mesophytic, tuberous climbers and lianas species. The area to its east is well-drained by several integrated drainage systems, while the area to the west has only one integrated drainage system, namely, the Luni drainage system situated in the southeastern part of the desert. However, Indira Gandhi Nahar Pariyojana (Indira Gandhi Canal Project or IGNP) has changed not only the fate of the Thar Desert due to the upsurge of a large irrigated area but also the vegetation and the habitat characteristics of the faunal elements.

The world has two types of desert climates, namely, warm and cold. The Thar Desert of Rajasthan falls under the former category with some extremely sensitive and fragile ecosystems surviving under severe and hostile conditions. The Thar Desert in India extends from the Sutlej River, surrounded by the Aravalli Range on the east, on the south by the salt marsh known as the Rann of Kutch (parts of which are sometimes included in the Thar) and on the west by the Indus River. The Indian Thar Desert joins the Iranian Desert and through it, the desert of the Middle East and finally the Sahara. The Thar Desert covers about three fifths of the total geographical area of Rajasthan and 9 % of the total geographic area of India. Of the total desert in India, 61 % falls in Rajasthan, 20 % in Gujarat, and 9 % in the Punjab and Haryana states. In Rajasthan, the Thar Desert covers 12 districts, namely, Bikaner, Churu, Hanumangarh, Sriganganagar, Pali, Jalore, Barmer, Sikar, Jhunjhunu, Nagour, Jaisalmer, and Jodhpur.

The Indian subcontinent is a major ecological region of the Indomalaya ecozone, one of the eight ecozones dividing earth's land surface, and the state of Rajasthan broadly falls under the Indomalaya ecozone. According to the Wildlife Institute of India (WII), India has a total of ten biogeographic zones and 26 biotic provinces. Rajasthan falls under the biogeographic zones 3 and 4, namely, the desert, covering the Thar and semiarid area covering the rest of the Rajputana or Rajasthan. The biological diversity of India is one of the most significant in the world since it has only 2.4 % of the total landmass of the globe but is home to over 7% of its animal species. Out of the total 1,196,903 animal species recorded from the world, India has 86,874 species, which means India is home to a little more than 7 % of the total animal species of the world.

The fauna of Rajasthan actually resembles that of West Asia and North Africa more than it resembles the fauna of most of the rest of India. The faunal richness of Rajasthan encompasses 140 species of fish, 14 amphibians, 67 reptiles (including eight endangered reptiles and five falling under Schedule I of the Indian Wildlife (Protection) Amendment Act, 2006, 477 birds (including 6 Critically Endangered, 5 Endangered, 12 Vulnerable, 19 Near-Threatened, 14 Red Data species, and one Conservation Dependent species) and 87 species of mammals (including seven of endangered mammals and ten species falling under Schedule I of the Act. Himalayan Tree Frog (*Polypedates maculatus*) has been recorded from Bansi (near Sitamata

Sanctuary), Banswara, and Jhalawar districts The reptilian species of significance include Isabelline Vine Snake (*Ahaetulla nasuta isabellinus*), Foresten's Cat Snake (*Boiga forsteni*) at Aravallis and a species of Lizard, *Phrynocephalus laungwalansis* endemic to Jaisalmer. Isabelline Vine Snake was recently seen in Phulwari and Kumbhalgarh Sanctuaries also. Indian Starred Tortoise (*Geochelone elegans*) was once common in some districts of Rajasthan but its population has severely declined recently. A significant population of Gharial *Gavialis gangeticus* is seen in the river Chambal even today.

The grasslands of eastern Rajasthan and parts of western Rajasthan hold significant number of the Lesser Florican *Sypheotides indicus* during monsoon. Unfortunately, the population of Indian White-rumped Vulture *Gyps bengalensis* and Indian Vulture (former name Long-billed Vulture) *G. indicus* has drastically reduced in the whole of Rajasthan by almost 99 % due to the killer drug diclofenac. The eastern plains are famous for Keoladeo National Park (KNP)—the only World Heritage Site in Rajasthan (so far as protected areas are concerned) which is home to thousands of migratory avifauna and other rare and endangered animals. The Southern Rajasthan harbors mammalian fauna such as the Mouse Deer or White-spotted Chevrotain (*Tragulus meminna*), Common Palm Squirrel (*Funambulus palmarum*), and Elliot's Giant Flying Squirrel or Large Brown Flying Squirrel (*Petaurista philippensis*) which are not found anywhere else in Rajasthan. The River Chambal has Gharial (*Gavialis gangeticus*), Marsh Crocodile or Mugger (*Crocodylus palustris*), and Gangetic River Dolphin (*Platanista gangetica*) apart from a variety of fishes. The presence of Wild Dog or the *Dhole* (*Cuon alpinus*), continues to be doubtful in Rajasthan.

The area south of 24°30 N latitude, Mt. Abu, Phulwari, Sitamata and Pratapgarh, Kumbhalgarh, and Shahabad (Baran district) is rich in biodiversity. Many species found in the Western Ghats and Deccan trap are also present in this zone and have small distribution range in Rajasthan. Western and northern distribution limits of many peninsular species end in this zone. Many of these species are generally not present in distribution north of 24°30 N latitude. Scimitar Babbler, *Pomatorhinus schisticeps obscurus*, Orange-headed Thrush (old name, White-throated Ground Thrush), *Zoothera citrina cyanotis*, Green Avadavat (*Amandava formosa*), Rajasthan Red-whiskered Bulbul (*Pycnonotus jocosus abunesis*) and Aravalli Red Spurfowl *Galloperdix spadicea caurina* are endemic to Mt. Abu and the surrounding area. In addition, both Jungle Babbler and Large Grey Babbler are found in the thorny deciduous forests/scrub jungles, whereas some species of creepers are also present in the open deciduous forests of Rajasthan. Only one species, namely Stoliczka's or White-browed Bushchat *Sexicola macrorhynca*, is confined to the Thar Desert. The Orange-headed Thrush is also seen in wet, cool, and shady pockets of Phulwari and Sitamata Sanctuaries. The White-naped Tit *Parus nuchalis* has been confined to arid zone of Rajasthan, Gujarat, and few pockets of South India. Leaf birds and fairy birds belonging to the family Irenidae, namely, Common Iora *Aeginnnthina tiphia* (Lineaus) and Marshall's Iora *A. nigeolutea* (Marshall) are also found at Mount Abu in Rajasthan while Pittas are winter visitors. Vindhyan Gorges (scrapland) has edaphic climax of *Anogeissus pendula* on its vast tract and comprises of Rock Bee

(*Apis dorsata*), Egyptian Vulture (*Neophron perctopterus*), Indian Vulture (old name Long-billed Vulture), *Gyps indicus*, Oriental Honey-buzzard (*Pernis ptilorhynchus*), Indian Pitta (*Pitta brachyura*), Tickell's Blue Flycatcher (*Cyornis tickelliae*), Indian Chat (old name, Brown Rock-chat), *Cercomela fusca,* and Eurasian Eagle-owl (*Bubo bubo*). Besides these species, the state holds Indian Skimmer *Rynchops albicollis*, congregations of Flamingo *Phoenicopterus roseus* at Sambhar Lake and Demoiselle Crane *Anthropoides virgo* at Khichan in Jodhpur district.

The mammalian fauna of the Thar Desert is diverse with nearly 68 species, which constitute about 18 % of total Indian mammals. The Wild Ass was not seen in Rajasthan for the last decade until a few were sighted in 2003 in areas adjoining Gujarat from where these animals had actually moved or rather sneaked. Except for Chinkara *Gazella bennettii* and in some areas Blackbuck *Antilope cervicapra*, the status of all the larger mammals is unsatisfactory and a few such as Caracal *Caracal caracal* is threatened. Of the 68 species, 29 species are listed in the Indian Wildlife (Protection) Amendment Act, 2006 and hence, need protection, though to a varying degree. Chinkara and Blackbuck are considered sacred by the *Bishnoi* community and are present in large numbers around the *Bishnoi* villages. The Nilgai *Boselephus tragocamelus* has a wide distribution in Rajasthan, but in the Thar Desert, unlike the Chinkara, it is not seen in the extreme arid areas where surface water is not available for most part of the year. Among bats, 12 species and subspecies are found in the Thar Desert. There is a great need to conserve the threatened wildlife of the Thar including some resident and migrant birds for which Rajasthan is globally important for conservation such as the Great Indian Bustard *Ardeotis nigriceps* (Critically Endangered), Lesser Florican *Sypheotides indica* (Endangered), Houbara or Macqueen's Bustard *Chlamydotis undulata* (Near Threatened), Stoliczka's or White-browed Bushchat *Saxicola macrorhyncha* (Vulnerable), Pied Tit or White-naped Tit *Parus nuchalis* (Vulnerable), Green Avadavat *Amandava Formosa* (Vulnerable), Demoiselle Crane *Anthropoides virgo*, Imperial or Black-bellied Sandgrouse *Pterocles orientalis* and vultures. Khichan in Jodhpur district is known for a large congregation of the winter visitor Demoiselle Crane *Anthropoides virgo*; a separate chapter has been dedicated to this species. Since effective ecological barriers are absent in Rajasthan, isolation is not effective and endemism is not so prominently seen.

Threatened mammals for which Rajasthan is globally important are Tiger *Panthera tigris*, Chinkara *Gazella Bennettii*, Nilgai *Antilope cervicapra*, Grey Wolf *Canis lupus,* and Caracal *Caracal caracal*. Presence of gorges (locally called *Khoh*) is a typical feature of Vindhyas, and they make an important tiger habitat. The population of Sloth Bear *Melursus ursinus*, an important species of the state confined to southern Aravallis and southeastern parts, is also decreasing. Large Brown Flying Squirrel (old name, Elliot's Giant Flying Squirrel) *Petaurista philippensis* is a characteristic fauna of the southern region. Likewise, the number of Golden Jackal, Gray Wolf, Bengal Fox, Red Fox, and Striped Hyaena is also declining in the agricultural zones. Mammals such as Gangetic River Dolphin *Platanista gangetica* and Smooth-coated Otter *Lutrogale perspicillata* are also present in the River Chambal. Two major carnivores, the Asiatic Lion *Panthera leo persica* and the Asiatic Cheetah *Acinonyx*

jubatus venaticus became extinct during the last 65–100 years, and the Wild Ass *Equus hemionus khur* has become extinct in Rajasthan four decades ago. In addition, the traditionally conserved *Orans* and *Gauchars* or Common Property Reserves and the age-old water conservation structures are also indicative of the wise use of the limited natural resources since ancient times. The religious beliefs and sociocultural traditions of the people of Rajasthan have contributed a great deal to the preservation of wildlife. Temples dedicated to various animals are a strong testimony to this, indicating the faunal linkages of the people, whereas birds such as *Kurjan* (Demoiselle Crane), Parakeet, Indian Peafowl, and House Crow are favorite themes of the Rajasthani folk music since time immemorial. *Bishnois* of Rajasthan stand apart from countless other sects and communities in India for their commitment to protect wild plants and animals. Amrita Devi, a *Bishnoi* lady who along with 363 villagers was martyred in the year 1730 while trying to stop tree-cutting by men of the then-ruler at the Khejadi village near Jodhpur district, is a burning example of the passion of *Bishnois* toward biodiversity conservation. Saako-363 Amrita Ki Khejadi (Hindi: साको - ३६३ अमृता की खेजडी) is an upcoming Hindi movie produced by Suraj Bishnoi and directed and written by Kalyan Seervi under the banner of Shri Maruddhara Films Pvt. Ltd. This film is based on the true story of Amrita Devi – a Bishnoi woman who fought with and revolted against the Deewan (Chief Minister of the Ruler) of the then *Jodhana* realm and his men to save Mother Nature and to particularly protect the ambient flora and fauna in her locale, *Khejarli* Village near Jodhpur. Planned to be shot in Rajasthan, the movie has the famous Bollywood actress Gracy Singh as the main lead and is expected to release in December 2013. The story is about a fearless woman's trials and tribulations to save the environment, a topic so relevant in the present times. The makers of the movie who belong to the Bishnoi Community have added a special clause in the film agreement whereby the cast and crew have been asked to abstain from non-vegetarian food and alcohol till the shooting is completed. The ethics of conservation nurtured by saints and spiritual teachers such as Guru Jambheshwarji, the great environmentalist of the fifteenth century, are deep-rooted in the religions and culture of Rajasthan. Unfortunately, the current generation seems to have been distancing from religious ethos and values regarding zoolatry.

Tribes constitute 12 % of the total population of Rajasthan, among which 39 % are *Bhils*. *Meena* is the second largest tribe. In fact, the southern belt of the state including whole of the *Mewar* and partly *Marwar* (Sirohi district) is together known as the tribal belt. The other well-known tribes and nomads of Rajasthan include *Gadiya Lohar, Garasia, Saharia, Damor, Bawaria, Mogiya, Meo, Banjara* (traveling tribes), *Kathodi, Rebari* (cattle breeders of *Mewar* region), *Sansi,* and *Kanjar*. Unfortunately, hunting continues to be an integral part of the socioeconomic life of tribes such as *Mogiya, Bawaria,* and *Pardhi*. They were recently held responsible for the killing of hundreds of tigers and panthers in the protected areas (PAs) and wilderness of Rajasthan, Gujarat, and Madhya Pradesh states during the current decade. In addition, *Pardhi* tribe hailing from Gujarat is the most skilled of poachers and frequently operates in the neighboring states of Madhya Pradesh and Rajasthan and even in the far eastern states. Tribal rehabilitation programmes (especially for

Mogiya) have been quite successful in providing them alternative sources of livelihood, child education, and female empowerment. They have also introduced young men to tourism, antipoaching activities, and cultivation of medicinal plants.

The state animal is the *Chinkara or Indian Gazelle*, the state bird is the Great Indian Bustard *Ardeotis nigricepes* (*Godavan* in Hindi and Rajasthani dialect), the state tree is *Khejri Prosopis cineraria*, and the state flower is *Rohida Tecomella undulata*, popularly known as the Desert or Marwar Teak. Oil India Limited's discovery of natural gas in the year 1988 in Jaisalmer basin has made Rajasthan into one of India's major revenue-producing states. Recent discovery of the presence of oil and natural gas in Deengod area of Hadoti region by the Oil and Natural Gas Commission (ONGC) presents another success story. On 14th March, 2013, a memorandum of understanding (MoU) was signed between the Government of Rajasthan and Hindustan Petroleum Corporation Limited (HPCL) for setting up a refinery-cum-petrochemical complex in the Barmer region. The *Mangla* oil field of Barmer would be the largest hydrocarbon zone in India and an industrial hub for India's petrochemical sector. Commercial production via this project is likely to begin from January, 2017. Currently, the income from crude oil is 50,000 million rupees, which is likely to increase by 3,500,000 million rupees per annum after the refinery is established. The tentative name given to this mega project is "Rajasthan Refinery Pariyojna." At present, in Rajasthan, *Cairn* is producing 175,000 barrels of crude oil per day. There are a total of 25 oil refineries in the country, which have a total processing capacity of 200 million tons of crude oil. The 9 million ton refinery, to come up in the Barmer-Sanchore basin, has been a long-pending demand of Rajasthan. About half of the crude oil processed at the refinery would come from Barmer's Mangala, Bhagyam, and Aishwarya oilfields operated by *Cairn India*, while the balance would be imported. At present, *Cairn* produces 175,000 barrels of oil per day (8.75 million tons a year) from these oilfields, with a potential to produce as much as 300,000 barrels (15 million tons) per day. The project would pave the way for setting up other ancillary industries, generating employment opportunities for about 170,000 people. The proposed complex would be the first such one specifically designed to produce petrochemicals from indigenous crude oil. On June 24, 2013 the Government of Rajasthan has finalized Pachpadra in Barmer district of western Rajasthan as the location for setting up a refinery worth 37,00,000 million Indian rupees. A new company called *HPCL Rajasthan Refinery Limited* (HRRL) came into force following a joint venture agreement between the state Government and HPCL on July 11, 2013. The project is likely to begin this year itself in November.

Economy of the state rests largely on monsoon-dependent agriculture, mining, stone-cutting and polishing, cement, zinc, textiles, and tourism. Livestock of the state includes the highest population of camels in India. Apart from threats to biodiversity conservation, frequent drought, illiteracy, female foeticide, child marriage, unemployment, population pressure, water scarcity, and poverty are key issues to be seriously handled if Rajasthan has to become one of the leading states of India. Conservation landmarks of the state cover 2.80 % (9,121.61 km^2) of the total area with three national parks namely, Keoladeo and Ranthambhore and the recently notified Mukundara Hills; 26 wildlife sanctuaries (WLS); four conservation

reserves; two eco-sensitive zones; two Ramsar Sites (Keoladeo National Park [KNP] and Sambhar Lake); KNP is also a World Heritage site; one proposed biosphere reserve [Desert National Park (DNP)]; two tiger reserves (Sariska Tiger Reserve and Ranthambhore National Park); five zoos/zoological gardens at Jaipur, Udaipur, Bikaner, Kota, and Jodhpur; one private zoo at Panchwati, Pilani; two biological parks; ten safari parks/deer parks; and 24 Important Bird Areas (IBAs) as identified by Bombay Natural History Society, Mumbai, India. KNP and Sajjangarh Wildlife Sanctuaries are walled protected areas (PAs) while the National Chambal Water Sanctuary is a ravine system. On the other hand, Taal Chhapar and Gajner Wildlife Sanctuaries in Churu and Bikaner districts are the PAs of arid zone. On May 17, 2013, the State Wildlife Board, Department of Forests, Government of Rajasthan has declared Jeenmata (Sikar District), Mansamata (Jhunjhunu District), Grass-farm Nursery (Jaipur District) and Mokhla (Jaisalmer District) as the new conservation reserves. The board also decided to increase the forest area of Sawai Mansingh WLS (situated near Ranthambhore Tiger Reserve) to 4,137.40 ha; of Kailadevi WLS to 9,624 ha; of Sariska Tiger Reserve to 39,816.98 ha; and of Bassi WLS to 5,396 ha. Likewise, 86.26 km^2 revenue area of Todgarh-Raoli WLS and some area of Ramgarh WLS which falls under the Bundi city will be excluded. It is interesting to note that majority of PAs of Rajasthan initially came into existence as hunting reserves and private zoos of former kings and royals. *Shikar* (hunting) was a favorite sport of the erstwhile rulers which always found a place in the itinerary of visiting viceroys and British officers in the Pre-Independence era. Royal families in Rajasthan also owned private zoos, most of which were taken up by the government following Independence and later developed as wildlife sanctuaries and national parks. Governed by the National Tiger Conservation Authority (NTCA, formerly "Project Tiger"), the tiger reserves of Rajasthan are of global significance. Following a ruling by the Supreme Court of India and subsequent orders issued by the Central Government, tourism activities will now be shifted from core areas of National Parks to buffer areas. To this end, a tiger safari will be created at the Olwari-Niwari forest area of Ranthambhore Tiger Reserve and Nahargarh Biological Park.

To keep the readers abreast with the overall view of the subject, relevant appendices have also been included. One of the appendices describes the names of different faunal species in local (*Rajasthani*) dialect. I would like to reiterate here that the desert is only a small part of the state of Rajasthan. Contrary to popular belief, Rajasthan has lush green fields, grasslands and cultivated lands, rocky protrusions, hilly terrains, jungles, and extensive wetlands too, strewn along and around the desert. Interestingly, the desert makes the state both famous and infamous due to its extremity of harsh climates and hardships faced by the human and animal inhabitants through various seasons round the year. It is also true that some of the oldest civilizations have emerged in these areas which are by definition called as the zones of scarcity and hardships. On the whole, the state of Rajasthan has remained an amphitheater of zoogeography. The present and past distribution of animals indicates that the state has witnessed many climatic upheavals. Two chapters have been wholly dedicated to understand the retrospective picture of the faunal diversity, geological scenario over a longstanding past (including the Akal

Wood Fossil Park at Jaisalmer) to present some interesting workable knowledge of the geography of Rajasthan. Through these introductory chapters, the authors have tried to convey a galaxy of important facts and information. For example, 40 % of Indian livestock, 80 % of the best camels, rich mineral and stone deposits like zinc, copper, marble (the Makrana marble was used in the construction of the world famous *Tajmahal* at Agra), granite, and 1 % of the total water of India (both ground and surface) is present in Rajasthan. It is not an exaggeration to mention here that there is no such publication currently available either in the Indian or the international market which exclusively deals with the scientific account of the vertebrate faunal diversity. I had been very keen to make it a unique and monumental work on Rajasthan's faunal wealth with well-elaborated and relevant contents and assemblage of varied titles. I have tried hard to give this book a strong scaffolding to carry on the commensurate weight of scientific contents, without losing elegance. The present edited volume has attempted to cover the pattern of distribution of vertebrate inhabitants and wildlife of Rajasthan—many of them finding a mention in the IUCN Red List of threatened species.

The untiring efforts in the direction of compiling this information brought an altogether fresh vision and insight into the present status of vertebrates in Rajasthan. One of the opening chapters deals with an interesting account of the fauna in retrospect, especially large mammals which gradually vanished over the 200 years. The killing of the last Asiatic Lion in 1876, the disappearance of the last Cheetah, the last sighting of the Siberian Crane (migratory) at Keoladeo National Park (KNP) in 2003, the White-naped Tit which vanished in the arid zone after 2005, many vanished species of vultures, the extinction of the Wild Ass, and the doubtful presence of *Dhole* (Wild Dog) indicate the gradually changing environment and anthropogenic pressures in the state. The underlying theme of this mega volume along an evolutionary gradient is self-evident while simultaneously indicating that vertebrate ecology and conservation are two inseparable aspects closely linked in the patterns that have been determined by the course of events in the remote past. In this volume, we have managed to select topics that will serve as a guide and stimulus for synthesis of knowledge that ought to flow from this work on the faunal diversity of Rajasthan mainly focusing the ecology of vertebrates. Contributors of this volume include both seasoned and young scholars, experienced ecologists, forest officials, teachers, social scientists, and life scientists. Please also see *Faunal Heritage of Rajasthan, India: Conservation and Management of Vertebrates*. Sharma B.K. et al. (eds.), Vol. 2, 2013, Springer (978-3-319-01344-2) for conservation management-related aspects.

It may seem illogical that a book on faunal diversity does not include invertebrates, but their inclusion would have made the book unwieldy and hefty. I am fully aware that a few faunal groups, especially the invertebrates, were left to be covered in the present endeavor since there are significant gaps in research and also the information received did not appear scientifically up to date despite collection of over 11 chapters. If feasible, attempts will be made to include these thoroughly revised and updated manuscripts and additional chapters on invertebrate faunal diversity of Rajasthan in a subsequent volume titled *Faunal Heritage of Rajasthan, India: Ecology and Conservation of Invertebrates*.

While exploring around to conceive this book during the early winters of 2006, the I was unpleasantly surprised to witness that though a good deal of research work was carried out on the flora and fauna of the state over the past decades, the available information was largely scattered, fragmented, and patchy. Though the Zoological Survey of India (ZSI), Kolkata; Bombay Natural History Society (BNHS), Mumbai; Wildlife Institute of India (WII), Dehradun; Salim Ali Centre for Ornithology and Natural History (SACON), Coimbatore; World Wide Fund for Nature-India (WWF-India), New Delhi; forest departments and other premier Governmental and non-governmental organizations (NGOs) of the country have done pioneering work on Rajasthan's fauna, such vital information and data have hardly been updated and are available only in discrete journals, separate volumes, monographs, conference proceedings, and small books dedicated to particular faunal groups and/or single species. The need of an efficient database center for providing updates on the current status of existing faunal species, their population and distribution has long been felt. In a recent development on May 12, 2013, the forest department, Government of Rajasthan has proposed to set up a training institute in the state where appropriate training in connection with wildlife, forests, and related aspects would be given by experts from India and abroad. A branch of this "institute of excellence" would be opened at Ranthambhore National Park in Sawai Madhopur. It is worthwhile to mention here that the Wildlife Institute of India (WII) situated at Dehra Dun (Uttrakhand) is currently the only such institute in India. A near total absence of relevant scientific information about the present status of vertebrate fauna and the poor state of efforts towards conservation and management of biodiversity in this part of the world has in fact propelled the Chief Editor to compile this edited volume. A few important papers invited as proceedings of the *National Conference on Conservation and Management of Faunal Diversity of Rajasthan* (*NCCMFDR*), organized by me at Jaipur, India from August 11–13, 2006 have also been included in this book.

It was a Herculean task to present the vertebrate fauna of Rajasthan in a systematic yet scientifically designed and tightly edited volume. A serious effort has been made to structure the manuscripts starting from lower to higher forms while placing them in a format comprising various faunal forms along with chapters focusing on the general biodiversity. For the ease of understanding by the reader, the entire manuscript has been split into four major sections. It was indeed tricky to provide appropriate headings to cover a wide variety of chapters under these heads. Last but not the least, the present edited volume is an earnest attempt towards the scientific documentation of existing vertebrate fauna of Rajasthan. It is hoped that these volumes will be useful for wildlife specialists, conservationists, environmentalists, zoologists, ecologists, researchers, students, policy-makers, and education administrators not only in Rajasthan and India but throughout the globe.

At this crucial juncture when the planet's natural resources are depleting rapidly, the animal life is being driven to its ultimate retreat in the fast diminishing ecosystems, wild creatures are annihilated, the insensitivity of humans towards fellow creatures is increasing and when man's outlook upon the domain of nature has drastically changed—the teachings of Indian philosophy, theology, moral and social sciences can help us to relive the times when the human race had comfort-

ably flourished by affectionately mingling with nature. A serious approach towards wildlife and forests is still lacking in India, the need for which is paramount. In fact, the callous attitude of policy-makers, administrators, politicians, and the intelligentsia coupled with greedy businessmen have badly affected the pace of welfare efforts and implementation of laws. The forgotten concepts of social sciences and the concepts of animal liberation and animal rights also seem pertinent in the present milieu, if India has to survive as a country which always commanded respect of the rest of the world on account of the culture and traditional values. The biggest testimony to this is our honest consideration of the protective umbrella or the environment around us as Mother Nature. A few quotes relevant to the present context and worth mentioning here are: *Man is the only creature that consumes without producing. He does not give milk, he does not lay eggs, he is too weak to pull the plough, and he cannot run fast enough to catch rabbits, Yet, he is the lord of all the animals*—George Orwell; *Life is life—whether in a cat, dog or man. There is no\difference there between a cat or a man. The idea of difference is a human conception for man's own advantage*—Saint Sri Aurobindo; *We can judge the heart of a man by his treatment of animals*—Immanuel Kant; *The Greatness of a nation and its moral progress can be judged by the way its animals are treated*—Mahatma Gandhi.

With its ancient culture, and rich traditional heritage India will surely act as the *Vishwaguru* (world teacher) in the times to come. In the present scenario of terrible unrest, biodiversity conservation is something pragmatic that must be directly linked with education and incorporated in the curricula at schools, colleges, and universities not only in India but the whole world. In a country of rich traditional heritage where *ahimsa parmodharma* (a phrase in Sanskrit language which means that "non-violence is the topmost duty to the extent that it supersedes all other duties") and *Vasudhaiva Kutumbakam* (a phrase in Sanskrit language which means that "the whole world is one single family") are the guiding principles, destruction should have no place. It is high time that we come together to living with nature, commiserate with the harmless animals and join hands to create a symphony of peaceful coexistence. Nature conservation is the key to this concept.

It is a pleasant coincidence that the book was accepted for publication in 2010—the international Year of Biodiversity and was being worked upon through 2011 which marked the beginning of a crucial decade in the International calendar for biodiversity. This was the start of the United Nations "Decade on Biodiversity" and was declared "International Year of Forests." It was a great delight to see that the final proof reading of the manuscript was completed towards the end of 2012—which is marked as the "International Year of Sustainable Energy" and when India hosted the XI Conference of Parties (CoP) on Convention on Biological Diversity (CBD) at Hyderabad.

Jaipur, Rajasthan, India
July 07, 2013

Dr. B.K. Sharma
Chief Editor

Acknowledgements

At the outset, I would like to thank the residual faunal wealth of Rajasthan and the Bishnoi community that had inspired me to create this book. This volume is also dedicated to all life forms (both companion and free-living animals) flourishing in the lap of Mother Nature. In addition, the handful of people I wanted to thank but the list swelled as it generally happens.

Writing acknowledgement for something one has been doing for years can be both easy and tricky. Easy because the person is quite intimate with the innumerable events that have quickly passed by and quietly slipping down the memory lane is the only way to gather them back, this is generally a pleasure. However, it becomes tricky because one cannot always lay down the pain and unpleasant facts and circumstances associated with such a task.

The book actually got conceived during my involvement as Organizing Secretary of the "National Conference on Conservation and Management of Faunal Diversity of Rajasthan" (NCCMFDR) held during August 11–13, 2006. Sponsored by the University Grants Commission (UGC)—the apex body governing the higher education sector in India and the Department of Science and Technology (DST),

Government of Rajasthan, deliberations of this meeting formed the basis of the need to compile such a publication. The idea of compiling the faunal abundance of Rajasthan and aspects of its conservation management in one place arose from the fact that when I desperately searched for a book describing the fauna of Rajasthan, I was wonderstruck not to find one. I wish to humbly acknowledge Dr. A.K. Mathur, the then Principal, R.L. Saharia Government PG College, Kaladera (Jaipur), Rajasthan, India, for rendering his support while I organized the above conference.

Thanks are also due to the Eco-Ethics International Union (EEIU), Germany and colleagues and members, organizing committee of the NCCMFDR-2006 especially Drs. Medhatithi Joshi, Rakesh Lata, (Govt. College, Kaladera) and Abhimanyu Singh Rathod (B.N. College, Udaipur).

I would like to express my gratitude towards my teachers Professors A.L. Bhatia (Late) and Reena Mathur, Former Heads and Prof. Shekhar Verma, Department of Zoology, University of Rajasthan, Jaipur, for their affection, encouragement, and blessings.

I am indebted to Mr. V.D. Sharma, Former Principal Chief Conservator of Forests, Government of Rajasthan; Ms. Geetanjali Bhattacharya, Zoological Society of London (ZSL); Ms. Sally Walker of Zoo Outreach; Dr. Gobind Sagar Bhardwaj, IFS, Department of Forests, Government of Rajasthan; and Mr. Bittu Sahgal of Sanctuary Asia (Mumbai) for their kind support.

I would like to especially mention Dr. G.V. Reddy, I.F.S., Department of Forests, Government of Rajasthan; Dr. S.M. Mohnot, Emeritus Scientist & Director, School of Desert Sciences and Chairman, Primate Research Centre, Jodhpur; and Dr. B.K. Tyagi, Officer-in-Charge, Centre for Research in Medical Entomology (ICMR,) Madurai, Tamil Nadu for their numerous e-mails and valuable suggestions.

I am personally grateful and owe special thanks to Dr. Divyabhanusinh Chavda, Naturalist, Conservation Expert, President, WWF-India and Member, Cat Specialist Group, who despite being extremely occupied spared time for personal meetings and supported this project with his creative ingenuity and invaluable advice. He also made me aware of the sources of relevant information including his own books, other published works, and archival material which otherwise I would not have known. Often, I had to take leave to meet and visit related people and places in Rajasthan and elsewhere in India in order to procure additional materials for this book.

Apart from agreeing to write a chapter at a short notice, Dr. Jeffrey Snodgrass of Colorado University, USA rendered fruitful suggestions which helped in improving the manuscript; I gratefully acknowledge his inputs.

I feel greatly privileged to have received valuable contributions from eminent authors without whom this volume would not have seen the light of the day. I am fortunate that apart from experienced teachers and colleagues, I enjoyed the counsel of some very competent wildlife experts and conservationists during the preparation of this volume.

I take this opportunity to profoundly thank Professor Paul Harvey, FRS, Head, Department of Zoology, University of Oxford, for he penned the foreword despite other potential academic and professional commitments.

Without expressing deep gratitude and thanks towards my scholarly co-editors, the thanks giving will not culminate whose active cooperation actually helped me to complete the book. Were it not for the encyclopedic knowledge of Dr. Rahmani and the hard work of Dr. Kulshreshtha, this volume would have lacked in substance.

My heartfelt thanks to Mr. Sunil Singhal, Mr. Devendra Bhardwaj, Dr. Tejveer Singh, Mr. Niranjan Sant, Mr. Aditya Roy, Mr. Jaysukh Parikh, Dr. Ashish Kothari, Mr. Arfin Zukof (Listening Post), Dr. Rakesh Vyas, Ms. Sonali Singh, Dr. Anil Chhangani, Mr. J.K. Tiwari, Prof. K. Sankar, Ms. Urva Sharma, and Ms. Babette de Jonge (Wild Cats Magazine/Wild Cats World, Masai Mara 2009), Sanctuary Asia Photo Library and the Victoria & Albert Museum, London for providing rare and beautiful pictures from their personal collection. Thanks Mr. Rajiv Lochan, Drs. Narendra Jain and R.S. Bhatnagar, Mr. Anshul Sinha, Ms. Vartika Sinha Pooja & Vijay Bishnoi, Rakesh & Daisy and Mr. Umakant Baluni (UGC) for all your concern and support.

I am overwhelmed with gratitude, pride, and indebtedness towards my siblings—Veena, Anant, Anand, and Ashutosh for they remained a constant source of inspiration and whose everlasting affection helped a great deal while working on this project; thank you for your moral support and good wishes.

It is worthwhile to mention here that right from the call for papers and collection of manuscripts to the interactions with the publishers, editing and proof reading the entire work stretched over five long years. I owe much to my charming daughter Anushka, and son Divyam, who actually grew up with the preparation of this volume and most of the time witnessed me working in my study, enriched the result and remain a great source of comfort for me.

While writing the acknowledgements, my heart goes out to *Jugal Bhawan*—the 65-year-old ancestral house in Jaipur built by my grandfather (Late) Pt. Jai Nath Sharma where I was born with four siblings and lived as a joint family until the end of 2011. The building has been demolished only to be reborn as an apartment called *Jugal Enclave*. The place not only witnessed my upbringing but also my struggles and survival in general and with this writing project in particular. In fact, the majority of the work related to these volumes was completed in a quiet corner of this palatial bungalow.

I immensely thank my publisher Springer for entrusting upon me and making the delivery on time. Janet Slobodien, Publishing Editor; Mellisa Higgs, Assistant Editor; Felix Portnoy, former Production Editor, Jeffrey Taub, the new Production Editor; and Manoranjan Mishra, Project Manager at SPi Content Solutions—SPi Global and his entire team deserve special thanks for doing all possible efforts to bring this peer-reviewed volume in such a refined form. My sincere thanks are also due to the anonymous reviewers whose thoughtful suggestions have greatly helped in improving the original manuscript. I also owe a debt of gratitude to many teachers, friends, colleagues, and students and to all those who have contributed variously in bringing out this volume in its present shape whom I might have missed mentioning here.

For the one person who supported me selflessly and out of the way while I was putting all my heart and soul into this book, working long hours and late nights despite occasional illness and loads of other commitments, she cheerfully stood beside me, I am short of words to wholeheartedly thank my spouse without whom, this mammoth task would not have reached fruition.

I must share with the readers that I had originally planned an almost 1,200 pages-long single volume entitled "*Faunal Heritage of Rajasthan, India: Ecology and Conservation of Vertebrates*" covering both ecology and conservation management under one cover. In order to make a hefty volume handy, Janet Slobodien suggested me to split this book into two volumes, rather two separate books titled "*Faunal Heritage of Rajasthan, India: General Background and Ecology of Vertebrates*" and "*Faunal Heritage of Rajasthan, India: Conservation and Management of Vertebrates*." The splitting may has caused marginal delay in the publication of this work but I am sure, the readers and contributors would appreciate the need to do so.

Above all, I profusely thank God Almighty for giving me enough courage during the gestation and prolonged labor and as always for everything. I would be grateful to the esteemed readers for their comments on the newborn twins. I hope the editors justify their aspirations; however, constructive criticism and suggestions are invited to further improve this volume in its future revisions. The only thing now left to be added is that responsibility for imperfections and failings, if any, are mine alone.

Jaipur, Rajasthan, India
July 07, 2013

Dr. B.K. Sharma
Chief Editor

Contents

Contributors

Harendra Singh Bargali The Corbett Foundation, Nainital, Uttarakhand, India

Devendra Bhardwaj Department of Forests and Wildlife, Government of Rajasthan, Jaipur, Rajasthan, India

Gobind Sagar Bhardwaj Department of Forests and Wildlife, Government of Rajasthan, Jaipur, Rajasthan, India

Chhaya Bhatnagar Department of Zoology, Mohanlal Sukhadia University, Udaipur, Rajasthan, India

Subramaniam Bhupathy Sálim Ali Centre for Ornithology and Natural History, Coimbatore, Tamil Nadu, India

A.K. Chhangani Department of Environmental Science, Maharaja Ganga Singh University, Bikaner, Rajasthan, India

Sumit Dookia School of Environment Management, Guru Gobind Singh Indraprastha University, Dwarka, New Delhi, India

Shalini Gaur Desert Regional Station, Zoological Survey of India, Jodhpur, Rajasthan, India

Shilpi Gupta Wildlife Institute of India, Dehradun, Uttarakhand, India

G.R. Jakher Maharaja Ganga Singh University, Bikaner, Rajasthan, India

Bela Kothari Department of Anthropology, University of Rajasthan, Jaipur, Rajasthan, India

Seema Kulshreshtha Department of Zoology, Shakambhar Government P.G. College, Sambhar Lake (Jaipur), Rajasthan, India

Sanjeev Kumar Desert Regional Station, Zoological Survey of India, Jodhpur, Rajasthan, India