



**Biodiversity  
of  
Desert National Park  
Rajasthan**

**V. Singh  
Monika Singh**

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**BOTANICAL SURVEY OF INDIA**

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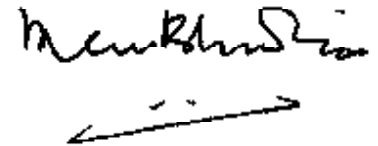
## FOREWORD

"Diversity of living organism" was first used by Alexander von Humboldt in 1800, but the real importance of biodiversity and its global concerns gained momentum only after the historic Rio Conference in 1992 wherein Worldwide importance of biodiversity and its conservation and protection were highlighted. For conserving and protecting the biota and ecosystems *in-situ*, certain areas have been set aside in many countries throughout the World. Protected areas in India have existed as "Abhayankars" or "Forest Reserves" from the very early times. Presently, National Parks, Biosphere Reserves or Wildlife Sanctuaries serve this purpose. Today, there has been a network of 89 National Parks, 489 Wildlife Sanctuaries and 13 Biosphere Reserves in India. Desert National Park is one such entity wherein conservation of natural genetic wealth, including their wild relatives as well as rare, threatened and endemic biota and their ecosystem and habitats are required to be preserved in totality. The exigencies of life in this fragile ecosystem of the Thar, which indeed has resulted in the selection of its biodiversity by adaptation and survival, needs thorough study about the structure and functioning since it is not only largest in area (3162 sq. km), but forms a unique cultural, demographical and geographical region of our country. In order to properly implement the conservation strategies and utilize the treasure of bioresources, there has been a great necessity of inventorisation and documentation of flora and fauna and their relationship to the ecosystem and with one-another. In the absence of such information, the management of protected areas can not produce desired results due to faulty planning and execution.

The present book on Biodiversity of Desert National Park has filled this vital gap as it contains entire biodiversitital information viz. physical and chemical nature of soil and water, climatic conditions, geology and topography, socio-economic aspects of inhabitants, besides flora and fauna. The floral diversity, which is an initial point for flow of energy, has been described in details, providing keys for identification, correct nomenclature, local names, diagnostic descriptions, ecology, phytogeographical aspects to understand migration and biological spectrum for phytoclimate. The authors have also assessed the bioperspective potential of the Park. Again, besides documenting the faunal diversity of the Park, the authors have also made an attempt to illustrate the interaction between flora and fauna and their interdependency, which has resulted in a food-web throwing light on flow of energy. The threatened flora and fauna, causes of threats and conservation aspects have found special attention in the book. This comprehensive, profusely illustrated compendium will be of immense value for Park managers for conservation and sustainable utilization of bioresources. It will also provide scientific leadership to foresters, environmentalists, conservationists, policy makers and planners for planning and implementation of field activities.

I congratulate Dr. V. Singh and Monika Singh who have spared no pains in providing thorough information of this fragile ecosystem for our national interest, particularly when the ecological scenario in this region is fast changing due to escalating human population in the past few decades. Since DNP is an invaluable refuge for biota driven to the verge of extinction due to habitat loss, the information so

presented in this volume will, it is hoped, keep pace with modern concept of biodiversity and its immediate as well as future sustainable use and survival. This will also help in evolving strategies to integrate conservation and development for socio-economic and environmental reasons for the benefit and uplift of the local population.



25<sup>th</sup> February, 2006  
Jodhpur, Rajasthan

(M. M. Bhandari)  
Emeritus Professor of  
Desert Taxonomy,  
J. N. Vyas University,  
Jodhpur (Rajasthan)

## PREFACE

It is well realized that due to both natural and unnatural factors, the biological resources of the earth are under varying degree of threat. During last two decades, there has been a greater consciousness about the threats to the biological diversity and it is widely realized that the loss of biodiversity has great environmental and economic impact. An environment rich in biological diversity offers the broadest array of options for sustainable economic activity, for sustaining human welfare and for adapting to change. India's strategies for conservation and sustainable utilization of biodiversity comprise providing special status and protection to biodiversity rich areas by declaring them as National Parks, Wildlife Sanctuaries, Biosphere Reserves, Ecologically fragile and sensitive areas, etc. In Rajasthan, four National Parks and twenty two Wildlife Sanctuaries have been established for the conservation of bioresources. Desert National Park is one of them and it was notified on 8<sup>th</sup> May, 1981 to conserve the peculiar desertic ecological and biological resources. Unfortunately, the biological wealth contained in the fragile ecosystem of Desert National Park has not been inventorised and documented so far. As such, the planning and management of the Park have greatly suffered.

In the present work, the floral and faunal diversity have been documented and analysed. The flora of the Park comprises 245 species of higher plants belonging to 148 genera and 52 families. For easy determination of taxa, keys have been provided from the rank of family to infra-specific level. Nomenclature has been updated along with important synonyms relevant to the flora of India and Rajasthan in particular. Short diagnostic description, based on personal observations, has been provided along with phenological and ecological data for each species and infra-specific taxa. Local names in Marwari (Rajasthani) dialect have been given to make the work usable at grass-root level.

Besides taxonomic information, the traditional knowledge of the inhabitants of Park regarding various uses of plants, including medicinal, has also been documented to determine the economic potential of the Park. The phytogeographical assessment of the flora has been done to understand the strength of various phytogeographical elements and also their routes of migration. Biological spectrum of the flora has been analysed to determine the phyto-climate of the area. The factors posing threat to biodiversity have been discussed and threatened taxa have been identified and categorized as per IUCN criteria. The wild relatives of crop plants have also been identified to determine the genetic potentiality of the Park for the improvement of crop/cultivated species. The endemic taxa which throw light on the centres of speciation have been documented. Some conservation and management strategies have also been offered for *in-situ* conservation in DNP, based on personal experiences.

The faunal wealth of Desert National Park has been documented with the help of Zoological Survey of India, Jodhpur and published literature. About 270 species, belonging to 200 genera and 98 families, have been enumerated. The fauna has been classified up to infra-specific level. Valid zoological names have been adopted and their local as well as English names have been provided. To understand the relationship and dependency of fauna on flora, observations on the behaviour of animals were taken, particularly for food and shelter. As a result of which, it could be possible to classify the fauna based on feeding habits viz. carnivorous, insectivorous, scavenger, herbivorous, etc. About 83 species of plants were recorded which are relished by wild fauna in the Park. Again, about 37 species of plants have been identified which either provide direct

shelter or shelter location based on living behaviour of animals. A food web has been drawn to determine the flow of energy in the Park. Besides identification of threatened fauna and their categorization as per IUCN criteria, the factors responsible for the threat have also been identified and discussed.

Besides providing geographical location of the Park, the topography, geology and soils, water resources and climatic data for rainfall, temperature, relative humidity, wind, etc, which determine and control the biological composition of an area, have been discussed. Up-to-date relevant literature has been reviewed. In the light of satellite vegetation map, the ground reality of biodiversity has been assessed and presented. A number of photographs, illustrations, maps and diagrams have been appended to supplement the output of present study.

It is hoped that work will be useful to environmentalists, botanists, researchers, wildlife managers, policy makers, etc.

The authors are thankful to the Director, Botanical Survey of India, Kolkata for constant encouragement and facilities provided during the course of present study. Thanks are also extended to the Ministry of Environment and Forests, New Delhi for the financial assistance provided for the present study. Dr. Q. H. Baqri, ex Additional Director and Dr. N. S. Rathore, Joint Director, Zoological Survey of India, Jodhpur deserve special thanks for their help and collaboration during field and laboratory studies without which it would have not been possible for us to achieve the goal. The authors are also grateful to the authorities of Desert National Park for their co-operation and facilities provided during the fieldwork.

Director, State Remote Sensing Application Centre, Jodhpur deserves sincere thanks for providing valuable remote sensing data on the Park, Directorate of Agriculture, Government of Rajasthan, Jaipur for providing climatic data and authorities of Soil Survey Division, Department of Agriculture, Udaipur for analyzing our water and soil samples taken from the Park.

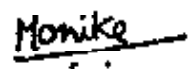
Thanks are also extended to the scientists and staff of Botanical Survey of India, Jodhpur for their help and suggestions, especially Shri. P. J. Parmar, Deputy Director, Shri. Khiv Ram, Fieldman and Shri Ratan Singh Purohit, Artist. Mr. A. K. Shrivastava and Ms. Anita Bana (JRFs) also deserve thanks for their help in various ways. Ms. Rinku Sharma, who carried out the computer work, deserves special thanks. The Publication section of the Botanical Survey of India is also thanked for promptly publishing this work.

Last but not the least, we thank Prof. M. M. Bhandari, ex Prof. & Head, Department of Botany, J. N. V. University, Jodhpur, renowned Indian desert taxonomist, for reviewing the present work and writing foreword for the book. The authors would welcome any suggestion from its readers that may be valuable in the future improvement of this book.

Date : 25<sup>th</sup> February, 2006



V. Singh



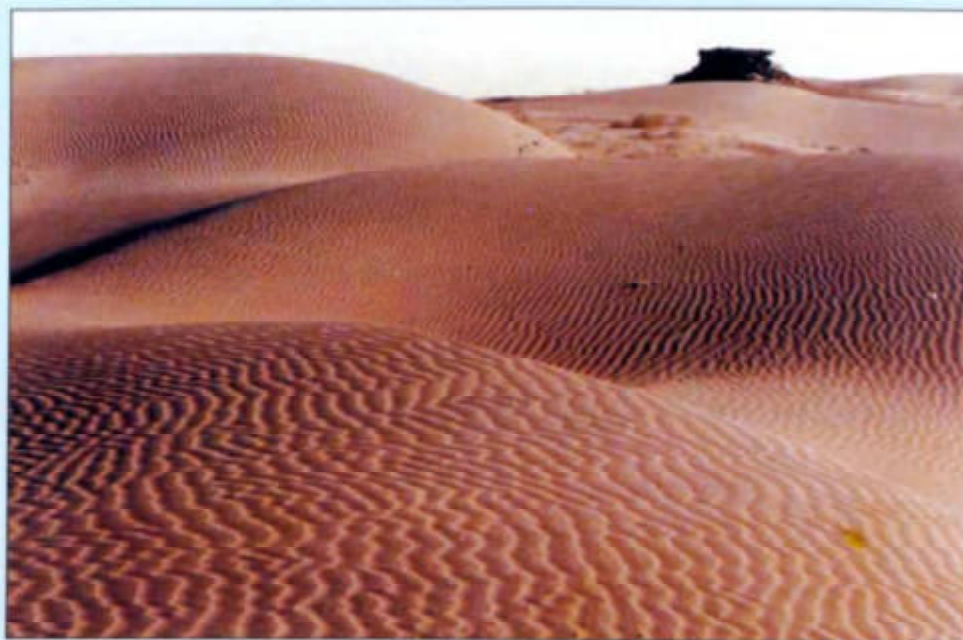
Monika Singh

# CONTENTS

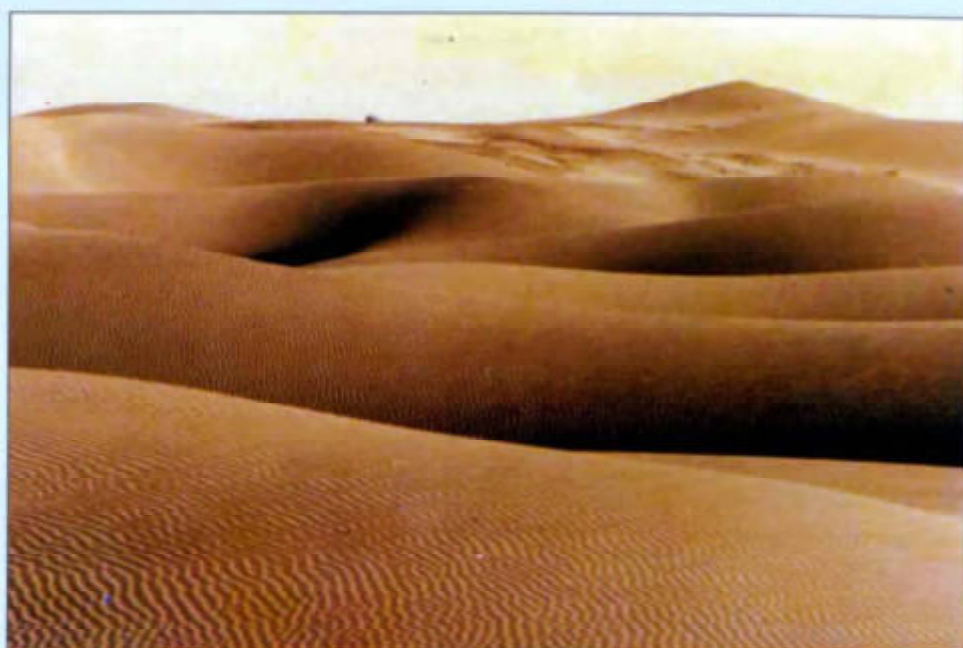
<i>Foreword</i>	iii
<i>Preface</i>	v
INTRODUCTION	1
JUSTIFICATION AND OBJECTIVES	3
GEOGRAPHICAL POSITION AND TOPOGRAPHY	5
GEOLOGY AND SOILS	9
WATER RESOURCES	11
CLIMATE	12
METHODOLOGY	15
FLORAL DIVERSITY	17
PRESENT STATUS OF KNOWLEDGE	26
VEGETATION TYPES	27
KEY TO THE FAMILIES	32
ENUMERATION OF SPECIES	35
FLORAL COMPOSITION – A STATISTICAL ANALYSIS	196
PHYTOGEOGRAPHICAL ASSESSMENT	199
BIOLOGICAL SPECTRUM	201
BIOPERSPECTIVE POTENTIAL	205
THREATS TO BIODIVERSITY	227
CONSERVATION AND MANAGEMENT STRATEGIES	236
FAUNAL DIVERSITY	243
REVIEW OF LITERATURE	245
ENUMERATION OF SPECIES	248
INVERTEBRATES	248
Nematoda	248
Mollusca	249
Arthropoda	249
VERTEBRATES	255
Amphibia	255
Reptilia	255
Aves	258
Mammalia	263

STATISTICAL SYNOPSIS	267
CONSERVATION AND MANAGEMENT	275
PLANT-ANIMAL RELATIONSHIP	281
REFERENCES	285
INDEX TO THE LOCAL NAMES – FLORA	303
INDEX TO THE BOTANICAL NAMES	305
INDEX TO THE LOCAL NAMES – FAUNA	327
INDEX TO THE ENGLISH NAMES – FAUNA	328
INDEX TO THE ZOOLOGICAL NAMES	330
INDEX TO THE PHOTOGRAPHS	341
INDEX TO THE FIGURES	343





1. Barren sand-dunes in Miajlar area.



2. Barren sand-dunes in Sam area.

**Plate-1.** Topography – Barren sand-dunes.



1. Barren shifting sand-dunes with stabilized ones in the back near Sam.



2. Stabilized sand-dune near Berisiyala.

**Plate-2.** Topography – Stabilized sand-dunes.



1. *Prosopis cineraria* (L.) Druce tree in the center and growth of *Calotropis procera* (Ait.) R. Br. in the back near Antia.



2. Growth of *Calotropis procera* (Ait.) R. Br. near Sam.

**Plate-3.** Topography – Sandy plains.





1. *Acacia senegal* (L.) Willd. and browsed stumps of *Leptadenia pyrotechnica* (Forssk.) Decne. near Miajlar.



2. Clumps of *Euphorbia caducifolia* Haines on rock outcrop near Sipla.

**Plate-4.** Topography – Sandy plains and rock outcrop.



1. Gravelly plain with exposed rock outcrop near Mathuo-ki-Basti occupied by *Prosopis juliflora* (Sw.) DC.



2. Dense community of *Lasiurus scindicus* Henr. with scattered *Capparis decidua* (Forssk.) Edgew. trees in gravelly plain.

**Plate-5.** Topography – Gravel and rocky areas.

## INTRODUCTION

Biodiversity refers to total variability within all organisms and ecological complexes within which it exists. Thus, biodiversity is a total variety of the life on the earth at gene, species and ecosystem levels. It is dynamic at all the three levels; the genetic composition of species changes overtime in response to natural and human induced selection pressures; the occurrence and relative abundance of species in ecological communities change as a result of ecological and physical factors; and ecosystem strongly responds to external dynamics and internal pressures. The biodiversity constitutes resources upon which families, communities, nations and future generations depend. It makes substantial contributions to the development of agriculture, medicine, industry, etc. Many species constitute the foundation of communities welfare in rural areas by providing food, fodder, medicine, fuel, fibers, dye, gum, resin, etc. Besides this, some species have been found useful in stabilization of climatic and edaphic characters of biomes. As such, it is difficult to determine the total economic value of the full range of goods and services that biodiversity provides.

After Convention on Biological Diversity (CBD) at Rio de Janeiro in June, 1992, which was ratified by India on February 18<sup>th</sup>, 1994, each party country of the Convention has the responsibility to conserve, restore and sustainably use the biological diversity within its jurisdiction to fulfill the human needs. For conservation and wise management of biological wealth, there has been a necessity to have correct and reliable knowledge about the living and non-living components of biodiversity through inventorisation, documentation and monitoring of the components.

India is one of the twelve mega-biodiversity centers of the World. Its strategies for *in-situ* conservation and sustainable utilization of bioresources comprise providing special status and protection to biodiversity rich areas by declaring them as National Parks, Wildlife Sanctuaries, Biosphere Reserves, etc. As such, a network of protected areas has been created in the country through 89 National Parks, 489 Wildlife Sanctuaries and 13 Biosphere Reserves.

Rajasthan is the largest State of India, having an area of 3,42,239 sq. km, forming eastern extremity of great arid and semi-arid belt of the World. In this State, 4 National Parks (including DNP) and 22 Wildlife Sanctuaries have been notified for the conservation of bioresources. More than 50 % part of Rajasthan State comes under desertic zone, called "Great Indian Desert". The Great Indian Desert or the Thar Desert is the eastern limit of the Sahara-Arabian desert and extends over 1.3 million sq. km between 22°30' N and 32°05' N and 68°05' E and 75°45' E in India and Pakistan. It is the most populous desert of the World and earlier known as "Thar Parker Desert" based on the name of a district of Sind Province, now in Pakistan. In India, it extends over 2,85,680 sq. km, of which Rajasthan covers 1,96,150 sq. km, Gujarat 62,180 sq. km, Punjab and Haryana 27,350 sq. km. The edaphic and climatic conditions of Indian Desert, spreading over several States, are almost identical, except Rann of Kutchh. As such, to conserve the biodiversity of saline tract, "Wild Ass Wildlife Sanctuary" has been established in Kutchh to protect flora and fauna. Another protected area "Jessoro Sloth Bear Wildlife Sanctuary" has been notified in northern Gujarat at Banaskantha district, the area which provides meeting ground for saline and real desertic elements. The desertic zones falling within the jurisdiction of Punjab and Haryana States are mostly under cultivation. As such, Rajasthan is the main custodian of desertic environment. The numerous life-forms – both floral and faunal, that have adapted



themselves to survive and multiply under the harsh habitat and climatic conditions in the desert, constitute invaluable stocks of rare germplasm which are too valuable from the biological point of view. The desert being a fragile ecosystem, its further denudation and deterioration is likely to remove forever one of the World's most engaging environments.

During recent years many developmental activities have taken place in the desert. The northern part of Rajasthan desert is under Indira Gandhi Canal, southern part is likely to be the command area of the Narmada Irrigation Project and the famous budge of Jaisalmer is under defence establishment, as well as under the command of canal system. As such, there is no other sizeable area left for establishing a conservation unit in the desert. Moreover, enormous increase in human and animal population and various socio-economic developments in the present age have been fastly depleting the natural resources of the region. The whole desert ecosystem is, thus, in danger of deterioration into a vast wasteland and typical biodiversity and invaluable stock of rare germplasm are on the verge of extinction.

Realizing the alarming deteriorating conditions of desert ecosystem and its biotic and abiotic components, a beginning was made in 1980 by notifying a Desert Wildlife Sanctuary on 4<sup>th</sup> August under Wildlife Protection Act 1972 to preserve desert ecosystem, flora and fauna. Again on 8<sup>th</sup> May 1981, the State Government of Rajasthan notified this area as Desert National Park. But, unfortunately nothing could go further towards the planning and management of the Park. In 1988, a proposal was submitted to the Ministry of Environment and Forests, Government of India, New Delhi to declare the Desert National Park with an area of 3,162 sq. km as a Biosphere Reserve to keep pristine conditions further unmolested and restore its original status to serve as a bench mark model of the desert as it once existed over a vast territory. A project document was prepared by Ministry of Environment & Forests, but unfortunately, this proposal also could not be materialized so far and is under consideration in the Ministry of Environment and Forests, Govt. of India, New Delhi.

Presently, about 3,162 sq. km area which was earlier under Desert Wildlife Sanctuary, has been marked physically on the site as Desert National Park and is under the control of Deputy Director (DFO), State Forest Department. In official records of State Forest Department and in the literature (scientific, technical and sociological) the area enjoys the name as National Park. Some workers have even called it as Biosphere Reserve (Mecna, 2000). However, in absence of well drawn policies and legal bindings, the conditions have deteriorated rapidly in the Desert National Park. In fact, this protected area presently does not fulfill even the basic requirements laid down under Wildlife Protection Act, 1972 for Wildlife Sanctuaries, National Parks and Biosphere Reserves. Although it enjoys the name of National Park, but could not get the conservation status of even a Sanctuary, till now. Some examples are :

- 37 villages and several Dhanis are situated within the Park, having 18,618 human and 38,429 livestock population.
- Land has not been acquired from the landlords because of lack of funds to pay as compensation (WLP Act 1972, sect. 24 (1), 26).
- Under Rajasthan Land Revenue Act 1956, the landlords have been given full "Khatedari" rights on 19<sup>th</sup> November, 1998, under which they may use the land for residential or commercial purposes with due permission; they also may sale or transfer it to other party (WLP Act, 1972, sect. 20); mining has been permitted without the use of explosives (WLP Act 1972, sect. 19-25).
- Fencing has been done here and there in limited area only.

- Plying of auto-vehicles and tourist activities are frequent in buffer zone.
- Agriculture cropping is being done, though in limited area.
- Grazing and harvesting of grass for fodder is permissible, not only for the residents of the Park, but also for surrounding villages situated outside the jurisdiction of the Park.

Further, proposal for construction of a feeder canal from Mohangarh to Gadra road passing through DNP is under active consideration of State Government of Rajasthan. Wildlife Department, Govt. of India, Ministry of Environment and Forests has agreed to permit Oil and Natural Gas Corporation Ltd. for survey of oil and gas in DNP area, at the cost of Rupees 5 Crores which would be utilized for the development of the Park (Rajasthan Patrika News, 8<sup>th</sup> September, 2002).

The ambiguity in the status of this protected area and its rapid deterioration, officially as well as unofficially, is due to lack of information on the valuable biodiversity it stores. Consequently, there have been lacunae in policy making and delay in decision taking for implementation of laws laid down under Wildlife Protection Act 1972. As such, the present study was undertaken to provide physical and factual information about the plant and animal resources of Desert National Park, their relationship and effect of anthropogenic activities on the whole ecosystem. Such study is inevitable in order to have a sound ecological development of the desert ecosystem of the Park.

### JUSTIFICATION AND OBJECTIVES

Since several plants and animals are vanishing from many regions of the World, there has been an urgent need for detailed account of all plants and animals before some disturbing factors affect the valuable biological wealth of natural ecosystems. In DNP, the exploitation of plant resources for timber, food, fodder, firewood, gum, resin etc and overgrazing are main biotic activities operating with adverse climatic and edaphic conditions. As such, the flora and fauna of the National Park is under great threat. The defence activities and poaching and hunting of wildlife have further deteriorated the fragile ecosystem of the Park. Therefore, it is inevitable, in order to have a sound ecological development of the desert ecosystem of the Park, first to identify its plant and animal resources, secondly to study the relationship of the flora and fauna with each other and with abiotic components and thirdly to study the effects of anthropogenic activities on the whole ecosystem.

Desert ecosystem has attracted the attention of botanists and ecologists since long back and voluminous literature is available on the floral components of desert as a whole (Bhandari, 1978, 1990; Shetty & Singh, 1987, 1991, 1993). But, unfortunately, as a protected area, DNP could not get due consideration; even basic information required for the management of a protected area is not yet available about the area of great biological interest. The only notable works are those of Pandey (1984) and Pandey *et al.* (1985) wherein preliminary efforts have been made towards the listing of plants growing in the Park area. A few years back, a project document "Thar Biosphere Reserve" was also published (prepared by Sankhala *et al.*, 1988) by the Ministry of Environment and Forests, Govt. of India, New Delhi. Recently, Meena (2000) has made an effort to compile different aspects about DNP. Besides these, there has been no synthesized information about actual floral and faunal components and their inter-relationship in DNP. The abiotic components which determine the biotic structure of an ecosystem have also not been analysed. Lack of adequate information has adversely affected planning and management of the Park, leading to present position.

In the present work, all the issues related to the conservation of biodiversity and management of the Park have been taken into account to save the biological wealth from havocs and threats. The important aspects of study include :

- Botanical survey of Desert National Park for 3 years in different seasons, collection of herbarium specimens and identification.
- Inventorisation of the flora of Desert National Park and it's documentation.
- Providing means of identification to the floral components from family to infra-specific level through keys, diagnostic descriptions, illustrations and photographs.
- Standardization of nomenclature of plants according to the ICBN, along with local names.
- Determination of depleting plant species and their categorization as per IUCN standards.
- Determination of the factors responsible for the depletion of plant and animal species and strategies for the conservation of species and habitat.
- Determination of bioperspective value of the Park area, including wild germplasm which has relationship with domestic crops.
- Determination of phytogeographical status of the flora and sketch of biological spectrum.
- Preparation of vegetation map of the Park area.
- Inventorisation of faunal components of the Park with the help of Zoological Survey of India.
- Determination of inter-dependency between flora and fauna in the Park and impact on each other, through personal observations and available literature.
- Assessment of impact of conservation measures on the flora and fauna since it's establishment based on comparative studies with unprotected areas.

It is hoped that the outcome of this study will be a valuable document for :

- I. the development of conservation plans and strategies and practices to ensure survival of unique biodiversity resources in the Park.
- II. developing and strengthening effective mechanism for biodiversity conservation both within and outside the National Park.
- III. the restoration of degraded ecosystem and recovery of endangered species and wild relatives of crop plants.
- IV. the protection and encouragement of traditional knowledge about the uses of biological resources that are compatible with conservation or sustainable use requirement.
- V. the formulation of eco-friendly, educational and public awareness programmes for domestic and foreign visitors in relation to conservation of the nature and natural resources.
- VI. understanding of food chain and flow of energy in the Park and determining the causes of threats, with respect to the flora and fauna.
- VII. providing supporting information which will be helpful in determining the status of this protected area as National Park or Biosphere Reserve.

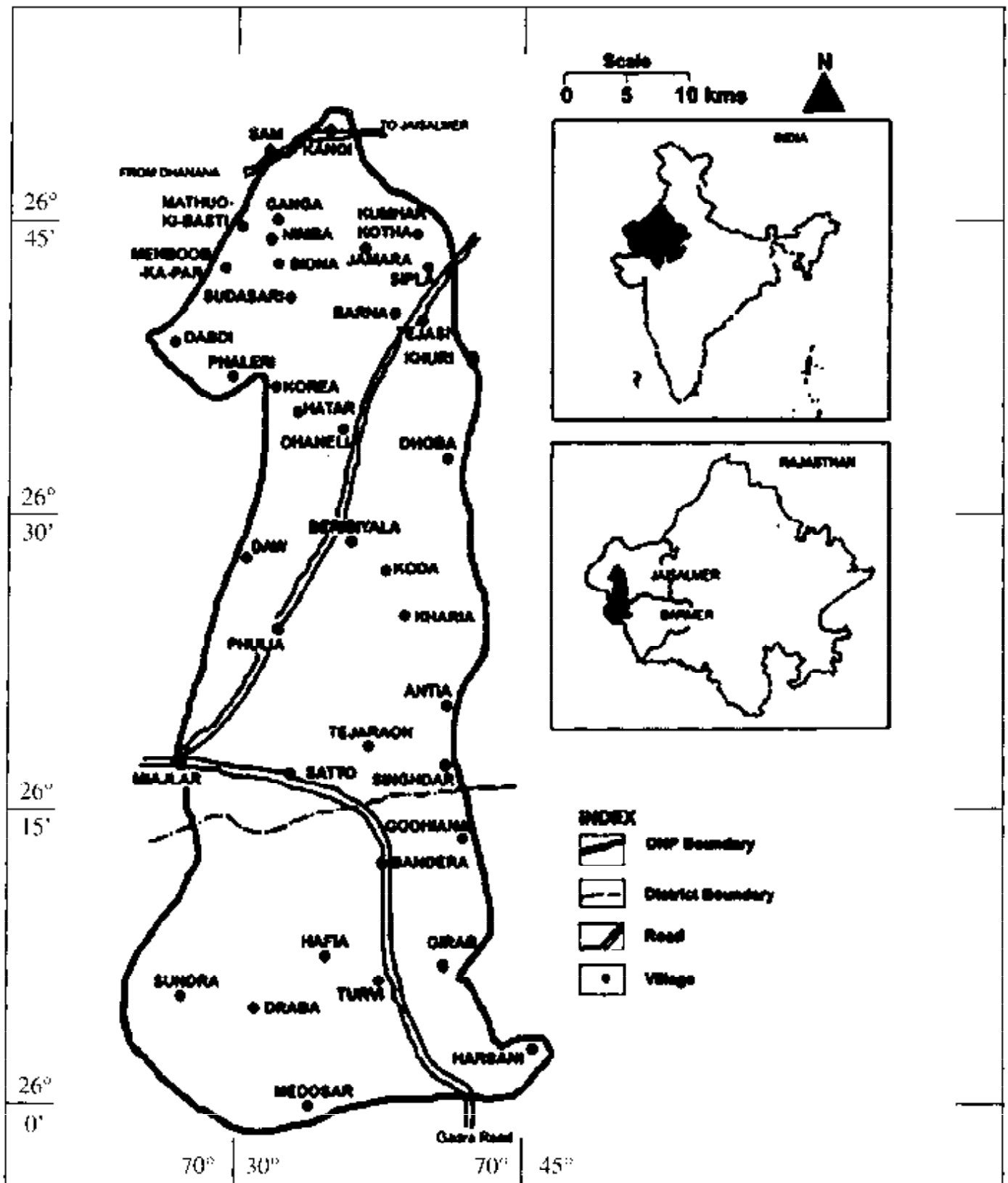
## GEOGRAPHICAL POSITION AND TOPOGRAPHY

Stretching over 3162 sq. km, partly in Jaisalmer (1900 sq. km) and partly in Barmer (1262 sq. km) districts, Desert National Park is situated between 25°47' N to 26°46' N and between 70°15' E to 70°45' E. The altitude of the area ranges between 181 m near Daw village and 289 m near Sam. It is 45 km from Jaisalmer and 120 km from Barmer towns in approach. The area is bounded by Jaisalmer-Sam axis in north, Gadra road-Barmer rail track in the south, Gadra-Harsani road in the east and the international boundary with Pakistan in the west. The western boundary has been shifted 20 km eastwards from international boundary from defence point of view. The northern boundary of the Park starts from Kilometer stone no. 34 on Jaisalmer-Dhanana road, passes through village Sam along the Jaisalmer-Dhanana road. The western boundary runs from Sam along Sam-Lunar track up to bifurcation for Meghwalon-ki-Dhani, passes through Miajlar village of Jaisalmer district and Sundra village of Barmer district. The southern boundary starts from Sundra village, passes through Medosar, Harsani and Singhdar villages of Barmer district on Sheo-Gadra road. The eastern boundary starts from Kilometer stone No. 68 on Sheo-Gadra road to villages Khijar and Girab in Barmer district and again through Antia, Khuri, Jamara and Kumhar Kotha villages to Kanoi village of Jaisalmer district (Map-1). Desert National Park forms only one per cent of the total arid region, housing a variety of unique species of flora and fauna of the desert. This is the area which has natural landscape, original vegetation, different landforms and traditional land use, low population density and suitable for an effective conservation unit.

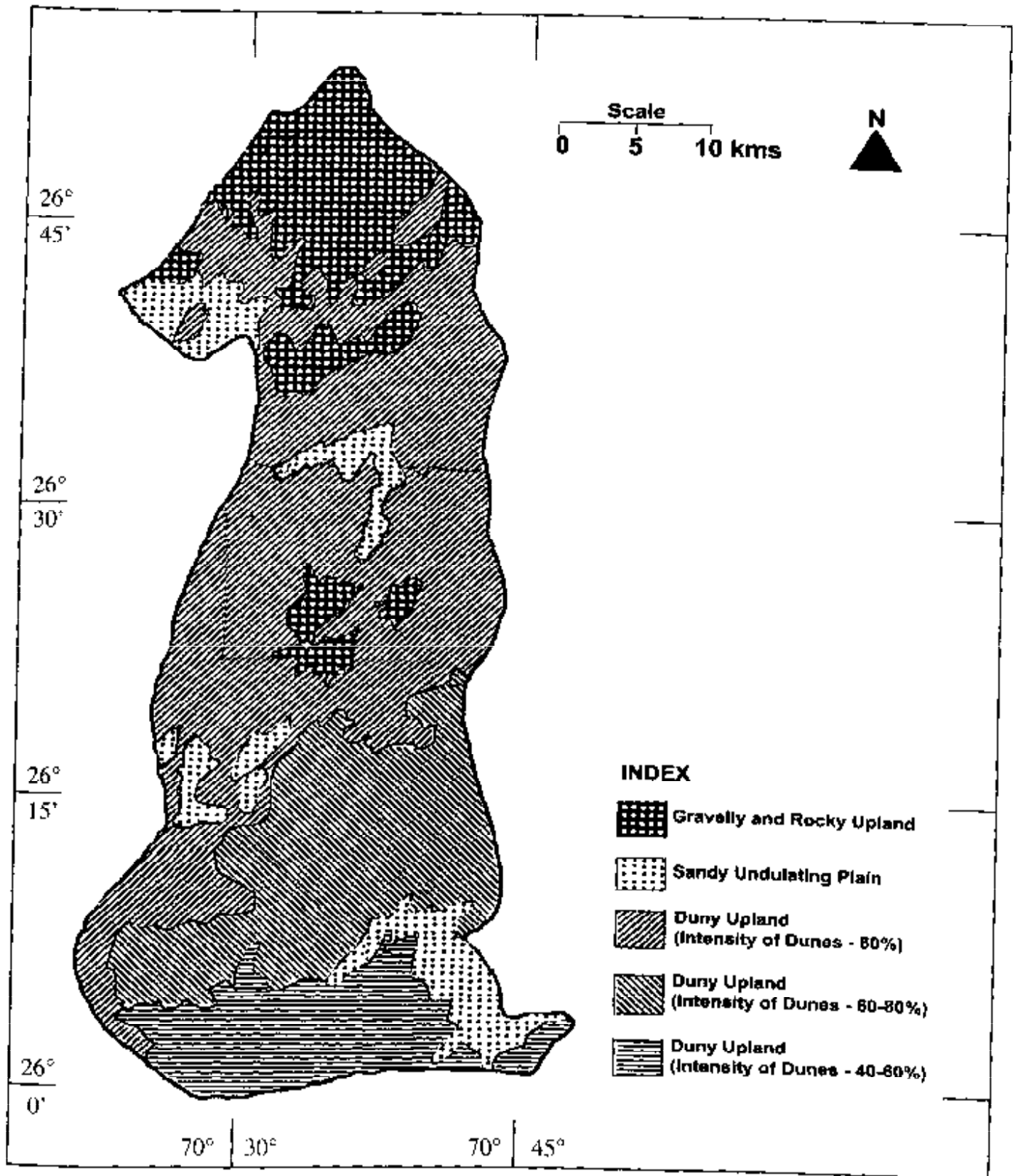
The idea behind the establishment of DNP originated because presently the northern part of Rajasthan desert is under Indira Gandhi Canal, southern part is likely to be the command area of Narmada Irrigation Project and the famous bulge of Jaisalmer is under the defence establishment as well as under the command area of the canal system. The result is that there is hardly any other sizeable area left for establishing a conservation unit to save unique flora and fauna confined to fragile desert ecosystem.

The area falling within the jurisdiction of DNP is largely sandy with shifting sand-dunes, semi-stabilized sand-dunes, stabilized sand-dunes (Plate-2) and inter-dunal flat lands. The pavements (locally called Magra or gravelly lands), rocky hills and plateau are few, mainly confined to the northern part except few outcrops in the center (Plate-4 & 5). The one-third southern part of the Park is dune upland (Plate-1), with sandy undulating plains (Plate-3) between Girab and Turvi in south-east and near Satto in north-western part. The central part of the DNP is also dominated by dune upland, with scattered patches of sandy undulating plains and rock outcrops between Hatar and Antia villages. The land slopes towards the south and north-west (Map-2 & 3).

The blown sand, due to aerodynamic processes and biotic interferences, forms shifting sand-dunes i.e. after some time they change their position or shift from one place to another. Near Sam, Khuri and Miajlar these types of dunes are common (Plate-1). Most of the dunes are soon inhabited by pioneer dune fixing plants like *Aerva javanica*, *Aristida* spp., *Calligonum polygonoides*, *Cenchrus* spp., *Cyperus atkinsonii* etc, resulting in established sand-dunes. The inter-dunal depressions mostly originate by wind depletion and by dried up beds of seasonal desert streams. The saline flat lands are very limited. There is no permanent water source. However, seasonal streams, locally called 'Nalhas' are found with limited catchment areas. But, they also soon dry out due to alluvial suffocation and excessive evaporation. During rainy season, the little flow of water is often locked by the local inhabitants in DNP in 'Khadeens' and 'Nadis' for cultivation and drinking purposes respectively. The area looks like a huge sand sea with few shrubs and herbs and limited tree species. It is amazing that a few showers, when it receives, turn it into a green carpet and good pasture land.

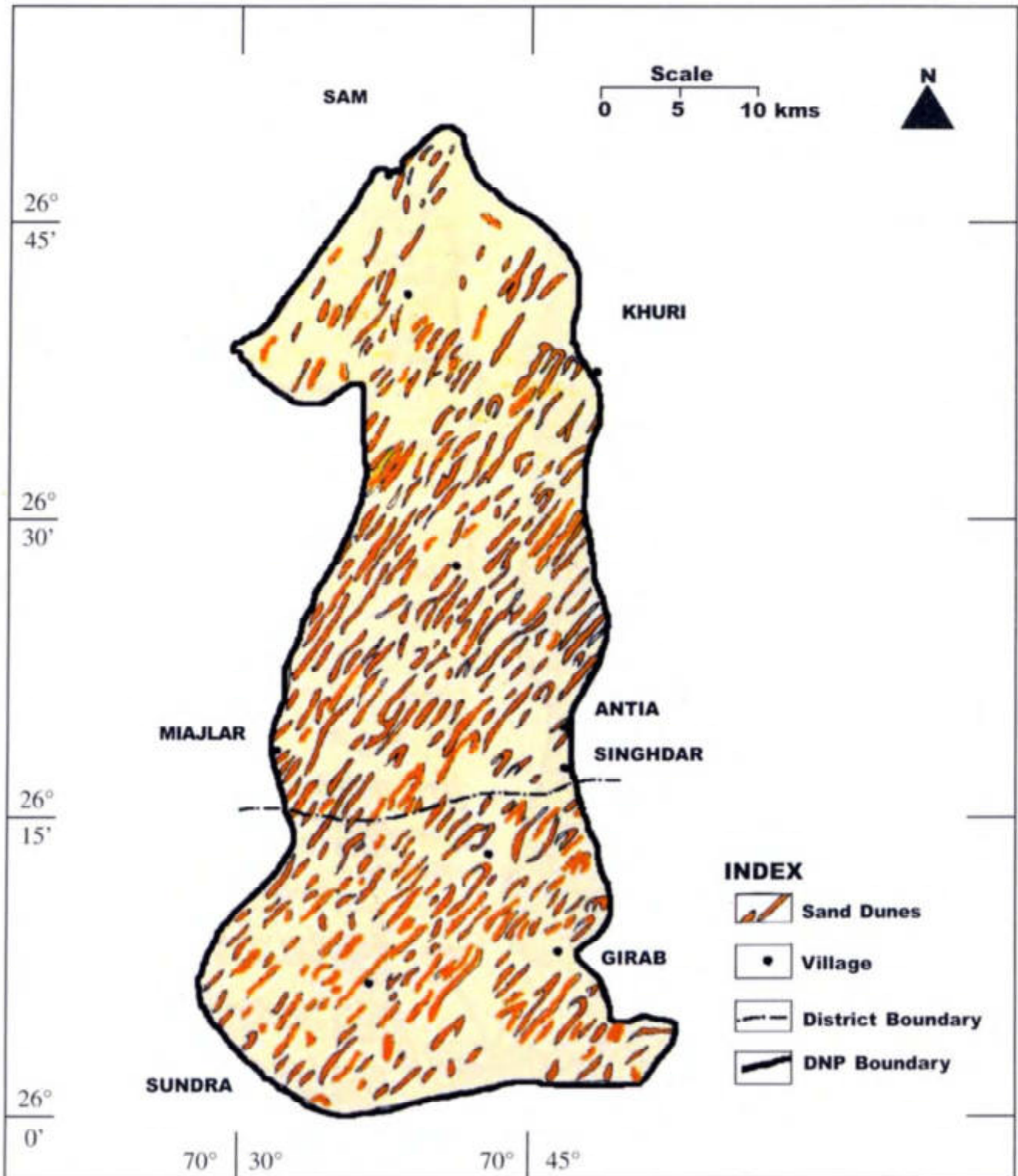


Map-1. Desert National Park - key map.



Map-2. Desert National Park - orography





Map-3. Desert National Park – sand-dunes distribution pattern, reproduced from Remote Sensing map

## GEOLOGY AND SOILS

### Geology

The desert area was submerged under sea during the Jurassic, Cretaceous and Eocene ages. It was uplifted probably sometimes in the upper Tertiary. It was during late Pleistocene after the last phase of glaciation that the desertic conditions were set in. Small outcrops of Jurassic rocks comprising limestone, sandstone and shale are found in the midst of desert sand and alluvium. Marine deposition resumed in the Eocene period before a climatic accident resulted in the desert. Blanford (1877) has studied the geology of Indian desert in rather details.

The geological formations in Desert National Park are identical to rest part of desert, but in major part, the rocks are covered with wind blown sand. In the northern part of the Park, the sandstone formations are exposed in the form of rock outcrop which gradually thins out in eastern and southern directions. The similar sporadic formations may be seen in the central part here and there near Kharia, Koda and Phulia villages. The sandstones are of feldspathic and ferruginous nature. The limestones and shales overlain by desert soil and alluvium are scattered in the central-eastern part of the Park between Kharia and Singhdar. Recently, Geological Survey of India has also identified huge deposits of limestone in the northern part of the Park near Sam. The central and southern most parts of the Park are mostly dune upland, with scattered sandy undulating plains.

### Soils

The soil forms a definite abiotic substrate for plant growth and development. It is the main source for almost all the essential elements to plants, found in the form of extraordinary complex chemical mixture of different minerals and organic substances. During present study, six soil samples were collected from Sam (S-1), Sudasari (S-2), Berisiyala (S-3), Miajlar (S-4 & S-5) and Girah (S-6) and physico-chemical structure, particle distribution in soils, moisture content and water holding capacity of soils were studied at Soil Survey Division, Deptt. of Agriculture, Udaipur.

Table-1. Distribution pattern of sand, clay and silt in Desert soils (in percentage).

Sample No.	Silt	Clay	Sand
S-1	1.8	1.0	95.2
S-2	1.6	1.1	95.8
S-3	1.8	1.1	95.1
S-4	1.9	1.8	94.6
S-5	2.0	2.0	94.0
S-6	2.0	2.5	93.5

The study revealed that the dominate soil of the Park is light-textured typical Desert soil, constituted with fine sand (93.5-95.8%), clay (1-2.5%) and silt (1.6-2%), see table-1. The chemical analysis (table-2) revealed that amounts of organic matter and other mineral nutrients are very low.

Table -2. Chemical analysis of Desert soils (in percentage).

Sample No.	pH	EC	% OC	% P	% Ca	% K	% Na	% N
S-1	8.25	0.32	0.10	0.015	0.85	0.0075	0.009	0.008
S-2	8.39	0.31	0.08	0.019	0.90	0.006	0.008	0.009
S-3	8.41	0.30	0.17	0.025	0.87	0.009	0.008	0.011
S-4	8.15	0.34	0.04	0.022	0.88	0.008	0.007	0.008
S-5	8.25	0.31	0.21	0.018	0.87	0.008	0.009	0.010
S-6	7.87	0.34	0.07	0.020	0.86	0.012	0.008	0.009

The organic carbon (OC) varies from 0.04 to 0.21 per cent, Phosphorus (P) 0.015 to 0.025 per cent, Calcium (Ca) 0.85 to 0.9 per cent, Potassium (K) 0.006 to 0.012 per cent, Sodium (Na) 0.007 to 0.009 per cent and Nitrogen (N) in the form of nitrates 0.008 to 0.011 per cent. Among heavy metals, Manganese and Copper are below critical limit. However, Zinc and Iron are adequate in the soil. Further, the moisture content (table-3) is very low in upper layer of soil up to 10 cm depth; it varies from 0.01 to 0.018 per cent. However, between 15-30 cm depth, the moisture content varies between 4.8 to 5.02 per cent. The water holding capacity of Desert soils is very low, varying from 20 to 23 per cent. Due to porous, loose and sandy texture, the percolation rate is rather high. The Desert soils of the Park are light brown in colour and have low biological activity. They are alkaline in nature as pH values vary from 7.87 to 8.41 (table-2). The electric conductivity (EC) varies from 0.3 to 0.34 (table-2). These soil types are prone to wind erosion and considered medium to low quality for sustaining natural vegetation.

Table -3. Moisture content and water holding capacity of the Desert soils (in percentage).

Sample No.	Moisture Content	Water Holding Capacity
S-1	0.01 % (0-10 cm)	22%
	4.8 % (15-30 cm)	
S-2	0.01 % (0-10 cm)	23%
	5.02 % (15-30 cm)	
S-3	0.018 % (0-10 cm)	20%
	4.90 % (15-30 cm)	
S-4	0.01 % (0-10 cm)	22.5%
	4.80 % (15-30 cm)	
S-5	0.012 % (0-10 cm)	23%
	5.02 % (15-30 cm)	
S-6	0.01 % (0-10 cm)	20.5%
	4.9 % (15-30 cm)	

Another soil type found in the Park is Grey-Brown Desert soil. It is saline in nature and distributed in patches in northern and central parts of the Park. It is suitable for sustaining healthy halophytic components, like species of *Chenopodium*, *Fagonia*, *Haloxylon*, *Tamarix*, etc.

### WATER RESOURCES

Water is the most precious natural resource of the earth. All the biological activities of living World are controlled by water. Due to low rainfall, DNP faces scarcity of surface water. There are no perennial rivers, permanent ponds, etc in Desert National Park. During rainy season, the water accumulates in several low-lying areas temporarily, called 'Khadeens' and "Nadis" and is used for cultivation and drinking purposes respectively.

Table-4. Physico-chemical properties of rain water stored in ponds, tanks, etc.

Sample No.	pH	EC mho/cm	Cation mg/lt.			Anion mg/lt			SAR
			Na <sup>+</sup>	Ca <sup>2+</sup> Mg <sup>2+</sup>	K <sup>+</sup>	HCO <sub>3</sub> <sup>-1</sup>	Cl <sup>-1</sup>	SO <sub>4</sub> <sup>-2</sup>	
S-1	7.28	0.31	1.0	2.5	0.24	2.5	1.0	0.24	0.89
S-2	7.45	0.33	1.0	2.5	0.15	2.0	1.0	0.65	0.89
S-3	7.80	0.24	1.15	2.0	0.36	2.5	1.0	0.01	0.76
S-4	7.85	0.39	1.35	3.0	0.18	3.0	1.5	0.03	1.15
S-5	7.35	0.25	1.15	2.5	0.18	2.0	1.0	0.02	1.1

During present study, five water samples were collected from ponds in different places viz. Sipla (S-1), Mathuo-ki-basti (S-2), Tejaraon (S 3), Bandera (S-4) and Singhdar (S-5) and analyzed at Soil Survey Division, Deptt. of Agriculture, Udaipur. The study revealed that pH value of stored rain water of ponds varies between 7.28 to 7.85, indicating salinity. The electrical conductivity (EC) varies from 0.24 to 0.39. The Calcium cations (Ca<sup>2+</sup>) and Magnesium cations (Mg<sup>2+</sup>) vary from 2-3 mg/lt and of Potassium (K<sup>+</sup>) from 0.15-0.36 mg/lt. However, Sodium (Na<sup>+</sup>) is better represented as cations vary from 1-1.35 mg/lt (table-4). Further, high concentration of Bicarbonate ions (HCO<sub>3</sub><sup>-1</sup>) was recorded (2-3 mg/lt) in comparison to Chlorides (Cl<sup>-1</sup>) (1-1.5 mg/lt) and Sulphates (SO<sub>4</sub><sup>-2</sup>) (0.1-0.65 mg/lt). The Sodium Absorption Rate (SAR) varies from 0.76 to 1.15 and Residual Sodium Carbonate (RSC) was found negligible (table-4). Thus, the chemical properties of rain water of ponds reflect brackish or saline nature, rich in Chlorides and Bicarbonates, neither good enough for cultivation nor for drinking.

The other source of water in the Park is ground water, but water table is very deep, varying from 50 to 100 m. General quality of ground water is highly saline or brackish. The higher T.D.S. (1000 per million) in ground water can cause many diseases in man and livestock in the National Park. The permissible limit of T.D.S. is 500 ppm in drinking water as determined by World Health Organization. As such, the ground water is not suitable for drinking. However, inhabitants use it for irrigation. They fetch water from deep wells with the help of camels and donkeys. The water table trends in ground water potential areas have reflected depletion in ground water levels in last 10 years, which varies from 0.55 m to 0.60 m in the Park. The

villagers store rain water in tanks, called "Tankas" in the campus of their houses for drinking and other domestic purposes.

### CLIMATE

The climate is typically arid. Pramanik & Ghose (1952a, 1952b) have defined arid regions in India as an area having a rainfall of 25 cm or less and a mean annual diurnal temperature of 32° C or more. Thornthwaite aridity index for the area is 84. The climate of DNP is characterized by extreme dryness of air i.e. very low humidity, large extremes of temperature and fitful and erratic rainfall. The south-west monsoon brings rainy season from the end of June to September, followed by winter season from October to mid of March and summer season from March to June.

#### Rainfall

The entire arid zone, however, forms a typical belt of low rainfall, but it is further erratic and very low in DNP. Most of the time, the area faces severe scarcity of water, resulting in famine. Desert National Park, located in the extreme western part of the State is beyond the full force of both the south west monsoon rising from the Arabian Sea and south-east monsoon from the Bay of Bengal. The reasons for low rainfall are (i) area comes within anticyclonic circulation, (ii) presence of large scale dust in the air and (iii) dry subsiding air.

Table-5. Twelve years rainfall data of Desert National Park.

Year	Rainfall in mm					
	June-Sep.	Oct.-Jan.	Feb.-May	Total	Normal	% Deviation
90-91	77.3	7.0	2.8	87.1	185.5	-53.0
91-92	124.5	4.8	24.8	154.1	185.5	-16.92
92-93	211.0	12.8	4.8	228.6	185.5	23.2
93-94	361.7	0.0	14.0	375.7	185.5	102.5
94-95	182.0	0.0	91.0	273.0	185.5	47.2
95-96	283.5	23.8	47.7	355.0	185.5	91.4
96-97	140.5	0.0	48.5	189.0	185.5	1.89
97-98	97.0	39.0	12.0	148.0	185.5	-20.22
98-99	298.0	28.10	119.0	445.1	185.5	139.94
99-2000	249.0	4.0	0.0	253.0	185.5	36.39
2000-01	145.0	0.0	0.0	145.0	185.5	-21.83
2001-02	165.0	6.0	2.6	173.6	185.5	-6.41
<b>Average</b>	<b>194.54</b>	<b>10.45</b>	<b>30.06</b>	<b>235.59</b>	<b>185.5</b>	<b>27.0</b>

(Source : Meteorological Department, Jaipur)

A perusal of table-5 revealed that average annual rainfall for last twelve years is 235.59 mm, which is higher than normal (185.5 mm) as estimated by Meteorological Department for arid areas of Indian desert.

Pramanik & Ghose (1952a, 1952b) have, however, defined aridity up to the areas receiving 250 mm annual rainfall. Moreover, under the latter definition, DNP falls in arid zones from rainfall parameters. The large scale plantations, conservation of flora and sustainable developmental activities have notably produced positive effect on the climate of desert area during recent years. As such, estimation of normal annual rainfall (185.5 mm) needs to be enhanced to average annual rainfall of 250 mm as proposed by Pramanik & Ghose (1952a, 1952b). In DNP, the maximum precipitation takes place during June to September (194.54 mm-average annual) and minimum during October to January (10.45 mm-average annual). This period may be considered driest in which about 33.33 per cent of 12 years received no rainfall during these months. The months of February to May receive showers with an average annual rainfall of 30.06 mm. On an average, there are 15-20 rainy days in DNP. The rains play a vital role in maintaining the biodiversity of DNP. As such, frequency and density of flora and fauna are very much related to the occurrence of rains and differ in different years accordingly.

### Temperature

A characteristic feature of the Thar desert is the great fluctuations in temperature, with cold winters and very hot summers. Desert National Park is located in extreme deserts area, as such, faces more extreme climatic conditions. In winters, the temperature falls at some places up to the freezing point. On the other hand, heat in summers is very intense and scorching, and sometimes mercury goes up to 48°C.

A perusal of table-6 revealed that mean monthly maximum temperature begins to rise rapidly from about the middle of March (33.2°C) and rises gradually to the maximum in May (44.6°C) and June (40.8°C). May is the hottest month in the Park when day's temperature sometime goes up to about 48°C, particularly in association with hot waves, called "Loo". During rainy season, from the end of June or beginning of July, the maximum temperature falls down to 35°C-36°C and remains almost constant up to September. It is interesting to record same range of mean monthly maximum temperature in the month of October, which is, however, classified as winter month due to quite low minimum temperature (22.2°C) in comparison to rainy months. The real winter season starts from November to February. In the month of November, the maximum temperature starts falling (31°C) and gradually falls down to 25.6°C during January, which is the coldest month of the year. Again in February, rise in mercury (28.4°C) starts, gradually leading to summers.

Table-6. Mean monthly temperature (°C) in the Desert National Park for 10 years from 1993.

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Max. Temp.</i>	25.6	28.4	33.2	37.9	44.6	40.8	36.4	35.3	36.0	36.1	31	26.2
<i>Min. Temp.</i>	7.8	9.8	17.2	22.2	25.8	23.3	26.4	29.5	24.6	22.2	14.1	8.2

(Source : Meteorological Department, Jaipur)

The trend of variation in mean monthly minimum temperature is almost similar to maximum temperature. December and January months bear lowest minimum temperature between 7.8°C to 8.2°C. A few foggy days are experienced sometimes during these coldest months. During February, there is very little rise (9.8°C), but, March (17.2°C) onwards up to September, there has been a gradual increase in temperature and mercury



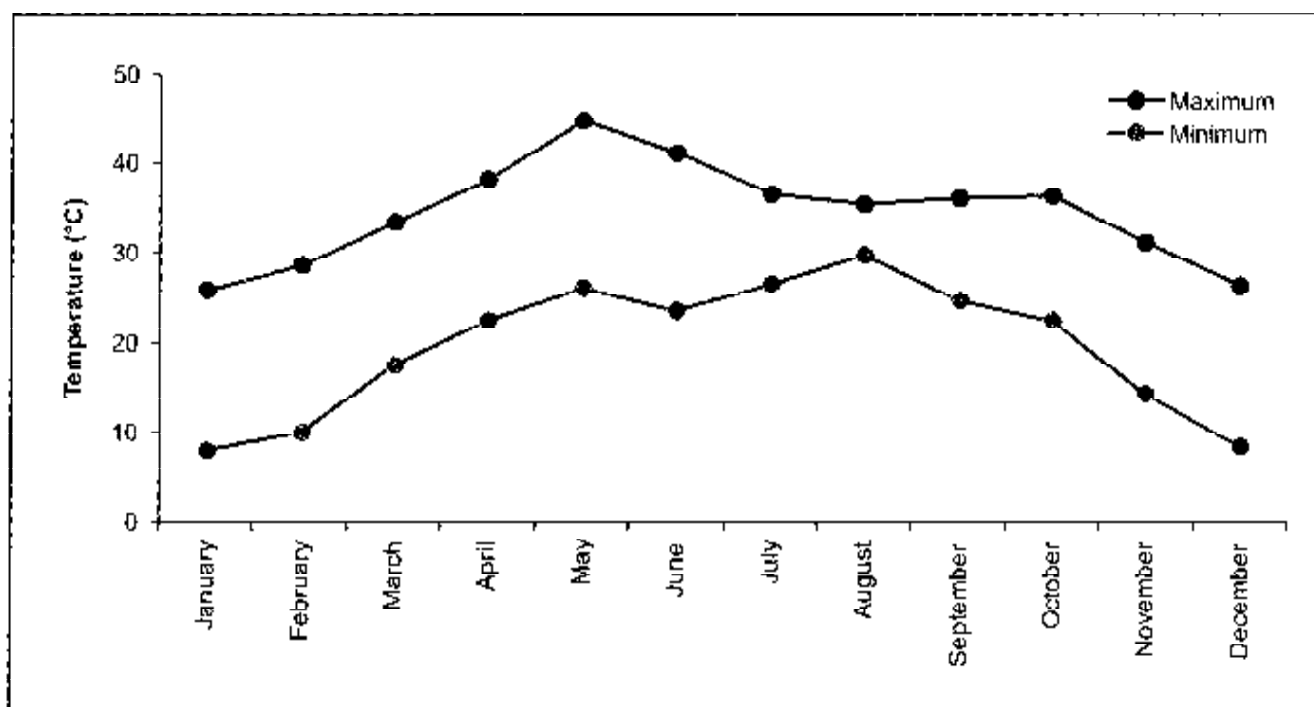


Diagram-1. Fluctuations in mean monthly maximum and minimum temperatures (°C).

fluctuates between 22.2°C to 29.5°C. Again in October, the temperature comes down to 22.2°C, indicating the beginning of winter months.

January is the coldest month when the mean daily temperature (max.) is about 25°C and mean daily temperature (min.) is about 7°C. The western disturbances passing across north India in the cold season affect the area and then it experiences cold waves and the minimum temperature sometimes goes down to freezing point and frost occurs. On account of the dryness of the atmosphere, clear sky and sandy nature of soils, there is a rapid radiation of heat from the earth soon after sunset, with the result, the temperature is considerably lowered at night.

### Relative humidity

As a result of high temperature, low rainfall and evaporation far exceeding precipitation, there is little moisture and humidity in the air. Data revealed that Relative humidity is minimum during March to June i.e. summer months and maximum during monsoon months viz. July to September. During the summer months, humidity is in general 30% to 40% in the morning hours and 10% to 15% in the afternoon hours. It is lowest in month of April and May. In the monsoon season, there is marked increase in humidity up to 70% to 80%. The maximum humidity was recorded during August. Relative humidity in cold season (December-February) generally varies between 40% to 50% in the morning hours and 20% to 25% in the afternoon hours.

### Winds

Winds are generally light in the post monsoon and winter months, lightest in the month of November (4.0-5.5 km/hr). Usually north-westerly and northerly winds are more frequent during this period. In the hot

summer season and during the monsoon, the winds are strong (20-30 km/hr) and generally blow from south-west to west. There is a large frequency of dust raising winds and sand storms during summers in Desert National Park. Dust storms, locally called "Andhis" are more common and strong in May and June, with velocity up to 136 km/hr. With high temperature and high evaporation rate, the strong winds complete the work of disintegration and soil erosion. After the rains have settled down the sand in the desert, there are practically no dust storms. However, the rainfall is usually associated with high velocity winds (15-25 km/hr or more).

### METHODOLOGY

To achieve the objectives of present work, intensive and extensive botanical exploration tours were conducted in the Park area for 3 years in different seasons so as to collect more and more plant species in flowering and fruiting state for better understanding of flora and floral composition of the Park. Special attention was paid to collect the ephemerals, which complete the life-cycle in a few days and vanish. The collected specimens were preserved as per standard norms in the herbarium of the Botanical Survey of India, Arid Zone Circle, Jodhpur (BSJO). All collected plant specimens were identified with the help of reputed literature, proper study of the materials and finally matching with authentic herbarium specimens deposited in BSJO and Central National Herbarium (CAL). Nomenclature of all taxa was brought up-to-date in accordance with International Code of Botanical Nomenclature (ICBN). Local names of almost all species were also noted. Bentham and Hooker's system of classification (1862-83) has been followed for documentation of plant wealth of the Park area.

The population studies were also carried out in DNP to determine frequency, density and abundance of rare and threatened species through quadrat method to classify the threatened species as per IUCN standards.

Ethnobotanical knowledge of residents of Park was collected, verified and documented to determine the bioprospective value of the Park. Reproductive bodies, particularly seeds, of some important useful species were collected and given to Regional Station of NBPGR, Jodhpur for the preservation of germplasm. The causes of threats to biodiversity were identified and conservation strategies were assessed.

To determine the inter-relationship between flora and fauna, help was taken from Zoological Survey of India, local people and authorities of the Park for the identification of fauna. Observations on the shelter and food habits of fauna in the Park were taken to draw a food chain of the Park and to determine the inter-dependency of fauna and flora.

Vegetation map of the Park produced through remote sensing by State Remote Sensing Department, Jodhpur was physically assessed on the ground and components and composition were identified. Soil and water samples were collected and tested at Soil Survey Department, Govt. of Rajasthan, Udaipur to know about the physico-chemical characters of soil and water. Data about temperature, rainfall, relative humidity, winds, etc were procured from Meteorological Department, Govt. of Rajasthan, Jaipur. The biotic components of the desert ecosystem of the Park have been analysed in relation to abiotic components of the ecosystem.

Further, the geology, topography, water resources, socio-economic aspects etc which have vital influence on the composition of biodiversity of the Park have also been analysed and discussed. The phytogeographical status has been determined, based on nativity of plant species, to determine routes of migration of plant species. The biological spectrum has been drawn, based on the habit of plants and their reproductive mechanism, to develop strategies for conservation.

The available literature on various aspects of present study have been critically examined and discussed before analyzing our observations. Attempts have been made to be fair, just, conclusive and result-oriented on all aspects of study. The observations and results have been systematically presented in the present work, with the hope that it will be a valuable document for monitoring the continued changes in the ecosystem and the biodiversity of the Park in future, and presently for bringing the DNP under legal framework of Protected areas.

# Floral Diversity





1. *Calotropis procera* (Ait.) R. Br., *Aerva javanica* (Burm. f.) Juss. ex Schult.,  
*Haloxylon salicornicum* (Moq.) Bunge and  
*Cenchrus ciliaris* L. on sand-dunes near Kanoi.



2. *Calligonum polygonoides* L. on sand-dunes near Satto.

**Plate-6.** Vegetation types – Sand-dunes and interdunal areas.





1. *Calotropis procera* (Ait.) R. Br. in inter-dunal areas near Sam, with *Capparis decidua* (Forssk.) Edgew., *Leptadenia pyrotechnica* (Forssk.) Decne. and *Crotalaria burhia* Buch.-Ham. ex Benth. towards dunes.



2. *Acacia tortilis* (Forssk.) Heyne subsp. *raddiana* (Savi) Brenan plantation on sand-dunes near Sam.

**Plate-7.** Vegetation types – Sand-dunes and inter-dunal areas.



1. *Moringa concanensis* Nimmo ex Dalz. & Gibs. trees on sand-dunes and typical scrub vegetation at the foot near Khuri.



2. A general view of scrub forests on sand-dunes and barren sand-dunes in the back near Kanoi.

**Plate-8.** Scrub vegetation on dunes – a general view.





1. *Capparis decidua* (Forssk.) Edgew., *Leptadenia pyrotechnica* (Forssk.) Decne., *Calligonum polygonoides* L., *Aerva javanica* (Burm. f.) Juss. ex Schult. and scattered trees of *Prosopis cineraria* (L.) Druce and *Acacia nilotica* (L.) Willd. ex Del. subsp. *indica* (Benth.) Brenan.



2. *Acacia senegal* (L.) Willd. trees with exposed root system with scattered shrubs of *Aerva javanica* (Burm. f.) Juss. ex Schult. and *Capparis decidua* (Forssk.) Edgew. between Phulia and Miajlar villages.

**Plate-9.** Vegetation types – Sandy and hummocky plains.



1. A general view of scrub forests between Khuri and Barna villages.



2. Grassland of *Lasiurus scindicus* Henr., associated with *Aristida* and *Cenchrus* spp. and scattered bushes of *Capparis decidua* (Forsk.) Edgew. near Ganga village.

**Plate-10A.** Vegetation types – Scrub forest and grassland.



1. *Lasiurus scindicus* Henr. – a climax grass of desert ecosystem.

**Plate-10B.** Vegetation types – Grassland.





1. Grassland of *Cenchrus biflorus* Roxb., with patches of *Lasiurus scindicus* Henr. near Nimba village.



2. Grassland of *Aristida* spp., with patches of *Lasiurus scindicus* Henr. and scattered trees of *Acacia nilotica* (L.) Willd. ex Del. subsp. *indica* (Benth.) Brenan and *Prosopis cineraria* (L.) Druce near Phulia.

**Plate-II.** Vegetation types – Grasslands in sandy and gravelly plains.

### PRESENT STATUS OF KNOWLEDGE

The flora and fauna which are confined to Thar Desert are unique. They are living representatives of races of plants and animals which have undergone great evolutionary changes after entering the desert over long period of time. Systematic work on phytodiversity of Indian Desert was started by Sir George King in 1868 when he made collections in Rajputana which resulted in his papers "*Famine food of Marwar (1869)*" "*Notes on vegetable products used as food during famine in Rajputana (1870)*" and "*Sketch of the flora of Rajputana (1879)*" These were the first scientific accounts on the flora of desert region. However, Brandis (1874) also made an attempt to give the general distribution of the forest species in Rajputana in his "*The Forest flora of the North-west and Central India*" References about the plants from Indian desert region may sometimes be seen in *Flora of British India* (Hooker, 1872-1897). Adams (1899) listed about 50 species of plants in his book "*The Western Rajputana States*" Later, Duthie (1903-1929) included this area in his "*Flora of Upper Gangetic Plains*" Macadam (1917) provided a list of trees from Jodhpur and Jaisalmer. It was during 1918-21 when Blatter & Hallberg intensively botanised the Indian desert and published "*The Flora of Indian Desert*" which remained the only authentic systematic account of the plants of Indian desert till independence.

The aridity and other factors influencing the vegetation in the desert attracted the attention of scientists and large number of research papers were published between 1950 and 1975 dealing with taxonomic account of desert flora. The notable contributors are ; Ramchandra Rao (1941), Sankhala (1951), Sarup (1951, 1952a, 1954, 1957, 1958a, 1958b), Krishnaswamy & Gupta (1952), Biswas & Rao (1953), Bhandari (1954, 1961a, 1961b, 1963, 1964a, 1964b, 1965, 1967), Bakshi (1954), Bhandari & Sarup (1957), Nair & Joshi (1957), Joshi (1958, 1961), Sarup & Puri (1960a, 1960b), Puri & Jain (1961, 1962), Puri *et al.* (1964), Bhandari & Singh (1964), Gupta & Bhandari (1965), Kanodia & Gupta (1969), Guha Bakshi (1969), Bhandari & Verdcourt (1970), Bhandari & Sharma (1977b), Dhillon *et al.* (1974), etc.

The most remarkable work on the phytodiversity of Indian desert was done by Bhandari (1978) who published a comprehensive flora of Indian desert containing 594 species with keys and detail descriptions of species. He added 90 more species and revised the flora in 1990 and discussed conservation aspects in 1991, 1994 & 1999. Subsequently, Pandey *et al.* (1984), Shetty & Pandey (1978, 1979, 1988) and Bhandari & Kumar (1995) etc added further to the flora of Indian desert. Another comprehensive work dealing with floral elements of Indian desert was published by Shetty & Singh (1987-1993) in the form of 3-volumed "*Flora of Rajasthan*" Desert National Park the area under present study, remained almost unexplored due to it's inaccessible approach and being on the western border line. The limited information has, however, been provided by Pandey *et al.* (1985), Pal & Meena (1999), Meena (2000) and Bhandari (2003).

A perusal of literature revealed that Indian desert has drawn more attention of ecologists rather than the taxonomists due to it's characteristic geology, topography, soils and climatic conditions. Various aspects of desert ecology have been studied in greater details viz. archeological aspects, plant associations and communities succession, influence of climate on vegetation, grasslands, rangelands, paleology, sedimentology, plant adaptations and other physiological features, afforestation problems, rehabilitation, anthropogenic influence, spreading deserts conditions and their control, etc. The ecological aspects of desert have come to focus after independence, particularly after 1950. The notable contributions are those of Bharucha (1951, 1955, 1960, 1975b), Agharkar (1952), Banerjee (1952), Biswas (1952), Ghosh (1952), Pramanik (1952), Puri (1952), Sarup (1952b, 1953), Chapline (1963a, 1963b), Joshi (1956), Shah (1957), Satyanarayan (1958,

1971), Dabodghao (1958), Prakash (1959), Prakash & Nanda (1961), Bhimaya *et al.* (1961a, 1961b, 1962, 1964), Sharma (1961, 1965), Rao & Kanodia (1962a, 1962b, 1963), Sen (1962), Kaul & Ganguli (1963), Meher-Homji (1963), Adyalkar (1964), Das & Bhimaya (1964), Das *et al.* (1964), Mulay *et al.* (1964), Bharucha & Meher-Homji (1965), Raheja (1965), Sen (1965, 1990), Satyanarayan *et al.* (1966a, 1966b), Bhimaya & Ahuja (1968), Chakravarty (1968a, 1968b), Gupta (1968, 1975), Gupta & Abichandani (1968), Sinha (1993), etc.

Some more recent and prominent works in the field of desert ecology to be added are those of Jain (1970), Cherian & Bole (1971), Gupta *et al.* (1971), Saxena (1977), Bora (1973), Joshi & Gupta (1973), Mann *et al.* (1974), Gupta & Prakash (1975), Shankar & Bhati (1977), Mertia & Bhandari (1978), Shankararayan & Sen (1987), Bhandari (1988), Malhotra (1988), etc. The literature cited above revealed that the area under Desert National Park forming extreme desert, has also been ecologically neglected. In the last decade of 20<sup>th</sup> century no remarkable ecological work has been done except the contribution of Dhabriya (1993). However, the desert ecosystem is one of the most fragile ecosystems and needs constant and regular monitoring.

During recent years, the morphological variations of smaller magnitude in some of the desert plants have attracted the botanists for cytological studies (Bhandari & Bhansali, 1974; Bhandari *et al.*, 1975). The socio-economic aspects of Indian desert have been studied by Chouhan (1993). Paleobotanical investigations in Thar desert have been conducted by Singh (1969) and geomorphological by Singh (1977). Various other aspects viz. ethnobotany, phytogeography, depleting plant resources and conservation, biological spectrum, etc have also received due consideration in biodiversity of Thar desert. The contributions made so far in these fields have been cited under respective chapters in this work. Unfortunately, most of the workers have selected biodiversity rich areas, particularly near cities and easily approachable places, for their studies, and the area presenting extreme desertic conditions under Desert National Park has remained neglected.

## VEGETATION TYPES

The vegetation in Desert National Park is quite sparse, consisting mainly stunted, thorny or prickly shrubs and few scattered trees. Perennial herbaceous flora is very limited, capable of drought resistance. The ephemerals come up during the rainy season, complete their life-cycle before the advent of winters and subsequently major part of the Park is transformed into open sandy plain, desolate and almost barren. Since, climate of the Park is homogenous, the vegetation can better be said to be edaphic controlled. A perusal of Satellite Vegetation Map obtained from State Remote Sensing Department revealed that vegetation is comparatively more dense in three areas viz. Bandera block in the south-east approximately between 70°32' and 70°42' longitude and 26°04' and 26°14' latitude. Topographically, this area is dominated by dune uplands (sand-dunes) and the intensity of dunes varies from 40-80 per cent. The central part covering major area between Miajlar, Antia, Kharia and Daw located approximately between 26°15' and 26°25' latitude and 70°24' and 70°42' longitude, which will be called Phulia block hitherto, also maintains comparatively rich vegetation cover. This area is also dominated by sand-dunes, with 60-80 per cent intensity. The third belt of rather thick vegetation lies in northern part of DNP, approximately between 26°35' and 26°40' latitude and 70°20' and 70°39' longitude. This block will be called Sudasari hitherto and again dominated by dune upland with intensity of dunes above 80 per cent. The rest part of Desert National Park bears very scattered and scanty vegetation.

In the light of Satellite Vegetation Map, the ground reality of vegetation cover was assessed during present study and it was noted that since edaphic conditions are not homogenous, a line of demarcation may be drawn regarding the distribution pattern of taxa based on topographic conditions. The community/ association dominance, frequency and abundance of taxa differ according to the habitats. The vegetation of DNP may be better classified as under :

**Sand-dunes and inter-dunal areas :** It has already been discussed that major area of DNP is occupied by sand-dunes of different orientations and magnitude. The unestablished sand-dunes maintain rather scanty vegetation than semi-established and established ones. Further, the inter-dunal areas show better vegetation cover of annuals due to better moisture contents in the soil. The common tree species of these habitats are : *Acacia nilotica* subsp. *indica*, *A. senegal*, *Prosopis cineraria* and *Salvadora oleoides*. The second layer of vegetation is occupied by shrubs and undershrubs viz. *Acacia jacquemontii*, *Aerva javanica*, *Calligonum polygonoides*, *Calotropis procera*, *Crotalaria burhia*, *Dipterygium glaucum*, *Leptadenia pyrotechnica*, etc. Among creepers, *Citrullus colocynthis* and several grasses like *Cenchrus biflorus*, *C. ciliaris*, *C. prieurii*, *Dactyloctenium scindicum*, *Eragrostis ciliaris*, *Lasiurus scindicus*, *Panicum antidotale*, *P. turgidum*, etc contribute to the sand-dune community in DNP. The third line of vegetation cover is of herbaceous ephemeral flora. The main herbaceous taxa which come up after rains, complete their life-cycle and disappear, include : *Fursetia hamiltonii*, *Indigofera argentea*, *I. cordifolia*, *I. linifolia*, *I. linnaei*, *Tephrosia fulciformis*, etc. The perennial sedges like *Cyperus arenarius*, *C. atkinsonii* and *C. conglomeratus* also play a vital role as sand binder on the sand-dunes and in inter-dunal gaps. At few places (near Sam) *Haloxylon salicornicum* and *Lycium barbarum* (near Daw) also contribute to the sand-dune communities (Plate-6, 7 & 8).

**Sandy and hummocky plains :** The sandy undulating plains are also scattered through out the Park between sand-dunes and maintain richer vegetation than dunes. The common tree representatives are the same as found on dunes, with additional taxa like *Acacia nubica*, *Capparis decidua*, *Prosopis juliflora*, *Salvadora persica* and *Tecomella undulata*. The shrubby elements include all species found on dunes, with additional taxa like *Abutilon bidentatum*, *A. fruticosum*, *A. indicum*, *Cordia gharaf*, *Grewia tenax*, *Lycium barbarum*, *Sida cordifolia*, *Ziziphus nummularia*, *Z. truncata*, etc.

The herbaceous flora forms green carpet during rainy season. There is hardly any species of herbaceous nature reported in this work, not found in sandy plains. However, the chief components are : *Alysicarpus monilifer*, *Cleome scaposa*, *C. vahliana*, *C. viscosa*, *Corchorus depressus*, *C. tridens*, *Fagonia schweinfurthii*, *Monsonia senegalensis*, *Polygala erioptera*, *Tribulus terrestris*, *T. rajasthanensis*, species of *Indigofera*, *Tephrosia*, several cucurbitaceous taxa like *Citrullus*, *Cucumis*, *Melothria maderaspatana*, etc, *Mollugo cerviana*, compositaceous species like *Dicoma tomentosa*, *Pulicaria angustifolia*, *P. crispa*, *Vernonia cinerascens*, etc, *Arnebia hispidissima*, species of *Anaranthus*, *Convolvulus*, *Euphorbia*, *Heliotropium* and several grasses and sedges. These herbaceous taxa in different combinations, frequency and density with trees and shrubby layer constitute different communities/associations in sandy plains at different places (Plate-9 & 10A/1).

It is again interesting to record several scandent shrubs and herbaceous climbers in sandy plains viz. species of *Rhynchosia*, *Dactyliandra welwitschii*, *Ipomoea pes-tigridis*, etc. Conclusively, these are shrubs and herbs which control the community/association structure in the Park, rather than trees.

Sandy plains also sustain good grasslands, particularly during rainy season. They may be grouped into two categories viz. *Lasiurus scindicus* dominated grasslands, with thin growth of other grasses like

*Dactyloctenium aegyptium*, species of *Cenchrus* and *Aristida*. Certain herbaceous plants like *Tribulus terrestris*, *Ipomoea pes-tigridis*, *Cucumis melo* var. *momordica* and legumes like *Atysicarpus vaginalis*, *A. monilifer*, *Indigofera hochstetteri*, *I. linifolia*, *Rhynchosia minima*, *Vigna trilobata*, etc further increase the palatable value of such grasslands (Plate-10A/2 & 10B). The second category of grasslands is dominated by *Cenchrus biflorus*, associated with thin growth of *C. ciliaris*, *C. prieurii* and *C. setigerus*. *Lasiurus scindicus* occurs in widely separated patches in such grasslands. Growth of *Aristida* species is very poor, but species like *Chloris barbata*, *Dichanthium annulatum*, *Digitaria ciliaris*, *Heteropogon contortus*, etc make their appearance. The herbaceous associates like *Indigofera cordifolia*, *Cleome gynandra*, *Boerhavia diffusa*, *Ipomoea indica*, *Dicoma tomentosa*, etc further increase the nutritive value of grasslands (Plate-11/1).

**Gravelly plains and rock outcrops :** This is the third major habitat of the area and its vegetation shows close affinity with semi-arid parts of the State, presenting a mixture of two types of elements. The tree species like *Acacia nilotica* subsp. *indica*, *A. senegal*, *Prosopis cineraria*, *P. juliflora*, *Salvadora oleoides*, *S. persica*, *Tecomella undulata*, etc constitute communities/associations with several shrubs and shrubby climbers viz. *Cadaba fruticosa*, *Cocculus pendulus*, *Commiphora wightii*, *Euphorbia caducifolia*, *Maerua oblongifolia*, *Pentstemonis nivalis*, *Sida ovata*, *S. tiagii*, etc. The other common shrubs are *Calotropis procera*, *Capparis decidua*, *Grewia tenax*, *Mimosa hamata*, *Ziziphus nummularia*, etc. The undershrubs adding to the communities/associations include *Hibiscus lobatus*, *Methania denhamii*, *Pavonia zeylanica*, *Sida cordata*, *Xanthium indicum*, etc.

The chief herbaceous components of gravel, which is formed by the action of wind, include : *Anticharis glandulosa* var. *caerulea*, *A. senegalensis*, *Borreria articularis*, *Chascanum marrubifolium*, *Cleome vahlana*, *C. viscosa*, *C. scaposa*, *Corchorus depressus*, *C. olitorius*, *Crotalaria hebecarpa*, *C. medicaginea*, *Echinops echinatus*, *Heliotropium rariflorum*, *Indigofera cordifolia*, *I. hochstetteri*, *I. linnaei*, *I. sessiliflora*, *Launaea procumbens*, *Monsonia senegalensis*, *Neurada procumbens*, *Polygala irregularis*, *Senna italica*, *Seetzenia lanata*, *Tephrosia subtriflora*, *Tribulus terrestris*, *Vahlia digyna*, species of *Amaranthus* and *Boerhavia*, *Euphorbia clarkeana*, *E. granulata*, etc. Several grasses, especially *Enneapogon desvauxii*, *Oropetium thomaeum*, species of *Aristida*, *Melanocentris abyssinica*, *M. jacquemontii*, *Tragus roxburghii*, etc form associations mostly with legumes. It is also interesting to record that among herbaceous species, quite a good number of species are prostrate and star-like with the branches remaining appressed to the ground to check the soil erosion.

The gravelly plains generally get converted into good grasslands dominated by *Aristida adscensionis*, associated with thin growth of *A. funiculata*, *A. hystriola* and *A. mutabilis*. Some other short grasses like *Tragus roxburghii*, *Enneapogon desvauxii*, *Melanocentris abyssinica*, *M. jacquemontii*, *Ochthochloa compressa*, *Oropetium thomaeum*, *Perotis hordeiformis*, *Stipagrostis plumosa*, etc enrich the density of such grasslands. The herbaceous flora is rather poor; the widely distributed main species include *Cleome scaposa*, *Fagonia schweinfurthii*, *Seetzenia lanata*, *Borreria articularis*, *Dicoma tomentosa*, *Tridax procumbens*, *Heliotropium bacciferum*, *Anticharis glandulosa* var. *caerulea*, *Striga angustifolia*, etc (Plate-11/2).

Besides above mentioned three mega habitats, there are few micro-habitats scattered here and there which maintain characteristic vegetation of its own type.

**Marshy habitats :** There are no perennial rivers, permanent ponds, etc in DNP. However, temporarily the water accumulates in excavated depressions, in "Khadeens" and "Nadis" near the villages (Singhdar, Bandera, Berisiyala, Tejaraon etc) and provide marshy habitats for some herbaceous plants viz. *Ammannia*



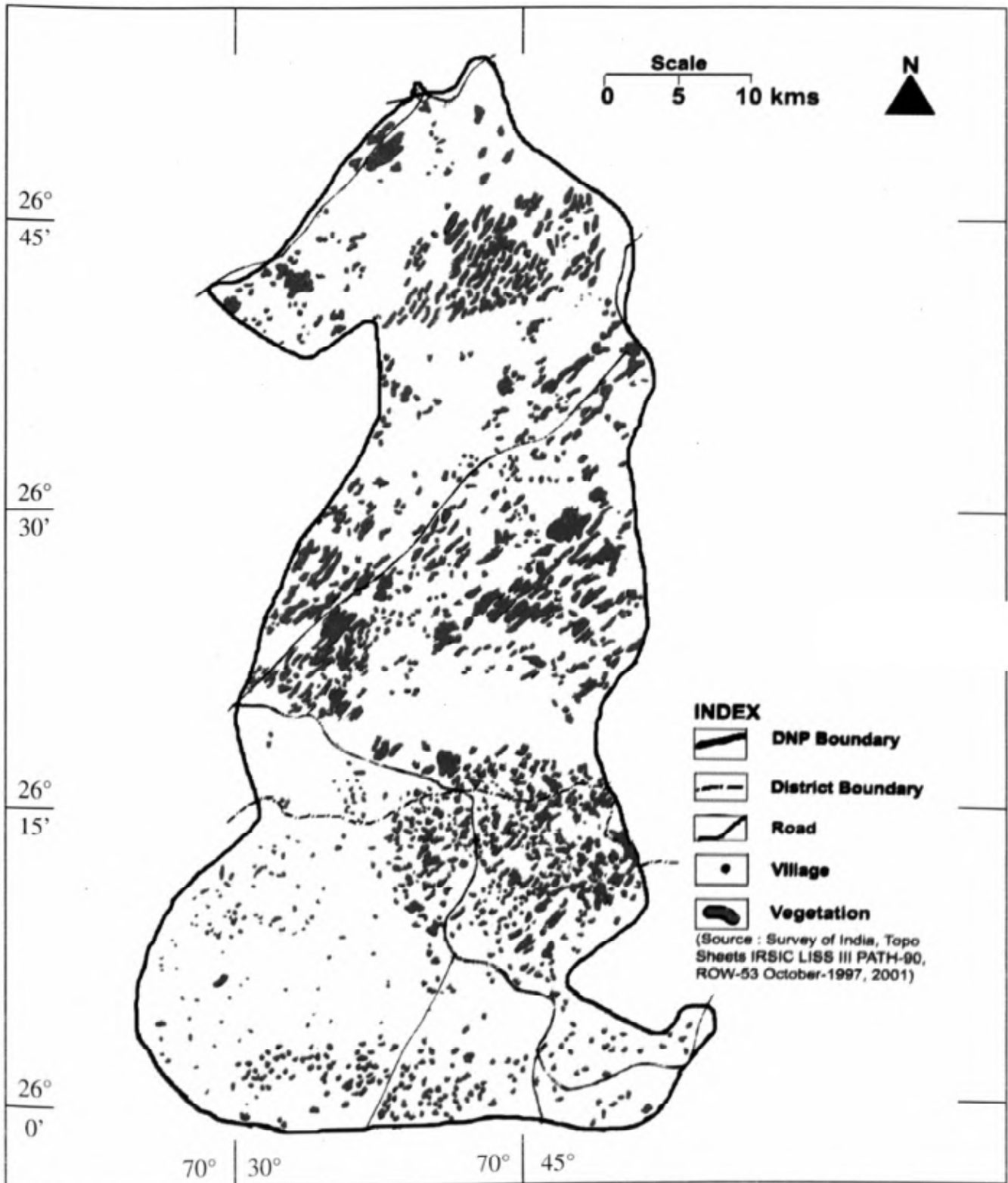
*baccifera*, *A. desertorum*, *Bergia ammannioides*, *B. suffruticosa*, *Enicostema axillare*, *Polygonum plebeium* var. *indica* and few sedges viz. *Bulbostylis barbata*, *Cyperus iria*, *C. rotundus*, *Eleocharis atropurpurea*, *Fimbristylis quinquangularis*, *Mariscus squarrosus*, *Schoenoplectus roylei*, etc. The only grass of marshy habitats is *Echinochloa colona*. These marshy components grow in different associations with variable frequency and density of taxa.

**Saline habitats :** There have been no identifiable saline tracts in the Park. However, occurrence of salt-loving species on Gray-Brown Desert soil viz. *Cressa cretica*, *Haloxylon salicornicum*, *Limeum indicum*, *Portulaca oleracea*, *Tamarix indica*, *Trianthema triquetra*, *Sesuvium sesuvioides*, *Zaleya govindia*, *Zygophyllum simplex*, etc indicates presence of higher concentration of salts in this soil. These taxa mostly form their own communities with low density.

**Weed and aliens :** Only rainy season crops are grown in the Park. There has been no phytosociological association between crops and weeds. The typical weed species are very few e.g. *Alternanthera sessilis*, *Alysicarpus vaginalis*, *Amaranthus viridis*, *Celosia argentea*, *Chenopodium album*, *Cleome viscosa*, *Cyperus rotundus*, *Digera muricata*, *Eragrostis amabilis*, *E. minor*, *E. pilosa*, *Euphorbia hirta*, *Heliotropium europaeum*, *Portulaca oleracea*, *Pulicaria angustifolia*, *P. crispa*, *Striga angustifolia*, *Tridax procumbens*, *Vigna trilobata*, etc. However, a good number of wasteland weeds (shrubs, undershrubs and herbs) enter the fields and thrive well due to better soil and water availability. The paucity in the number of typical weeds is due to unfavourable climatic and soil conditions for these taxa. There has been, however, little competition between crops and weeds due to characteristic root-systems of crops and weeds.

**Unusual habitats :** Some plants don't grow on land surface, but grow as epiphyte, saprophyte or parasite. Former two categories of plants are lacking in the Park. However, *Cistanche tubulosa* – a root parasite grows on the roots of *Calotropis procera* and *Salvadora oleoides* on sand-dunes and in plains.

In the end, it may be concluded that variability in the vegetation of DNP is controlled by the edaphic factors, particularly orography of the Park to the extent that Map-2 may be considered as a representation of Satellite vegetation map (Map-4).



Map-4. Vegetation map of Desert National Park, reproduced from Remote Sensing map.

## KEY TO THE FAMILIES

- 1a. Flowers arranged in cones. Ovules naked, borne on the surface of megasporophylls. Stigma absent. **49. Ephedraceae**
- 1b. Flowers not arranged in cones. Ovules enclosed in megasporophylls. Stigma present. 2
- 2a. Leaves with reticulate venation. Flowers usually 4 or 5-merous or multiple of it, rarely 3 or 6-merous (*Menispermaceae*). Seeds with two cotyledons. Vascular bundles in the stem arranged in concentric rings. 3
- 2b. Leaves with parallel venation. Flowers usually 3 or 6-merous. Seeds with 1 cotyledon. Vascular bundles in the stem scattered. 57
- 3a. Perianth differentiated into calyx and corolla, 2 to many seriate. 4
- 3b. Perianth generally either calycine or petaloid or absent, not differentiated into calyx and corolla, usually uniseriate. 50
- 4a. Petals polypetalous or atleast some of the petals free. 5
- 4b. Petals united variously, forming a short or long tube. 37
- 5a. Calyx of distinct sepals. Ovary superior or immersed in the disc. 6
- 5b. Calyx of united sepals. Ovary usually included in the calyx-tube or inferior. 27
- 6a. Torus small or elongated, not expanded. 7
- 6b. Torus thickened and expanded into a fleshy disc. 21
- 7a. Stamens indefinite (15 or more). 8
- 7b. Stamens few, not more than 10. 12
- 8a. Ovary elevated on a gynophore. **4. Capparaceae**
- 8b. Ovary not elevated on gynophore. 9
- 9a. Leaves fleshy. Placentation free-central or basal-central. **6. Portulacaceae**
- 9b. Leaves not fleshy. Placentation neither free-central nor basal-central. 10
- 10a. Stamens monadelphous. 11
- 10b. Stamens free. **11. Tiliaceae**
- 11a. Epicalyx usually present. Anthers 1-locular. **9. Malvaceae**
- 11b. Epicalyx absent. Anthers 2-locular. **10. Sterculiaceae**
- 12a. Stamens raised on the axis. Gynophore present. 13
- 12b. Stamens not raised on the axis. Gynophore absent. 14
- 13a. Herbs. Flowers usually yellow. Fruit a 2-valved capsule. **3. Cleomaceae**
- 13b. Woody shrubs or small trees. Flowers whitish, creamish or pinkish to scarlet, never yellow. Fruit an indehiscent berry. **4. Capparaceae**
- 14a. Climbing shrubs. Flowers unisexual. Gynoecium apocarpus. **1. Menispermaceae**
- 14b. Herbs, shrubs or trees. Flowers usually bisexual. Gynoecium syncarpus. 15
- 15a. Flowers zygomorphic. **5. Polygalaceae**
- 15b. Flowers actinomorphic. 16
- 16a. Leaves scale-like. Seeds with a crest of long hairs at the apex. **7. Tamaricaceae**
- 16b. Leaves well developed. Seeds without a crest of hairs. 17
- 17a. Petals 4, cruciform. Stamens 6, tetradynamous. Placentation parietal. **2. Brassicaceae**

17b. Petals 4 or 5, not cruciform. Stamens not tetradynamous. Placentation axile or free central.	18
18a. Leaves not fleshy. Placentation axile.	19
18b. Basal leaves fleshy. Placentation free central.	6. <i>Portulacaceae</i>
19a. Stamens monadelphous.	10. <i>Sterculiaceae</i>
19b. Stamens free.	20
20a. Leaves alternate. Sepals valvate.	11. <i>Tiliaceae</i>
20b. Leaves opposite. Sepals imbricate.	8. <i>Elatinaceae</i>
21a. Placentation parietal. Fruit a 3-valved, elongated, pod-like capsule. Seeds winged.	18. <i>Moringaceae</i>
21b. Placentation axile. Fruit not elongated. Seeds not winged.	22
22a. Styles 5, quite free. Filaments often connate at base only.	13. <i>Geraniaceae</i>
22b. Style solitary, if more, than more or less united. Stamens totally free or monadelphous.	23
23a. Stamens monadelphous.	16. <i>Meliaceae</i>
23b. Stamens free.	24
24a. Ovules usually one in each cell.	25
24b. Ovules usually two in each cell, sometimes more.	26
25a. Spiny shrubs or trees. Leaves simple. Fruit a drupe.	17. <i>Rhamnaceae</i>
25b. Tall trees, not spiny. Leaves compound. Fruit a samara.	14. <i>Simaroubaceae</i>
26a. Resinous undershrubs, shrubs or trees. Leaves dotted. Stamens without appendages.	15. <i>Burseraceae</i>
26b. Small woody herbs, not resinous. Leaves not dotted. Stamens often with appendages.	12. <i>Zygophyllaceae</i>
27a. Fruit a legume.	28
27b. Fruit various, but not legume.	30
28a. Leaves bipinnate. Flowers actinomorphic, in heads or in dense cylindric spikes.	21. <i>Mimosaceae</i>
28b. Leaves simple or pinnate. Flowers zygomorphic, neither in head, nor in dense cylindric spikes.	29
29a. Flowers papilionaceous; odd petal adaxial. Stamens 1 or 2-adelphous.	19. <i>Fabaceae</i>
29b. Flower caesalpinaceous; odd petal not adaxial. Stamens free.	20. <i>Caesalpiaceae</i>
30a. Stamens definite, not more than 10.	31
30b. Stamen usually indefinite, more than 10.	35
31a. Ovary superior.	27. <i>Molluginaceae</i>
31b. Ovary inferior.	32
32a. Plants climbers or prostrate; stem tendril-bearing. Flowers unisexual.	25. <i>Cucurbitaceae</i>
32b. Plant erect; stem not tendril-bearing. Flowers hermaphrodite.	33
33a. Placentation pendulous from the top of the ovary.	23. <i>Vahliaceae</i>
33b. Placentation not pendulous, but otherwise.	34
34a. Leaves often fleshy. Petals absent.	26. <i>Aizoaceae</i>
34b. Leaves not fleshy. Petals present.	24. <i>Lythraceae</i>
35a. Leaves exstipulate. Carpels more or less united.	36
35b. Leaves stipulate. Carpels distinct or solitary.	22. <i>Rosaceae</i>
36a. Leaves often fleshy. Petals absent. Ovules basal.	26. <i>Aizoaceae</i>

36b. Leaves not fleshy. Petals crumpled when present, episepalous. Placentation usually axile.	<b>24. Lythraceae</b>
37a. Ovary inferior.	38
37b. Ovary superior.	39
38a. Flowers in heads. Anthers united, Ovary 1-celled.	<b>29. Asteraceae</b>
38b. Flowers not in heads. Anthers not united, Ovary more than 1-celled.	<b>28. Rubiaceae</b>
39a. Leafless, non chlorophyllous root parasites.	<b>38. Orobanchaceae</b>
39b. Leaf bearing green plants, autotrophic, not parasites.	40
40a. Leaves usually alternate.	41
40b. Leaves, atleast lower ones, opposite.	44
41a. Ovary obliquely placed in the flower; ovules indefinite in each cell.	<b>36. Solanaceae</b>
41b. Ovary either antero-posterior or lateral; ovules definite in each cell.	42
42a. Trees or shrubs.	<b>34. Ehretiaceae</b>
42b. Herbs or undershrubs.	43
43a. Climbing or prostrate herbs. Style usually terminal. Fruit a capsule.	<b>35. Convolvulaceae</b>
43b. Erect, diffuse or prostrate herbs or undershrubs. Style gynobasic. Fruits of 4, 1-seeded nutlets or a drupe.	<b>33. Boraginaceae</b>
44a. Flowers regular. Stamens as many as corolla-lobes. Ovary generally of 2-carpels.	45
44b. Flowers irregular. Stamens less than corolla-lobes. Ovary of 2-4 carpels.	47
45a. Plants with milky latex. Pollens in pollinia. Fruit a follicle.	<b>31. Asclepiadaceae</b>
45b. Plants without milky latex. Pollens not in pollinia. Fruit not follicle.	46
46a. Trees or shrubs. Fruit a berry.	<b>30. Salvadoraceae</b>
46b. Herbs. Fruit various, not a berry.	<b>32. Gentianaceae</b>
47a. Fruits elongated. Seeds winged.	<b>39. Bignoniaceae</b>
47b. Fruits not elongated. Seeds not winged.	48
48a. Stem with swollen nodes. Bracts conspicuous. Stigmatic arms often unequal.	<b>40. Acanthaceae</b>
48b. Stem without swollen nodes. Bracts absent or minute. Stigmatic arms equal.	49
49a. Ovules many in each cell.	<b>37. Scrophulariaceae</b>
49b. Ovules 1-2 in each cell.	<b>41. Verbenaceae</b>
50a. Flowers all bisexual.	51
50b. Flowers unisexual or polygamous.	55
51a. Ovary superior.	52
51b. Ovary inferior.	<b>46. Aristolochiaceae</b>
52a. Leaves with sheathing ochreate stipules.	<b>45. Polygonaceae</b>
52b. Leaves exstipulate.	53
53a. Perianth tubular, petaloid. Fruits glandular.	<b>42. Nyctaginaceae</b>
53b. Perianth not tubular, bract-like. Fruits not glandular.	54
54a. Flowers bracteate, bracts and sepals mostly scarious.	<b>43. Amaranthaceae</b>
54b. Flowers ebracteate, or if bracteate, bracts and sepals not scarious.	<b>44. Chenopodiaceae</b>

- 55a. Trees. Flowers enclosed in a hollow receptacle which becomes fruit or in catkins. 48. *Moraceae*
- 55b. Herbs, shrubs or rarely trees. Flowers neither enclosed in receptacles nor in catkins. 56
- 56a. Ovary 3-celled, with 1 or 2 ovules in each cell. 47. *Euphorbiaceae*
- 56b. Ovary 1-celled. 43. *Amaranthaceae*
- 57a. Plants grass-like. Perianth absent or modified in hairs, bristles or scales. Flowers in spikelets. 58
- 57b. Plants not grass-like. Perianth present, petaloid. Flowers not in spikelets. 50. *Liliaceae*
- 58a. Culms usually solid, triangular in section, not noded. Leaves not ligulate. Anthers basifixed. Fruit an achene. 51. *Cyperaceae*
- 58b. Culms usually fistular, cylindrical or flattened, noded. Leaves ligulate, leaf-sheath splits. Anthers dorsifixed or versatile. Fruit a caryopsis. 52. *Poaceae*

## ENUMERATION OF SPECIES

### 1. MENISPERMACEAE

#### *COCCULUS* DC. (*nom. cons.*)

*Cocculus pendulus* (J. R. & G. Forst.) Diels in Engl. Pflanzenr. 46 : 237. f. 78. 1910; Bhandari, Fl. Indian Desert 28. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 60. 1987; Pramanik & Gangopadhyay in Sharma & Balakrishnan, Fl. India 1 : 320. 1993. *Epibaterium pendulum* J. R. & G. Forst. Char. Gen. Pl. 108. t. 54. 1776. *Menispermum laeaba* Delile, Fl. Egypt. 104. t. 51. f. 2-3. 1813. *Cocculus laeaba* (Delile) DC. Syst. Nat. 1 : 529. 1817; Hook. f. & Thoms. in Hook. f. Fl. Brit. India 1 : 102. 1872; Duthie, Fl. Gangetic Plain 1 : 29. 1903.

Local name : *Pilwan*.

Twining, woody, 4-5 m high, much-branched shrubs; branches slender, puberulous when young, terete. Leaves 2-2.5 x 0.5-0.8 cm, oblong-lanceolate to oblong-ovate, cuneate at base, generally glabrous or slightly puberulous on both surfaces; basal nerves 3-5. Male flowers minute, subsessile, in axillary fascicles; peduncles ca 1.5 cm long. Sepals ovate-elliptic, fleshy or membranous; outer 3 smaller, sparsely pubescent; inner 3 larger, glabrous. Petals 0.8-2 x 0.5-1 mm, ovate. Female flowers axillary, solitary or 2 to 3-together; peduncles 0.7-1.3 cm long. Sepals and petals as in males. Drupes 4-7 x 3-5 mm, ovoid, compressed, black on drying.

Fl. & Fr.: October-January.

Ecology : Occasional, found twining usually on *Capparis decidua* (Forssk.) Edgew. and *Prosopis cineraria* (L.) Druce.

Specimens examined : Near Barna, Monika 16503 (BSJO); Sudasari, Monika 16689 (BSJO).

### 2. BRASSICACEAE

#### *FARSETIA* Turra

*Farsetia hamiltonii* Royle, Ill. Bot. Himal. Mount. 1 : 71. 1834; Hook. f. & Anders. in Hook. f. Fl. Brit. India 1 : 140. 1872; Duthie, Fl. Gangetic Plain 1 : 41. 1903; Bhandari, Fl. Indian Desert 33. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 73. 1987; Debnath in Sharma & Balakrishnan, Fl. India 2 : 94. 1993.



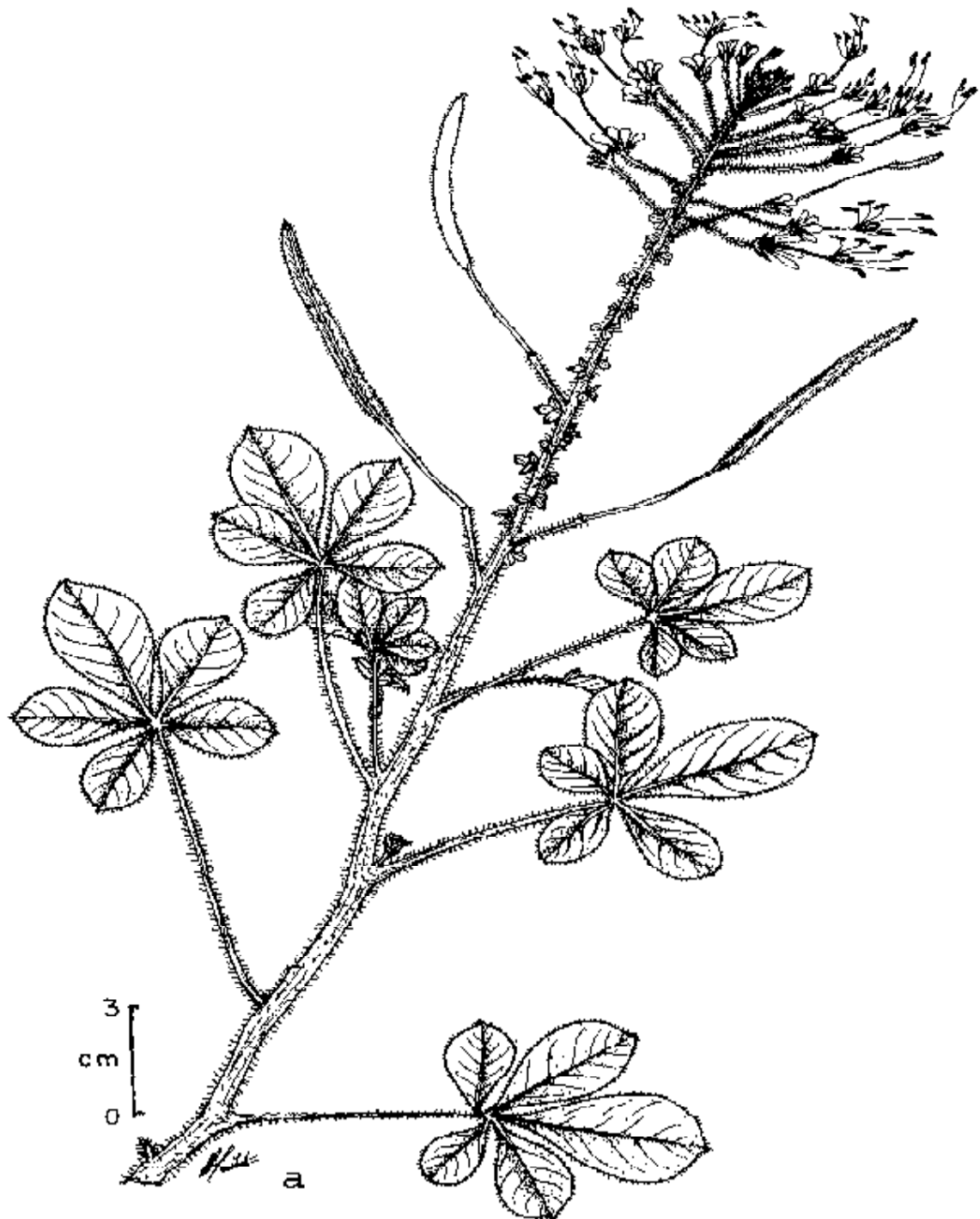


Fig. 1. *Cleome gynandra* L. : a. Habit.

Local name : *Hiran-chaba*.

Annual herbs, 40-50 cm high, often woody at base, densely clothed with adpressed, white hairs. Leaves sessile, 2-4 x 0.2-0.4 cm, linear, strigose, entire. Inflorescence a terminal raceme, 5 to 20-flowered, lax, ebracteate. Flowers 5-6 mm across, white to pink. Sepals 3-4 mm long, oblong, strigose. Petals 4-5 mm long, oblong, cuneate at base, rounded at apex. Stamens 3-4 mm long. Style thin, ca 2.5 mm long; stigma bilobed. Fruit a silique, linear, oblong, compressed, nearly rounded towards both ends, covered with bipartite, adpressed hairs; valves 1-nerved, subtorulose. Seeds 2-3 x 0.7-0.9 mm, uniseriate, orbicular, brownish-black, winged; wings ca 1 mm broad, membranous, hyaline.

*Fl. & Fr.*: February-November.

*Ecology* : Common, found in sandy areas in association with *Cleome viscosa* L., *Citrullus colocynthis* (L.) Schrad., *Cenchrus biflorus* Roxb., *Dipterygium glaucum* Decne., etc.

*Specimens examined* : Near Miajlar, *Monika* 16522 (BSJO); Girab, *Monika* 16653 (BSJO); Near Barna, *Monika* 16780 (BSJO); 10 km from Sam along Dhanana road, *Shetty* 3448 (BSJO).

### 3. CLEOMACEAE

#### CLEOME L.

- |   |                       |
|---|-----------------------|
| 1a. Leaves compound, not setose papillose.                  | 2                     |
| 1b. Leaves simple, setose papillose.                        | 2. <i>C. scaposa</i>  |
| 2a. Flowers white. Androgynophore present.                  | 1. <i>C. gynandra</i> |
| 2b. Flowers yellow. Androgynophore absent.                  | 3                     |
| 3a. Leaflets 3. Stamens 6. Capsules up to 9 mm long.        | 3. <i>C. vahliana</i> |
| 3b. Leaflets 3-5. Stamens numerous. Capsules 2.5-9 cm long. | 4. <i>C. viscosa</i>  |

1. *Cleome gynandra* L. Sp. Pl. 671. 1753; Bhandari, Fl. Indian Desert 40. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 80. 1987; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 309. 1993. *C. pentaphylla* L. Sp. Pl. ed. 2. 938. 1763. *Gynandropsis pentaphylla* (L.) DC. Prodr. 1 : 238. 1824; Hook. f. & Thoms. in Hook. f. Fl. Brit. India 1 : 171. 1872; Duthie, Fl. Gangetic Plain 1 : 51. 1903.

Local name : *Safed-bagro*.

Annual herbs, up to 50 cm high; stem much-branched, clothed with long and short, glandular, spreading hairs. Leaves 3 to 5-foliolate; leaflets unequal, obovate-elliptic to oblanceolate, cuneate at base, acute at apex, serrulate-denticulate at margins, glabrous on bothsides except few hairs on midrib; central leaflet 1-7 x 0.4-4 cm; lateral leaflets up to 3.5 x 1.5 cm. Petioles 3-8 cm long; petiolules ca 3 mm long. Inflorescence 10-30 cm long, lax, many-flowered, corymbose raceme. Bracts 8-15 mm long, trifoliolate, foliaceous, much reduced upwards. Flowers 1-2 cm across, white, rarely pink; pedicels 0.2-2.5 cm long, filiform. Sepals 1.5-3 x 0.5-1.5 mm, ovate-obovate, acuminate, puberulous, caducous. Petals 3-18 x 1-6 mm, obovate to oblanceolate. Anthers ca 2 mm long. Capsules 3-12 cm long, erecto-patent, cylindric, compressed, tapering at both ends; stalk 2-4 cm long; valves papery. Seeds 15-40, ca 1 mm across, reniform, compressed, brown to black (Fig.-1).

*Fl. & Fr.*: Throughout the year.

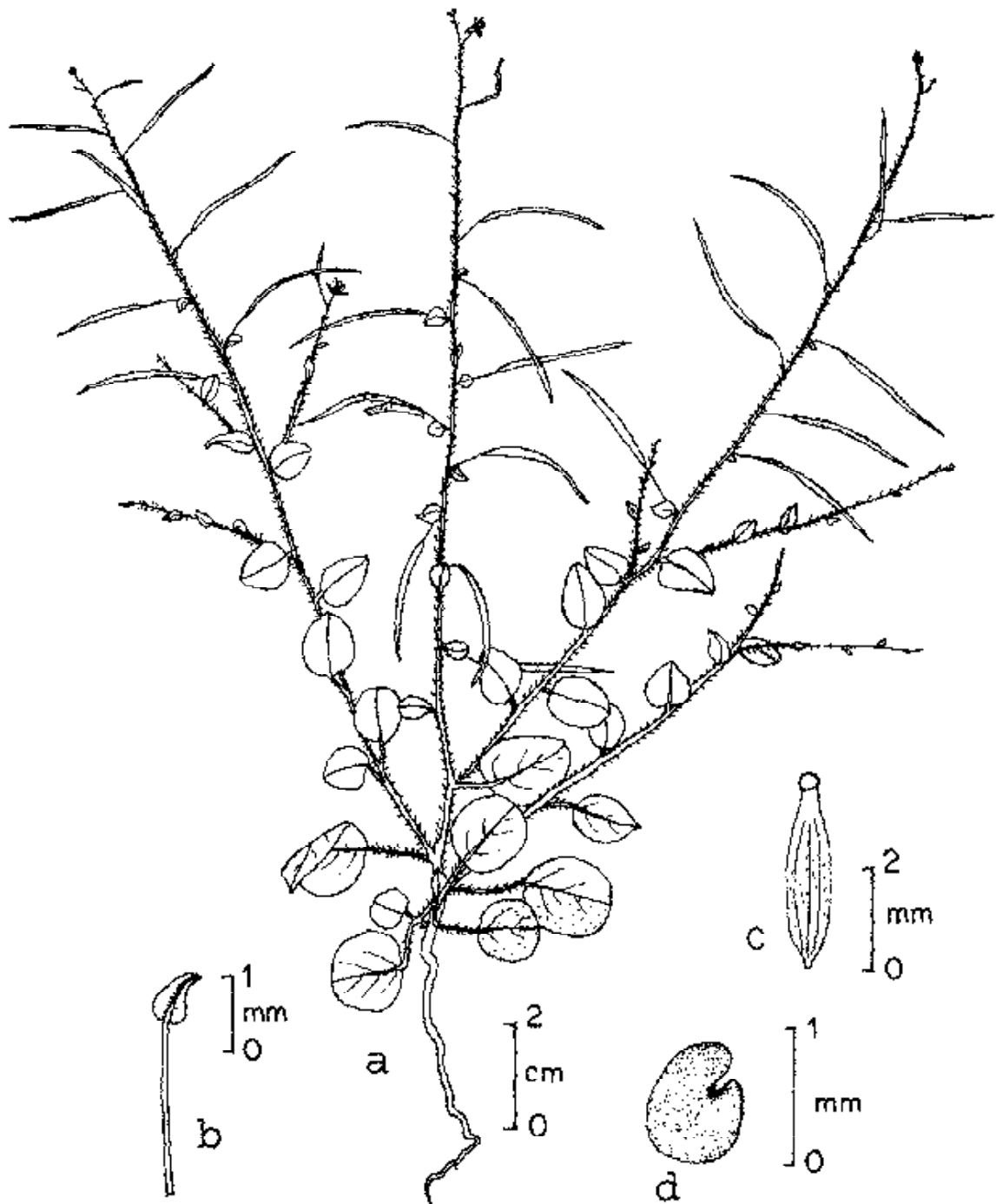


Fig. 2. *Cleome scaposa* DC. : a. Habit, b. Stamen, c. Fruit, d. Seed.

*Ecology* : Common, found in sandy soils in association with *Aristida adscensionis* L., *Arnebia hispidissima* (Sieber ex Lehm.) DC., etc.

*Specimens examined* : Sudasari, *Monika* 16690 (BSJO), *Pandey* 7842 (BSJO); Sam, *Monika* 16711 (BSJO).

*Notes* : Great variations were noted in plant height, leaf size and in flower colour (pure white to pink) in the Park area.

2. *Cleome scaposa* DC. Prodr. 1 : 239. 1824; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 82. 1987; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 314. 1993. *C. papillosa* Steud. Nom. Bot. ed. 2. 1 : 382. 1840; Hook. f. & Thoms. in Hook. f. Fl. Brit. India 2 : 168. 1872. *C. gracilis* Edgew. in J. Asiat. Soc. Bengal 16 : 1212. 1847; Bhandari, Fl. Indian Desert 39. 1978.

Annual, erect herbs, up to 60 cm high, much-branched, strongly aromatic; stem woody at base, slender, whitish, clothed with glandular and eglandular hairs. Leaves 1.5-3 x 0.5-1.5 cm, broadly elliptic, rounded to cordate at base, obtuse at apex, entire. Petioles up to 2.5 cm long, larger in basal leaves and gradually shorter above. Racemes lax, 12-15 cm long, bracteate in lower part, glandular hairy. Flowers 3.5-5 mm across, yellow; pedicels 1-3 mm long, elongating up to 8 mm in fruit. Bracts minute, glandular. Sepals 1.5-2 mm long, elliptic. Petals 2-3 x 1-1.5 mm, ovate, glabrous. Stamens 6; filaments ca 2 mm long, glabrous; anthers oblong. Stigma capitate. Capsules 2-3 x 0.1-0.2 cm, striated, glabrous. Seeds glabrous, minute, many, granulate, brownish-black (Fig.-2).

*Fl. & Fr.*: August – December.

*Ecology* : Rare, found in gravelly soils, often forming pure communities.

*Specimens examined* : Sudasari, *Monika* 16580 (BSJO); Along the way to Mehboob-ka-par, *Monika* 16587 (BSJO).

3. *Cleome vahliana* Fresen. in Mus. Senck. 2 : 110. 1837; Bhandari, Fl. Indian Desert 40. 1978; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 316. 1993. *C. brachycarpa* Vahl ex DC. Prodr. 1 : 240. 1824, *pro parte*, non *Gynandropsis brachycarpa* (Vahl) DC. 1824; Hook. f. & Thoms. in Hook. f. Fl. Brit. India 1 : 169. 1872; Duthie, Fl. Gangetic Plain 1 : 50. 1903; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 79. 1987. *C. brachycarpa* Vahl ex DC. var. *glauca* Blatt. & Hallb. in J. Bombay Nat. Hist. Soc. 26 : 221. 1918. *C. brachycarpa* Vahl ex DC. var. *longipetiolata* Sabnis in J. Indian Bot. Soc. 3 : 178. 1924.

*Local name* : *Madhio*.

Much-branched, glandular, perennial herbs, up to 1 m high; branches many from woody base, glandular-pubescent. Leaves 3 to 5-foliolate; middle leaflet longest, 5-10 x 2.5-5 mm, obovate-oblong, acute, viscid-puberulous. Petioles 5-10 mm long; petiolules short. Flowers yellow, in lax, leafy, bracteate racemes; pedicels 9-12 mm long, filiform. Bracts 3-foliolate, subsessile. Sepals 2-2.5 mm long, ovate-lanceolate, glandular hairy outside. Petals 6-7 x 1.5-2 mm, ovate-oblong, subacute, glabrous. Stamens 6, one rarely imperfect. Ovary covered with thick, glandular hairs. Capsules 9-12 x 2.5-3.5 mm, oblong, inflated. Seeds many, ca 1mm in diam., subglobose, brown, minutely pitted.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in sandy and gravelly soils in association with *Anticharis senegalensis* (Walp.) Bhandari, *Heliotropium bacciferum* Forssk., *Eragrostis minor* Host, etc.

*Specimens examined* : Near Satto, *Monika* 16644 (BSJO); Along Miajlar- Sundra road, *Monika* 17158 (BSJO); Near Kanoi, *Pandey* 7879 (BSJO).

*Notes* : The specific name *C. brachycarpa* attributed to Vahl ex DC. refers to two different elements viz. a Peruvian plant which De Candolle had transferred to *Gynandropsis* calling *G. brachycarpa* (Vahl) DC. and other ineditus name of Vahl for an Arabic plant. Since *C. brachycarpa* Vahl ex DC. forms basionym and type of the Peruvian plant *G. brachycarpa* (Vahl) DC., the present name *C. vahliana* Fresen. has been accepted as valid name for this taxon.

4. *Cleome viscosa* L. Sp. Pl. 672. 1753; Hook. f. & Thoms. in Hook. f. Fl. Brit. India 1 : 170. 1872; Duthie, Fl. Gangetic Plain 2 : 50. 1903; Bhandari, Fl. Indian Desert 42. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 82. 1987; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 317. 1993.

Local name : *Bagro*.

Erect, annual herbs, up to 1 m high, clothed with glandular hairs. Leaves 3 to 5-foliolate; leaflets 1.5-5 x 0.5-2 cm, subsessile, subequal, obovate to elliptic-oblong, cuneate at base, acute at apex. Petioles up to 5 cm long, hairy at base. Racemes leafy, up to 30 cm long, laxly few-flowered. Flowers 1-1.5 cm across, yellow, bracteate; pedicels ca 8 mm long. Bracts subsessile. Sepals 4, 5-10 x 2-4 mm, oblong-lanceolate, acute at apex, glabrous inside, densely glandular hairy outside. Petals 4, 8-12 x 3-5 mm, subequal, obovate or oblanceolate. Stamens 12-15; filaments unequal in length, inflated at apex; anthers linear. Ovary 6-8 mm long, beaked, densely glandular hairy; style glabrous; stigma capitate. Capsules 2.5-9 cm long, erect, on 2-3 cm long pedicels, terete, linear-oblong, beaked; beak 8-10 mm long. Seeds many, reniform, black (Plate-12/1).

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, usually found in sandy habitats in association with *Aristida* spp., *Cenchrus biflorus* Roxb., etc; also grows as a weed in cultivated fields.

*Specimens examined* : Along the way to Mehboob-ka-par, *Monika* 16584 (BSJO); Sam, *Monika* 16615 (BSJO).

#### 4. CAPPARACEAE

- |  |                       |
|--|-----------------------|
| 1a. Undershrubs or bushy herbs. Fruits samara, winged, 1-seeded.                                 | 3. <i>Dipterygium</i> |
| 1b. Trees or shrubs, erect or scandent. Fruits berry or capsule, more than 1-seeded, not winged. | 2                     |
| 2a. Sepals uniseriate, united at base. Fruits moniliform.  | 4. <i>Maerua</i>      |
| 2b. Sepals 2-seriate, free up to base. Fruits not moniliform.                                    | 3                     |
| 3a. Stipular spines present. Stamens 6 or more, inserted at the base of gynophore.               | 2. <i>Capparis</i>    |
| 3b. Stipular spines absent. Stamens 4-5, inserted half way up on the gynophore.                  | 1. <i>Cadaba</i>      |

1. *CADABA* Forssk.

*Cadaba fruticosa* (L.) Druce in Rep. Bot. Exch. Club Soc. Brit. Isles 3 : 415. 1914; Bhandari, Fl. Indian Desert 36. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 83. 1987; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 250. 1993. *Cleome fruticosa* L. Sp. Pl. 671. 1753. *Cadaba indica* Lam. Encycl. 1(2) : 544. 1785; Hook. f. & Thoms. in Hook. f. Fl. Brit. India 1 : 172. 1872.

Local name : *Dabi*.

Low, straggling or scandent shrubs, 1.5-3 m tall; stem much-branched, terete; old twigs glabrous, smooth; young ones mealy pubescent with simple and glandular hairs. Leaves simple, 2-5 x 0.2-0.4 cm, entire, elliptic to ovate, rounded at base, obtuse at apex. Petioles 2-5 mm long. Inflorescence terminal, one-sided corymbose raceme, few-flowered. Flowers ca 1.5 cm across, white; pedicels 5-8 mm long. Bracts 5-6 mm long, subulate. Sepals 10-12 x 2-5 mm, greenish, acute. Petals 10-15 x 2-4 mm, spatulate, claw very narrow. Stamens 4-5, inserted at half way down on gynophore. Ovary cylindrical-oblong; style absent; stigma sessile, pubescent. Fruits 3-5 cm long, green, narrowly cylindrical, irregularly torulose, glandular-pubescent. Seeds ca 2.5 x 2 mm, many, striate, black, surrounded by orange-red aril.

*Fl. & Fr.*: Throughout the year.

*Ecology* : Rare, found in sandy habitats in association with *Capparis decidua* (Forssk.) Edgew., *Prosopis cineraria* (L.) Druce, etc.

*Specimens examined* : Along Satto-Miajlar road, *Monika* 16668 (BSJO); Along Miajlar-Sundra road, *Monika* 17154 (BSJO).

2. *CAPPARIS* L.

*Capparis decidua* (Forssk.) Edgew. in J. Linn. Soc. Bot. 6 : 184. 1862; Bhandari, Fl. Indian Desert 37. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 85. 1987; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 265. 1993. *Sodada decidua* Forssk. Fl. Aegypt.-Arab. 81. 1775. *Capparis aphylla* Roth, Nov. Sp. Pl. Ind. Or. 238. 1821; Hook. f. & Thoms. in Hook. f. Fl. Brit. India 1 : 174. 1872; Duthie, Fl. Gangetic Plain 1 : 53. 1903.

Local name : *Ker*.

Much-branched shrubs or small trees, up to 6 m high; branches slender, suffruticose; twigs zig-zag, glabrous, armed with stipular spines; spines yellowish, straight, 3-6 mm long. Leaves confined to young twigs, early caducous, fleshy, subsessile, linear, spinous-tipped. Flowers 2-3 cm across, pinkish-red, in 15 to 20-flowered, corymbose racemes or in fascicles, ebracteate; pedicels 1-1.5 cm long, slender. Sepals 4, 8-10 x 3-5 mm, elliptic, acute, unequal, tomentose. Petals 4, 9-10 x 2.5-3 mm, oblong, obtuse. Stamens 10-15; filaments 1-1.8 cm long, reddish, glabrous. Ovary glabrous, beaked. Fruits berry, 5-20 mm across, globose, on thin stalk, glabrous, green when young, becoming purple-red on maturity. Seeds many, reniform, black (**Fig.-3; Plate-19/2**).

*Fl.*: February – May; *Fr.*: June – November.

*Ecology* : Very common plant of sandy habitats throughout the area, often found in association with *Calotropis procera* (Ait.) R. Br., *Ziziphus nummularia* (Burm. f.) Wight & Arn., etc.

*Specimens examined* : Near Ganga, *Monika* 16513 (BSJO); Sehmani, *Monika* 16613 (BSJO).



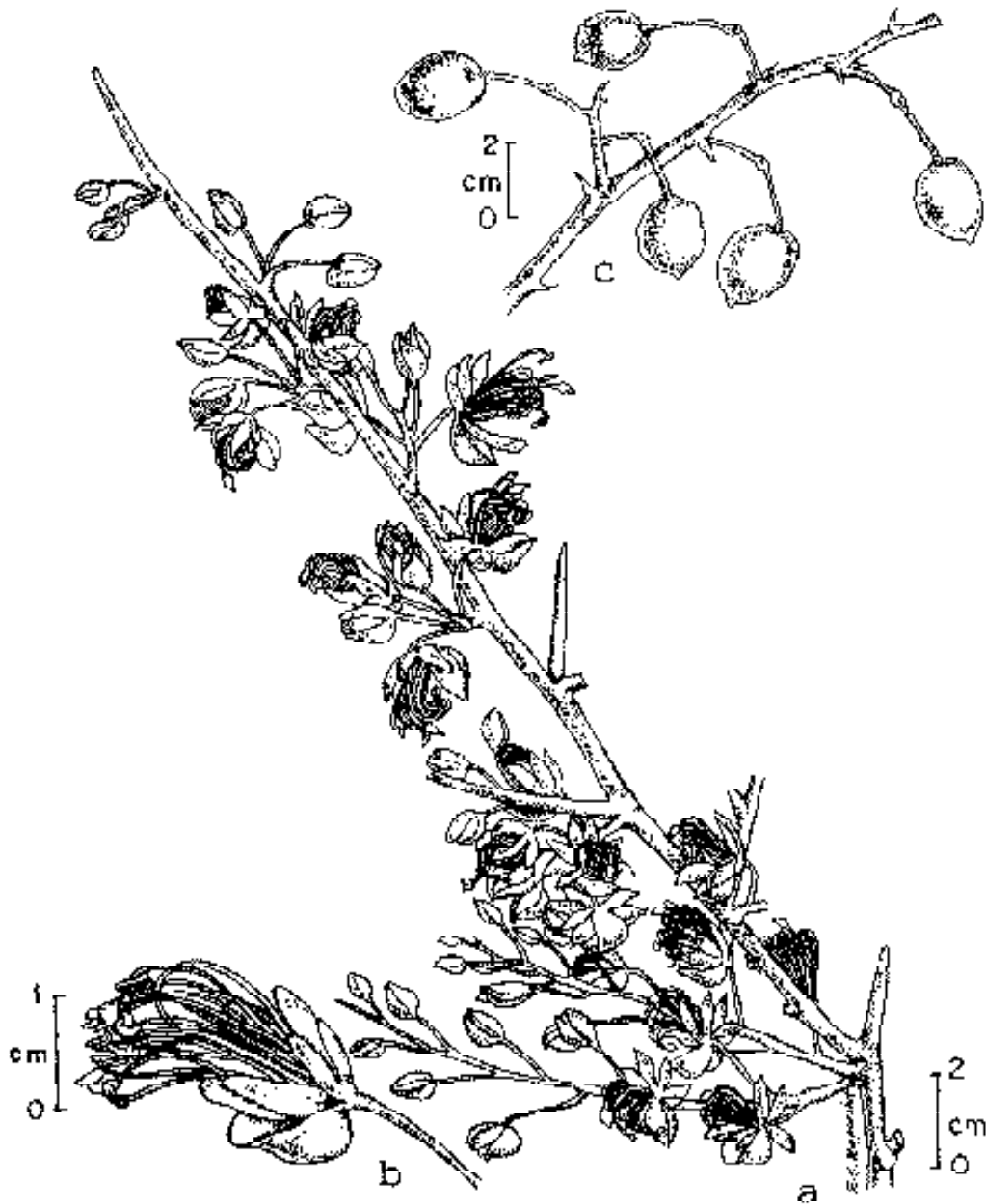


Fig. 3. *Capparis decidua* (Forsk.) Edgew. : a. Flowering twig, b. Flower, c. Fruiting twig.

3. *DIPTERYGIUM* Decne.

*Dipterygium glaucum* Decne. in Ann. Soc. Nat. ser. 2 (4) : 66. 1835; Hook. f. & Anders. in Hook. f. Fl. Brit. India 1 : 164. 1872; Bhandari, Fl. Indian Desert 43. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 88. 1987; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 327. 1993.

Woody, perennial undershrubs, 40-50 cm high, glabrous; branches divaricate, ending in lax racemes, glaucous, grooved. Leaves simple, 6-20 x 2-8 mm, elliptic-oblong or oblong-obovate, entire, larger at base, upper ones subsessile to sessile, fleshy. Petioles of basal leaves up to 2 cm long. Flowers yellow, in terminal, lax, few-flowered, bracteate racemes. Bracts ca 2.5 mm long, scaly. Sepals 4, 0.8-2 mm long, green, free, ovate, acute. Petals 4, 2.5-3.5 x 1-2 mm, ovate-elliptic, obtuse at apex. Stamens 6, equal, 2.5-3 mm long; filaments filiform. Ovary superior, obovoid; style ca 0.5 mm long; stigma capitate. Fruits 2-4 x 1-3 mm, drooping, indehiscent samara, ellipsoid, laterally compressed, transversely wrinkled, with translucent wings. Seeds ca 3.5 x 2 mm, solitary, rugose, black.

Fl.: June – October; Fr.: July – December.

Ecology : Found on gravelly as well as sandy grounds in association with *Cleome viscosa* L., *Tribulus terrestris* L., etc.

Specimens examined : Near Khuri, Monika 16507 (BSJO); Sam, Monika 16545 (BSJO), Pandey 7803 (BSJO); Bidna, Monika 16775 (BSJO).

4. *MAERUA* Forssk.

*Maerua oblongifolia* (Forssk.) A. Rich. in Guill. & Perr. Fl. Seneg. Tent. 1 : 32. t. 5. 1831; Bhandari, Fl. Indian Desert 43. 1978; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 331. 1993. *Capparis oblongifolia* Forssk. Fl. Aegypt.-Arab. 99. 1775. *Nieburhia arenaria* DC. Prodr. 1 : 244. 1824. *Maerua arenaria* (DC.) Hook. f. & Thoms. in Hook. f. Fl. Brit. India 1 : 171. 1872, incl. var. *glabra* & *scabra*; Duthie, Fl. Gangetic Plain 1 : 51. 1903; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 89. 1987.

Local name : *Aropa*.

Large, scabrous, woody, climbing shrubs; bark smooth, pale brown. Leaves 5-7 x 1.5-3 cm, elliptic-oblong, attenuate at base, obtuse or mucronate at apex, glabrous. Petioles 6-8 mm long, terete. Corymbs axillary and terminal, dense-flowered. Flowers 2-2.5 cm across, greenish-yellow, mildly fragrant; pedicels 0.5-1.5 cm long, glabrous. Bract small, ovate, acuminate. Calyx forming 5-6 mm long tube, lined by a tubular, truncate disc; lobes 1-1.5 x 0.3-0.5 cm, oblong, acute, glabrous outside, pubescent within, villous along margins. Petals on cup-shaped disc, ca 1 x 0.5 cm, ovate-lanceolate, acuminate at apex, undulate along margins. Stamens many, inserted on 4-5 mm long torus; filaments white, glabrous. Ovary cylindrical, ca 5 mm long, truncate at apex; stigma more or less conical. Gynophore 2-2.5 cm long, glabrous. Fruits 8-12 cm long, constricted between the seeds, forming an elongated, twisted and knotted berry, each knot 1-seeded, light brown. Seeds brown, more or less globose, minutely echinate or tuberculate.

Fl.: January – March; Fr.: February – May.

Ecology : Rarc, found in gravelly habitats climbing on shrubs and small trees.

Specimen examined : DNP, Shetty 3484 (BSJO).

## 5. POLYGALACEAE

*POLYGALA* L.

- 1a. Bracts persistent. Capsules pubescent. Seeds with conspicuous strophiole. **1. *P. erioptera***  
 1b. Bracts caducous. Capsules glabrous. Seeds without strophiole. **2. *P. irregularis***

1. *Polygala erioptera* DC. Prodr. 1 : 326. 1824; Bennett in Hook. f. Fl. Brit. India 1 : 203. 1872; Duthie, Fl. Gangetic Plain 1 : 62. 1903; Bhandari, Fl. Indian Desert 46. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 96. 1987; Sundara Raghwan in Sharma & Balakrishnan, Fl. India 2 : 467. 1993.

Erect, annual or perennial, pubescent herbs, 40-50 cm high. Leaves 1.5-3.5 x 0.4-0.8 cm, subsessile, oblong to linear or elliptic-obovate, narrowed at base, acute at apex, glabrous above, tomentose beneath. Flowers pinkish-purple, solitary or in extra-axillary, up to 3.5 cm long racemes; pedicels up to 2 mm long. Bracts persistent. Sepals 5, persistent, unequal; outer 3 ovate, ca 1.5 mm long; wing sepals 1.5-3 mm long, with green central stripe. Petals 3-lobed. Ovary ovoid, ca 1 mm long, pilose; style curved, broadened at middle; stigma capitate. Capsules 3-5 x 2-2.5 mm, oblong, obliquely notched, pubescent. Seeds 3-4 x 1-2 mm, oblong, black, densely pilose; strophiole 3-lobed, with a few hairs (Plate-12/2).

*Fl. & Fr.*: January - December.

*Ecology* : Common, found in sandy plains usually in association with *Cenchrus* spp., *Euphorbia granulata* Forssk., etc.

*Specimens examined* : Near Kanoi, *Monika* 16568 (BSJO); Miajlar, *Monika* 16664 (BSJO); Mathuoki-Basti, *Monika* 16737 (BSJO); North of Munabao, *Pandey* 7909 (BSJO).

2. *Polygala irregularis* Boiss. Diagn. Pl. Or. Nov. ser. 1. 1 : 8. 1842 & Fl. Orient. 1 : 469. 1867; Raizada, Suppl. Duthie, Fl. Gangetic Plain 13. 1976; Bhandari, Fl. Indian Desert 47. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 96. 1987; Banerjee in Sharma & Balakrishnan, Fl. India 2 : 472. 1993.

Perennial herbs; stem branching from a more or less woody base; branches ascending, adpressedly pubescent, terete, striate, the older with conspicuous cicatrices of fallen leaves. Lower leaves 1-3.5 x 0.2-0.5 cm, oblanceolate or obovate; upper leaves 6-8 x 1-1.5 mm, linear-lanceolate, attenuate at base, subacute at apex, puberulous on both surfaces. Flowers pink, in 6-15 cm long, lateral or terminal racemes; pedicels 1.5-2 mm long, hairy. Bracts 3, ovate, acute, hairy, caducous. Sepals persistent, hairy; outer ones linear-oblong, ca 2 mm long; wing sepals obliquely ovate, ca 4 x 2 mm, glabrous, greenish-white, with purple or green arched veins. Lateral petals ca 4 mm long, obovate, cuneate, somewhat truncate at the obscurely undulate apex. Capsules 6-7 mm long, obliquely obovate, winged, glabrous. Seeds obconical, acute at base, crowned by bulbous-tipped clavate papillae at broader end and adpressed hairy at proximal end, dark brown to black.

*Fl. & Fr.*: December - October.

*Ecology* : Rare, mainly found in sandy habitats in association with *Polygala erioptera* DC., *Cleome gynandra* L., *Mollugo cerviana* (L.) Seringe, etc.

*Specimen examined* : Near Berisiyala, *Monika* 16680 (BSJO).

## 6. PORTULACACEAE

## PORTULACA L.

*Portulaca oleracea* L. Sp. Pl. 445. 1753; Dyer in Hook. f. Fl. Brit. India 1 : 246. 1874; Duthie, Fl. Gangetic Plain 1 : 69. 1903; Bhandari, Fl. Indian Desert 50. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 102. 1987; Rao in Sharma & Sanjappa, Fl. India 3 : 4. 1993.

Local names : *Kulfa, Luni, Luno.*

Prostrate or diffuse herbs; branches many, radially spreading, glabrous, green to pink. Leaves alternate or subopposite, often somewhat crowded towards the end of branches, 1.5-3 x 0.7-1.3 cm, fleshy, sessile, obovate-spathulate, truncate or obtuse at apex, with *ca* 1 mm long, axillary, stipular hairs. Flowers yellow, 2-8 in terminal clusters surrounded with involucreal leaves and inconspicuous hairs. Bracts *ca* 5 x 6 mm, ovate, acuminate. Sepals up to 8 x 8 mm, united below into a tube, free part fleshy, oblong-ovate, keeled or slightly winged. Petals 3-10 x 2.5-8 mm, broadly obovate. Stamens 7-8; filaments *ca* 4 mm long; anthers small. Ovary ovoid; style short, with 3-6, subulate lobes. Capsules 6-9 mm long, ovoid, shining, dehiscent above the base, circumscissile. Seeds many, 0.6-0.7 mm in diam., reniform, granulate, black.

*Fl. & Fr.*: Throughout the year.

*Ecology* : Common, found mostly in moist places and as a weed in cultivated fields. Main associates are *Zygophyllum simplex* L., *Cucumis melo* L., *Trianthema triquetra* Rottl. ex Willd., etc.

*Specimens examined* : Sudasari R. F., *Monika* 16695 (BSJO), *Pandey* 7845 (BSJO); Sam. *Monika* 16713 (BSJO); Pond near Berisiyala, *Pandey* 7862 (BSJO).

## 7. TAMARICACEAE

## TAMARIX L.

*Tamarix indica* Willd. in Ges. Naturf. Freunde Berlin Neue Schr. 4 : 214. 1803; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 106. 1987; Shetty & Pandey in Sharma & Sanjappa, Fl. India 3 : 25. 1993. *Tamarix gallica* L. var. *indica* (Willd.) Ehrenb. in Linnaea 2 : 276. 1827; Dyer in Hook. f. Fl. Brit. India 1 : 248. 1874. *T. indica* Koen. ex Roxb. Fl. Ind. 2 : 100. 1832, *nom. illegit.*, non Willd. 1803. *T. gallica auct. plur.*, non L. 1753; Dyer in Hook. f. Fl. Brit. India 1 : 248. 1874. *T. troupii* Hole in Indian For. 45 : 248. 1919; Bhandari, Fl. Indian Desert 56. 1978.

Large shrubs or small trees, up to 2-3 m high, with slender, pendulous branches. Leaves 2-4 mm long, subulate-acute from a triangular, semi-amplexicaul base, imbricate when young. Racemes lateral or terminal, panicle, spike-like. Flowers pink, bisexual; pedicels 2-3 mm long. Bracts ovate, acute. Sepals 5, ovate, minute, minutely denticulate on margins. Petals 2-2.2 x 1-1.2 mm, oblong, rounded or notched at tip. Disc 5-lobed. Stamens 5, inserted opposite the lobes. Ovary bottle-shaped, trigonous; styles 3, articulated to the ovary. Capsules 3-4 x 0.6-1.5 mm, glabrous, conical, pale pink. Seeds 0.5-0.6 mm long, with a plume of white hairs (2 mm long coma), black.

*Fl. & Fr.*: September - March.

*Ecology* : Occasional, found in marshy or wet saline habitats, usually forming its own community.

*Specimens examined* : Miajlar road, *Monika* 16637, 17139 (BSJO); Stream along Miajlar road, *Shetty* 3407 (BSJO).

## 8. ELATINACEAE

### BERGIA L.

- 1a. Erect, annual herbs. Flowers many, in dense, axillary, cymose clusters. Stamens 5. **1. *B. ammannioides***  
 1b. Decumbent or spreading, perennial herbs. Flowers solitary or 2-8, in axillary fascicles. Stamens 10. **2. *B. suffruticosa***

1. *Bergia ammannioides* Roxb. ex Roth, Nov. Pl. Sp. 219. 1821; Roxb. Fl. Ind. 2 : 457. 1832, 'ammanoides'; Dyer in Hook. f. Fl. Brit. India 1 : 251. 1874; Duthie, Fl. Gangetic Plain 1 : 73. 1903; Bhandari, Fl. Indian Desert 57. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 107. 1987; Bhattacharya in Sharma & Sanjappa, Fl. India 3 : 33. 1993. *Elatine ammannioides* (Roxb. ex Roth) Wight & Arn. Prodr. 41. 1834. *Bergia ammannioides* Roxb. ex Roth var. *pentandra* Wight, Ill. Ind. Bot. 54. t. 250. 1840.

Local name : *Jal-bhangra*.

Annual, erect, much-branched herbs, 10-20 cm high; branches terete, reddish-purple, glandular pubescent or glabrescent, swollen at nodes. Leaves 1.5-3 x 0.3-1 cm, oblanceolate or elliptic, attenuate at base, gradually tapering to short petiole, acute at apex, upper half distantly serrate with gland-tipped teeth, lower half entire. Stipules 2-3 mm long, triangular-lanceolate, acute, serrate, pubescent. Flowers minute, in dense, axillary cymes forming clusters, reddish-pink or white; pedicels 1-2 mm long, slender, pubescent. Sepals 5, ca 1.5 x 0.5 mm, linear-lanceolate, acute, glandular pubescent. Petals 5, elliptic-oblong, acute, white or reddish-pink. Stamens 5; filaments glabrous; anthers pale. Ovary subglobose, glabrous; styles 5, short, stigmatic tip reddish. Capsules ca 1 mm long, subglobose, reddish. Seeds many, minute, ovoid, glabrous, dark brown, shining.

Fl. & Fr.: August - March.

*Ecology* : Commonly found in the moist sandy places near tanks, in association with *Glinus lotoides* L., *Cyperus rotundus* L., etc.

*Specimen examined* : Near Berisiyala, *Pandey* 7871 (BSJO).

2. *Bergia suffruticosa* (Delile) Fenzl. in Denkschr. Bot. Ges. Regensb. 3 : 183. 1841; Bhandari, Fl. Indian Desert 57. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 109. 1987; Bhattacharya in Sharma & Sanjappa, Fl. India 3 : 36. 1993. *Lancretia suffruticosa* Delile, Fl. Egypt. 213. t. 25. 1813. *Bergia odorata* Edgew. in J. Asiat. Soc. Bengal 7 : 765. 1838; Dyer in Hook. f. Fl. Brit. India 1 : 251. 1874.

Local name : *Kharbuji*.

Decumbent or spreading, aromatic herbs, with woody base; stem shortly hispid; branches many, opposite. Leaves 0.5-2 x 0.2-1 cm, elliptic-ovate or oblong-lanceolate, narrowed at base, subacute at apex, crenate, densely glandular-pubescent on both surfaces, subsessile. Stipules linear-lanceolate. Flowers white, solitary or in axillary, 2 to 6-flowered fascicles; pedicels ca 2 mm long, pubescent. Sepals 2-6 x 1-3 mm, ovate-oblong, apiculate, pubescent outside and on the margins. Petals slightly longer than the sepals, obovate-oblong, entire. Stamens 10, opposite to the sepals. Capsules ovoid, whitish-pink. Seeds numerous, minute, oblong-ellipsoid, shining, dark brown.

*Fl. & Fr.*: October – February.

*Ecology* : Rare, found in drying beds of tanks and water streams in moist sandy soils. Plants make association with *Cyperus rotundus* L., *Glinus lotoides* L. and sometimes with *B. ammannioides* Roxb. ex Roth.

*Specimens examined* : Along Miajlar-Sundra road, *Monika* 17142 (BSJO); Near Berisiyala, *Pandey* 7869 (BSJO); Kanoi, *Pandey* 7882 (BSJO).

## 9. MALVACEAE

- |  |                    |
|--|--------------------|
| 1a. Fruit a capsule, dehiscent.  | 2. <i>Hibiscus</i> |
| 1b. Fruit schizocarpic, indehiscent; carpels (mericarps) usually separating. | 2                  |
| 2a. Epicalyx present.  | 3. <i>Pavonia</i>  |
| 2b. Epicalyx absent.   | 3                  |
| 3a. Mericarps 1-seeded, not dehiscent by apical slits.                       | 4. <i>Sida</i>     |
| 3b. Mericarps 2 to 3-seeded, dehiscent by apical slits.                      | 1. <i>Abutilon</i> |

### 1. *ABUTILON* Mill.

- |  |                         |
|--|-------------------------|
| 1a. Mericarps 8-10.  | 2. <i>A. fruticosum</i> |
| 1b. Mericarps more than 10.                                | 2                       |
| 2a. Mericarps mucronate or acuminate, exceeding the calyx. | 3                       |
| 2b. Mericarps obtuse, without a mucro, shorter than calyx. | 4. <i>A. pannosum</i>   |
| 3a. Mericarps 6-8 mm long, acuminate.                      | 1. <i>A. bidentatum</i> |
| 3b. Mericarps 10-13 mm long, acute with a small mucro.     | 3. <i>A. indicum</i>    |

1. *Abutilon bidentatum* Hochst. ex A. Rich. Tent. Fl. Abyss. 68. 1847; Mast. in Hook. f. Fl. Brit. India 1 : 326. 1874; Bhandari, Fl. Indian Desert 59. 1978; Parnar in Shetty & Singh, Fl. Rajasthan 1 : 115. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 260. 1993.

Perennial undershrubs; stem and branches densely woolly, intermingled with soft, stellate, spreading and simple hairs. Leaves 5-10 x 2-10 cm, ovate, cordate at base, acuminate at apex, irregularly toothed, densely pubescent with stellate and few simple hairs on both surfaces. Petioles 6-10 cm long. Stipules 1-2 mm long. Flowers yellow, axillary, solitary or in panicles; pedicels / peduncles 2-5 cm long. Calyx cup-shaped, divided up to half way down; lobes 5-6 x 2-3 mm, ovate, acute, densely velvety pubescent. Corolla 1.8-2 cm in diam. Staminal column 2-3 mm long. Schizocarps ca 1cm across; mericarps 18-20, 10-13 x 7-8 mm, oblong, gradually acuminate, bidentate at apex, 2 to 3-seeded. Seeds 1-1.5 mm across, reniform, brownish-black, minutely hairy.

*Fl. & Fr.*: August-December.

*Ecology* : Rarely found in sandy and gravelly habitats in wastelands in association with *Amaranthus* spp., *Heliotropium* spp., etc.



*Specimens examined* : Near Satto, *Monika* 16641 (BSJO); Along Miajlar road, *Monika* 17147 (BSJO).

*Notes* : Variety *major* (Blatt. & Hallb.) Bhandari reported from desert region does not occur in DNP.

2. *Abutilon fruticosum* Guill. & Perr. in Guill. *et al.* Fl. Seneg. Tent. 1 : 70. 1831; Mast. in Hook. f. Fl. Brit. India 1 : 328. 1874; Bhandari, Fl. Indian Desert 60. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 116. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 263. 1993.

Local name : *Imarati*.

Much-branched, rigid, perennial undershrubs, 60-120 cm high; stem terete, slender, densely covered with whitish hairs. Leaves 1.5-5 x 1.2-4.8 cm, ovate, acute at apex, cordate at base, denticulate, covered with soft, whitish hairs on both surfaces. Petioles 2-3 cm long, stellate pubescent. Stipules 1-3 mm long, linear. Flowers yellow, axillary, solitary; pedicels 2-3 cm long, articulated at apex, stellate pubescent. Calyx campanulate, divided up to half way down; lobes 3-4 x 2-3 mm, triangular-ovate, acute, 3-nerved, densely pubescent. Corolla 5-8 x 2-3 mm, campanulate. Staminal column 3-4 mm long, stellate hairy. Schizocarps 5-11 mm long; mericarps 8-10, 5-10 x 4-6 mm, obliquely truncate, without awns, densely stellate hairy, 2 to 3-seeded. Seeds 1-1.5 mm across, dotted with minute, brownish-white, hooked hairs.

*Fl. & Fr.*: September- January.

*Ecology* : Rarely found in gravelly habitats in association with *Cleome scaposa* DC., *Fagonia* spp., etc.

*Specimen examined* : Along Miajlar road, *Shetty* 3394 (BSJO).

*Notes* : Variety *chrysoarpa* Blatt. & Hallb. reported from desert area does not occur in DNP.

3. *Abutilon indicum* (L.) Sweet, Hort. Brit. ed. 1, 54. 1826; Mast. in Hook. f. Fl. Brit. India 1 : 326. 1874; Bhandari, Fl. Indian Desert 61, 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 116. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 266. 1993. *Sida indica* L. Cent. Pl. 2 : 26. 1756.

Local name: *Kanghi*.

Erect, perennial, tomentose undershrubs, 1-1.5 m high; stem woody with age. Leaves 3-18 x 1.8-16 cm, ovate, cordate at base, acuminate at apex, serrate, velvety tomentose on both surfaces. Stipules deflexed. Flowers yellowish-orange, solitary, axillary; pedicels 2-2.5 cm long, jointed near the top. Calyx 8-10 mm long, campanulate, divided up to the middle, stellate pubescent; lobes apiculate, triangular. Corolla 2-3 x 1-1.5 cm; petals obovate. Staminal column ca 7 mm long, hairy at the base. Schizocarps ca 2 cm across, cylindric, truncate, stellate pubescent; mericarps 15-20, 1.2-1.5 x 0.5-0.6 cm, reniform, acuminate and mucro turned backwards. Seeds 3-4 x 1-2 mm, reniform, punctate with minute warts, hairy at hilum, greyish-brown.

*Fl. & Fr.*: October-January.

*Ecology* : Occasional, found in wastelands in gravelly habitats in association with *Heliotropium strigosum* Willd., *Fagonia bruguieri* DC., etc.

*Specimen examined* : Near Sundra, *Monika* 17167 (BSJO).

*Notes* : Variety *guineense* (Schum.) Borss. reported from desert region does not occur in DNP.

4. *Abutilon pannosum* (Forst. f.) Schlecht. Bot. Zeit. 9 : 828. 1851; Bhandari, Fl. Indian Desert 62. 1978; Abedin in Fl. West Pakistan 130 : 72. 1979; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 118. 1987;

Paul in Sharma & Sanjappa, Fl. India 3 : 268. 1993. *Sida pannosa* Forst. f. in Comment. Phy. & Soc. Reg. Sci. Goetting. ser. 2. 9. 1787. *S. glauca* Cav. Icon. 1 : 8. t. 11. 1791. *S. mutica* Delile ex DC. Prodr. 1 : 470. 1824. *Abutilon glaucum* (Cav.) Sweet, Hort. Brit. 1 : 54. 1826; Raizada, Suppl. Duthie, Fl. Gangetic Pl. 26. 1976. *A. muticum* (Delile ex DC.) Sweet, Hort. Brit. ed. 2. 65. 1830; Mast. in Hook. f. Fl. Brit. India 1 : 327. 1874. *Sida tomentosa* Roxb. Fl. Ind. ed. Carey 3 : 178. 1832. *Abutilon tomentosum* (Roxb.) Wight & Arn. Prodr. Fl. Pen. Ind. Or. 1 : 56. 1834.

Local name : *Kanghi-buti*

Undershrubs, up to 1.5 m high; stem slender, densely velvety. Leaves 5-12 x 5-12 cm, orbicular to rounded-ovate, cordate at base, acute to acuminate at apex, 5 to 9-nerved from the base, densely hairy on both surfaces, margins irregularly toothed. Petioles 5-10 cm long. Stipules 2-10 mm long, linear, acute, hairy. Flowers yellowish-orange, large, solitary, axillary; pedicels 1.5-2 cm long. Calyx campanulate, divided up to the middle; lobes 0.8-1.5 x 0.5-0.8 cm, ovate. Corolla 3-4 cm in diam.; lobes obliquely triangular, glabrous. Schizocarps 0.5-1 cm long, subglobose; mericarps 20-25, each 6-10 x 2-5 mm, reniform, compressed on two sides, almost rounded, densely hairy on outer margins. Seeds 2-3 per mericarp, scabrous, brownish.

Fl. & Fr.: October-March.

Ecology : Occasional, mostly found in sandy places in association with *Cleome viscosa* L., *Heliotropium* spp., etc.

Specimens examined : Near Satto, Monika 16665 (BSJO); Along Miajlar- Sundra road, Monika 17155 (BSJO).

## 2. *HIBISCUS* L. (nom. cons.)

- |   |                           |
|---|---------------------------|
| 1a. All leaves entire. Capsules globose. Seeds hirsute, cottony.                                    | 3. <i>H. micranthus</i>   |
| 1b. Leaves entire and shallowly 3-lobed both. Capsules oblong-ovoid. Seeds tuberculate or glabrous. | 2                         |
| 2a. Involucral bracts conspicuous, linear, acute.   | 1. <i>H. amblyocarpus</i> |
| 2b. Involucral bracts absent or very rudimentary.   | 2. <i>H. lobatus</i>      |

1. *Hibiscus amblyocarpus* Hochst. ex Webb. Fragm. Fl. Aeth.-Aegypt. 45. 1854; Rakshit & Kundu in Bull. Bot. Surv. India 12 : 174. 1972; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 120. 1987. *H. punctatus* Dalz. in Dalz. & Gibs. Bombay Fl. 20. 1861; Mast. in Hook. f. Fl. Brit. India 1 : 340. 1874. *H. obtusilobus* auct. plur. non Gareke 1849; Bhandari, Fl. India Desert 65. 1978.

Erect, annual undershrubs, up to 1 m high; stem stellate pubescent when young. Leaves 3-8 x 1.5-7.5 cm, simple, ovate, obtuse, entire or unequally shallowly 3-lobed, middle lobe longer than laterals. Stipules 4-5 mm long, linear-lanceolate. Flowers axillary, solitary, pale pink; pedicels shorter than the petioles. Involucre bracts 8-12, 4-5 mm long, flat. Bracteoles free, linear, spine-tipped, hairy. Calyx divided half way down; lobes lanceolate. Corolla white or pale pink, slightly exceeding the calyx. Capsules ovoid, beaked, pubescent, exceeding the calyx. Seeds reniform, muciculate, black.

Fl. & Fr.: September-October.

Ecology : Rare, found in rocky and gravelly habitats.

Specimen examined : DNP, Tiwari 916 (BSJO).

2. *Hibiscus lobatus* (Murr.) O. Ktze. Rev. Gen. Pl. 3 (2) : 19. 1898; Bhandari, Fl. Indian Desert 64. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 121. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 336. 1993. *Solandra lobata* Murr. in Comment. Phy. & Soc. Reg. Sci. Goetting. 6 : 20. t. 1. 1785. *Hibiscus solandra* L'Herit. Stirp. Nov. 1 : 103. t. 49. 1788; Mast. in Hook. f. Fl. Brit. India 1 : 336. 1874; Duthie, Fl. Gangetic Plain 1 : 89. 1903.

Erect, annual herbs, up to 1 m high; stem and branches pubescent. Leaves 3-12 x 1.5-8.5 cm, polymorphous, lower leaves larger and long-petioled, orbicular-ovate, upper ones deeply or shallowly 3-lobed, pubescent on both surfaces, margins crenate or bluntly toothed. Petioles 3-6 mm long, terete, pubescent. Stipules 1.5-8 mm long, filiform, setaceous. Flowers pink, axillary, solitary in basal part and in terminal racemes. Peduncles 4-6 cm long, jointed about 1 cm below the apex. Involucre bracts absent or 6-8, very minute, linear. Calyx 6-7 mm long, campanulate, 5-lobed, enlarging in fruit, hispid. Corolla 10-15 mm long; petals obovate, transparent. Staminal column very small, ca 5 mm long. Capsules ovoid, slightly wrinkled, pubescent, shortly beaked. Seeds ca 1.5 x 1.3 mm, obovate-tetrahedral, tubercled, black.

*Fl. & Fr.*: August-October.

*Ecology* : Occasional, found in sandy habitats in association with *Amaranthus viridis* L., *Heliotropium strigosum* Willd., etc.

*Specimen examined* : Near Barna. Monika 1658 (BSJO).

3. *Hibiscus micranthus* L. f. Suppl. Pl. 308. 1781; Mast. in Hook. f. Fl. Brit. India 1 : 335. 1874; Duthie, Fl. Gangetic Plain 1 : 89. 1903; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 122. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 330. 1993. *H. ovalifolius sensu* Boissier, Fl. Or. 1 : 839. 1867, non (Forssk.) Vahl 1790; Bhandari, Fl. Indian Desert 56. 1978.

Undershrubs, up to 1.5 m high; branches terete, slender, scabrid with scattered, stellate bristles. Leaves 1.5-3.5 x 0.5-2.5 cm, ovate or oblong, acute or obtuse at apex, serrate, scabrid with stellate hairs on both surfaces. Petioles 0.3-1 cm. Stipules filiform, hairy. Flowers white, turn to purplish-pink with age, axillary, solitary; pedicels up to 2 cm long, jointed much below the middle, slender, scabrid with stellate hairs. Involucre bracts 6, filiform, hairy, much shorter than the calyx. Calyx 4-5 mm long, divided up to half way down; lobes 3-4 mm long, lanceolate, stellate hairy outside. Corolla 1-1.2 x 0.3-0.4 cm, oblong, obtuse, often reflexed, stellate pubescent outside. Stamens in tufts or staminal column. Capsules ca 8 mm in diam., globose, pubescent. Seeds reniform, black, cottony with long, silky hairs.

*Fl. & Fr.*: March-December.

*Ecology* : Rare, found in the gravelly-rocky habitats in association with *Euphorbia caducifolia* Haines and *Cleome scaposa* DC.

*Specimen examined* : On Hillocks in Damodara, Shetty 3446 (BSJO).

### 3. PAVONIA Cav. (nom. cons.)

*Pavonia zeylanica* (L.) Cav. Diss. 3 : 134. t. 48. f. 2. 1787; Mast. in Hook. f. Fl. Brit. India 1 : 331. 1874; Raizada, Suppl. Duthie, Fl. Gangetic Plain 32. 1976; Bhandari, Fl. Indian Desert 70. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 129. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 257. 1993. *Hibiscus zeylanicus* L. Sp. Pl. 697. 1753.

Erect, much-branched, glandular-pubescent undershrubs. Leaves 1.5-2.5 x 1-1.2 cm, more or less roundish, slightly cordate at base, usually 3 to 5-lobed, rarely entire, dentate. Petioles 1.8-3 cm long, viscid, hairy. Stipules subulate, small. Flowers pink, axillary, solitary; pedicels longer than petioles, viscid hairy, jointed near the middle or above. Involucre bracts 8-12, free, linear, hairy, ciliolate. Calyx-lobes 3-3.5 mm long, lanceolate. Corolla 11-12 mm long. Mericarps 5, trigonous, rounded on the back, slightly wrinkled and veined, glabrous, enclosed in the persistent involucre. Seeds 2-2.2 mm long, brown, with longitudinal white lines of spirally curled hairs on the back and sides.

*Fl. & Fr.*: September – December.

*Ecology* : Common, found in waste places in sandy habitats in association with *Peristrophe paniculata* (Forssk.) Brummitt, *Sida* spp., etc.

*Specimen examined* : Miajlar village, *Monika* 17108 (BSJO).

#### 4. *SIDA* L.

- |   |                         |
|---|-------------------------|
| 1a. Prostrate or trailing herbs. Mericarps 5.   | 1. <i>S. cordata</i>    |
| 1b. Erect undershrubs. Mericarps 6-10.  | 2                       |
| 2a. Leaves cordate at base. Mericarps 10.   | 2. <i>S. cordifolia</i> |
| 2b. Leaves cuneate or rounded at base. Mericarps 6-8.   | 3                       |
| 3a. Calyx 8-10 mm long. Carpels loosely but completely enclosed by the calyx; mericarps prominently reticulated on the sides. | 4. <i>S. tiagii</i>     |
| 3b. Calyx 5-6 mm long. Carpels not completely enclosed by the calyx; mericarps not reticulated.                               | 3. <i>S. ovata</i>      |

1. *Sida cordata* (Burm. f.) Borssum in Blumea 14 : 182. 1966; Bhandari, Fl. Indian Desert 72. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 131. 1987. *Melochia cordata* Burm. f. Fl. Ind. 143. 1768. *Sida veronicifolia* Lam. Encycl. 1 : 5. 1783; Duthie, Fl. Gangetic Plain 1 : 80. 1903. *S. humilis* Cav. Diss. 5 : 277. t. 134. f. 2. 1788; Mast. in Hook. f. Fl. Brit. India 1 : 322. 1874, *incl. vars.*

*Local name* : *Adio-bul*.

Annual, prostrate or trailing herbs, up to 1 m long; stem and branches stellately hispid and glutinous scabrid. Leaves 2-5 x 1.8-4 cm, ovate-cordate, acute, crenulate-dentate, sparsely pubescent on both surfaces. Petioles 2-3 cm long, swollen at base and at apex. Stipules 3-4 mm long, subacute. Flowers yellow, axillary, solitary or paniculate to fasciculate; pedicels jointed just above the middle, slender. Calyx 4-5 mm long, sparsely villous with long hairs; lobes longer than the tube, acute. Corolla 5-6 mm long. Staminal tube sparsely pubescent. Mericarps 5, 4-5 mm long, mucous, dehiscent, thin-walled, slightly longitudinally keeled on the back, minutely pubescent, with very short, connivent awns. Seeds ca 2 mm long, glabrous, brownish-black.

*Fl. & Fr.*: August-November.

*Ecology* : Occasional, found in sandy habitats under the shade of trees and shrubs like *Prosopis cineraria* (L.) Druce, *Capparis decidua* (Forssk.) Edgew., etc.

*Specimen examined* : Barna, *Monika* 16778 (BSJO).

2. *Sida cordifolia* L. Sp. Pl. 684. 1753; Mast. in Hook. f. Fl. Brit. India 1 : 324. 1874; Duthie, Fl. Gangetic Plain 1 : 82. 1903; Bhandari, Fl. Indian Desert 72. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 131. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 285. 1993.

Perennial, erect undershrubs, up to 1 m high; stem and branches softly villous mixed with stellate pubescence. Leaves 2.5-7 x 1-4 cm, ovate-oblong, shallowly cordate at base, subobtuse at apex, margins slightly crenate, stellate pubescent on both surfaces. Petioles up to 3 cm long, stellate pubescent. Stipules filiform, ca 5 mm long. Flowers yellow, axillary, upper flowers nearly sessile and fasciculate towards the tips of the branches forming subspicate inflorescence; pedicels 1-2 cm long, jointed much above the middle. Calyx 6-8 mm long, campanulate, 5-lobed, 10-ribbed, tomentose; lobes triangular, hairy. Corolla 7-8 mm long. Staminal column hirsute. Mericarps 10, 3-sided, sides strongly reticulate, ciliate on upper margins, awned; awns 2, 3-3.5 mm long, much exerted from calyx. Seeds ca 2 mm in diam., trigonous, glabrous, tufted-pubescent near the hilum, brownish-black.

*Fl. & Fr.*: September-January.

*Ecology*: Found in sandy to gravelly habitats, mainly under the shade of *Prosopis cineraria* (L.) Druce, *Capparis decidua* (Forssk.) Edgew., etc.

*Specimen examined*: Sudasari, Monika 16690 (BSJO).

3. *Sida ovata* Forssk. Fl. Aegypt.-Arab. 124. 1775; Bhandari, Fl. Indian Desert 73. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 131. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 288. 1993. *S. grevioides* Guill. & Perr. in Guill. et al. Fl. Sencg. Tent. 1 : 71. 1831; Mast. in Hook. f. Fl. Brit. India 1 : 323. 1874; Duthie, Fl. Gangetic Plain 1 : 81. 1903.

Local name : *Balro*.

Erect undershrubs; stem and branches grey-tomentose with stellate hairs. Leaves 2-4 x 1-3.5 cm, oblong-ovate, rounded at base, obtuse at apex, crenate, densely pubescent with stellate hairs on both surfaces. Petioles 1-1.5 cm long, tomentose. Stipules ca 4 mm long, linear-lanceolate, stellate pubescent. Flowers yellow, axillary, solitary; pedicels 0.5-1 cm long, shorter than petioles, jointed just below the calyx. Calyx campanulate; lobes 5-6 x 2-4 mm, ovate, subacute, densely stellate pubescent outside. Petals 0.8-1 x 0.3-0.5 cm, obliquely obovate, sparsely hairy outside. Staminal column stellate hairy. Mericarps 7-8, 3-4 mm across, nearly glabrous, laterally reticulate; awns 2, linear, very short. Seeds ca 2 mm in diam., rounded-reniform, glabrous except with stellate hairs near the hilum, black.

*Fl. & Fr.*: July - February.

*Ecology*: Sometimes found near cultivated fields in sandy soils with other rainy season weeds.

*Specimen examined*: North of Gadra road, Shetty 2316 (BSJO).

4. *Sida tiagii* Bhandari in Ann. Arid Zone 16 (4) : 455. 1977 & in Fl. Indian Desert 74. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 133. 1987; Paul in Sharma & Sanjappa, Fl. India 3 : 294. 1993. *S. pakistanica* Abedin in Pakistan J. Bot. 11 : 54. 1979.

Local name : *Bal*.

Much-branched, perennial undershrubs, densely stellate tomentose all over; stem terete or sulcate, woody at base. Leaves 1.5-3 x 1-2 cm, ovate-oblong or obovate, subobtuse or truncate at apex, rounded at

base, entire, crenate-serrate, 3 to 5-nerved from base. Petioles 1-1.5 cm long. Stipules linear. Flowers pale yellow, axillary, solitary; pedicels 0.2-1 cm long, jointed just below the calyx. Calyx-lobes free up to the middle, 6-7 x 3-5 mm, stellate pubescent, mucronate, enlarged in fruit. Petals 7-10 x 5-6 mm, obliquely obovate. Staminal column hirsute. Schizocarps pentangular-ovoid, enclosed within the calyx; mericarps 7-8, woody, prominently reticulated on the sides, strongly rugose on the back, 2-awned at apex. Seeds glabrous, with a tuft of stellate hairs at hilum, black (Fig.-4).

*Fl. & Fr.*: September-November.

*Ecology* : Rare, found in the sandy habitats forming isolated patches of few individuals.

*Specimen examined* : DNP, Tiwari 869 (BSJO).

## 10. STERCULIACEAE

### *MELIHANIA* Forssk.

*Melhanian denhamii* R. Br. in Denh. & Clapp. Trav. App. 232. 1826; Mast. in Hook. f. Fl. Brit. India 1 : 373. 1874; Bhandari, Fl. Indian Desert 75. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 141. 1987; Malick in Sharma & Sanjappa, Fl. India 3 : 438. 1993.

Suffruticose herbs, woody at base; branches many, densely stellate tomentose. Leaves 1.5-5 x 1-2.5 cm, ovate-oblong or elliptic, rounded and 5-nerved at the base, obtuse or apiculate at apex, crenate-serrate, stellate hairy above, hoary pubescent beneath. Petioles 1.5-3 cm long, subterete. Stipules ca 5 mm long, subulate, filiform, hairy. Flowers axillary, solitary, orange-yellow; peduncles ca 2 cm long, divided above into 2-3 pedicels 2-6 mm long. Involucral bracts 3, 1 x 1.5 cm, reniform, membranous, stellate pubescent, accrescent, enclosing the capsules. Calyx-lobes 4-6 mm long, lanceolate to ovate-oblong, acuminate, stellate tomentose outside, glabrous inside. Petals 4-5 mm long, obovate, glabrous, veined. Stamens 4, 3-4 mm long, alternating with 4 staminodes; staminodes 2-2.5 mm long. Ovary ca 2 mm in diam., hairy. Capsules 4-6 mm in diam., globose, dehiscence loculicidal. Seeds 1-2 in each locule, angled, smooth, black.

*Fl. & Fr.*: June-November.

*Ecology* : Rare, found in sandy habitats particularly in inter-dunal areas.

*Specimens examined* : Near Khuri, Monika 16782 (BSJO); Along Miajlar road, Shetty 3409 (BSJO); Near Sundra, Pandey 7905 (BSJO).

## 11. TILIACEAE

- |   |                     |
|---|---------------------|
| 1a. Shrubs. Petals with a gland at base. Fruit a subglobose drupe, indehiscent. | 2. <i>Grewia</i>    |
| 1b. Herbs. Petals without gland at base. Fruit an elongated capsule, dehiscent  | 1. <i>Corchorus</i> |

### 1. *CORCHORUS* L.

- |   |                        |
|---|------------------------|
| 1a. Plants prostrate. Capsules 4-valved, slightly curved, 1-2 cm long.                        | 1. <i>C. depressus</i> |
| 1b. Plants erect. Capsules 3 or 5-valved, straight, more than 3 cm long.                      | 2                      |
| 2a. Capsules 3-valved, striated, terminating into 3, 2-fid, spreading tips.                   | 3. <i>C. tridens</i>   |
| 2b. Capsules 5-valved, 10-ribbed, entire-beaked, not terminating into divided spreading tips. | 2. <i>C. olitorius</i> |



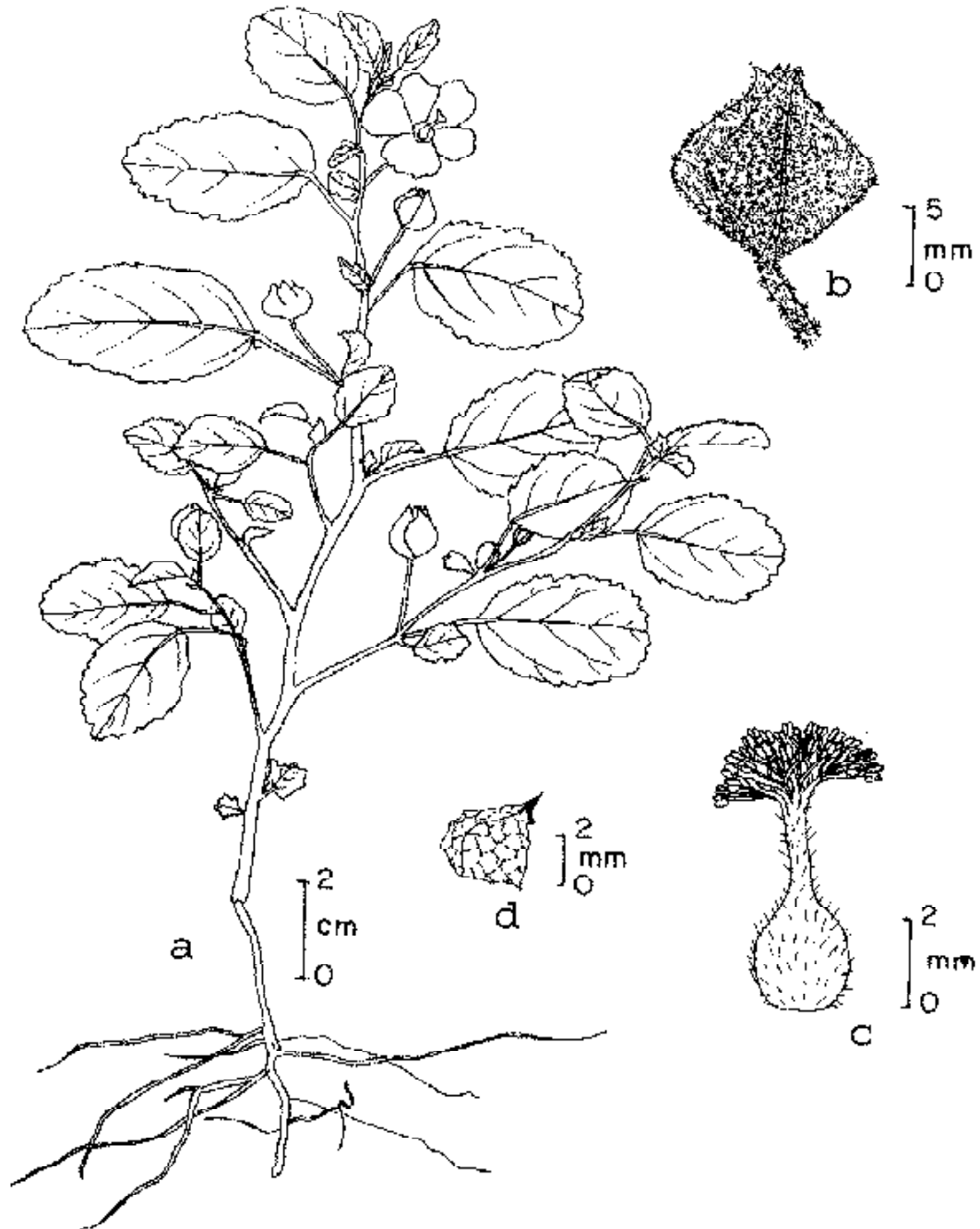


Fig. 4. *Sida tiagii* Bhandari : a. Habit, b. Fruit enclosed in calyx, c. Androecium, d. Mericarp.

1. *Corchorus depressus* (L.) Vicary in J. Asiat. Soc. Bengal 16 : 1160. 1847; Stocks in Proc. Linn. Soc. 1 : 367. 1848; Bhandari, Fl. Indian Desert 78. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 147. 1987; Daniel & Chandrabose in Sharma & Sanjappa, Fl. India 3 : 486. 1993. *Antichorus depressus* L. Mant. Pl. 1 : 64. 1767. *Corchorus antichorus* Raeusch. Nom. Bot. ed. 3. 158. 1797; Mast. in Hook. f. Fl. Brit. India 1 : 398. 1874; Duthie, Fl. Gangetic Plain 1 : 121. 1903.

Local name : *Chamkas*.

Perennial, prostrate herbs; branches many, closely adpressed to the ground from woody root-stock, young branches sparsely hairy, older ones glabrous. Leaves 1-3 x 0.5-1.5 cm, elliptic, obovate-elliptic to roundish, crenate-serrate, 8-nerved, glabrous, basal appendages absent. Petioles 1-1.5 cm long, minutely hairy, swollen near the base of lamina. Stipules ca 3 mm long. Flowers yellow, 6-8 mm across, in leaf-opposed, subsessile, 2 to 4-flowered cymes. Sepals 3-4 mm long, linear-oblong, apiculate. Petals ca 5 x 2 mm, oblong-obovate. Stamens 7-8; filaments yellow; anthers dorsifixed. Capsules 1-2 cm long, cylindrical, glabrescent, beaked; beak 1-1.5 mm long. Seeds black, 3-gonous, obliquely truncate, smooth.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in sandy habitats, fallow fields and in wastelands. Main associates are *Tribulus* spp., *Boerhavia* spp., etc.

*Specimens examined* : Bidna, Monika 16516 (BSJO); Near Sehmari, Monika 16614 (BSJO); Miajlar village, Monika 17114 (BSJO); Along Miajlar road, Shetty 3408 (BSJO); Near Ganga village, Pandey 7810 (BSJO).

2. *Corchorus olitorius* L. Sp. Pl. 529. 1753; Mast. in Hook. f. Fl. Brit. India 1 : 397. 1874; Duthie, Fl. Gangetic Plain 1 : 120. 1903; Bhandari, Fl. Indian Desert 79. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 148. 1987; Daniel & Chandrabose in Sharma & Sanjappa, Fl. India 3 : 487. 1993. *C. decemagularis* Roxb. Fl. Ind. 2 : 382. 1832.

Local name : *Chamghus*.

Annual, erect, branched herbs, up to 30 cm high, with woody base; stem and branches glabrous. Leaves 4-11 x 3-3.5 cm, lanceolate to ovate-lanceolate, acute at apex, serrate, lower serratures produced into filiform appendages, glabrous except on nerves which are sparsely hairy. Petioles 2-3 cm long, pubescent. Stipules 7-8 mm long, subulate, glabrous. Flowers yellow, 12-15 mm across, leaf-opposed, solitary or 2 to 3-together in short peduncled cymes, subsessile. Bracts 4-5 mm long. Sepals 5-7 mm long, linear-oblong, apiculate. Petals 5-7 mm long, oblong-spathulate. Stamens many; filaments glabrous. Ovary cylindrical, sparsely hairy. Capsules 4-6 cm long, 10-ribbed, glabrous, beaked; beak entire, 3-5 mm long. Seeds trigonous, black.

*Fl. & Fr.*: July-January.

*Ecology* : Occasional, found in moist sandy soils, particularly near cultivated fields in association with *Indigofera tinifolia* (L. f.) Retz., *Gisekia pharnaceoides* L., etc.

*Specimens examined* : Near Sehmari, Monika 16686 (BSJO); Sudasari, Pandey 7839 (BSJO).

3. *Corchorus tridens* L. Mant. Alt. 566. 1771; Mast. in Hook. f. Fl. Brit. India 1 : 398. 1874; Duthie, Fl. Gangetic Plain 1 : 121. 1903; Bhandari, Fl. Indian Desert 80. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 148. 1987; Daniel & Chandrabose in Sharma & Sanjappa, Fl. India 3 : 488. 1993. *C. trilocularis* auct. non L. 1767; Burm. f. Fl. Ind. 125. t. 37. f. 2. 1768. *C. burmanni* DC. Prodr. 1 : 505. 1824.

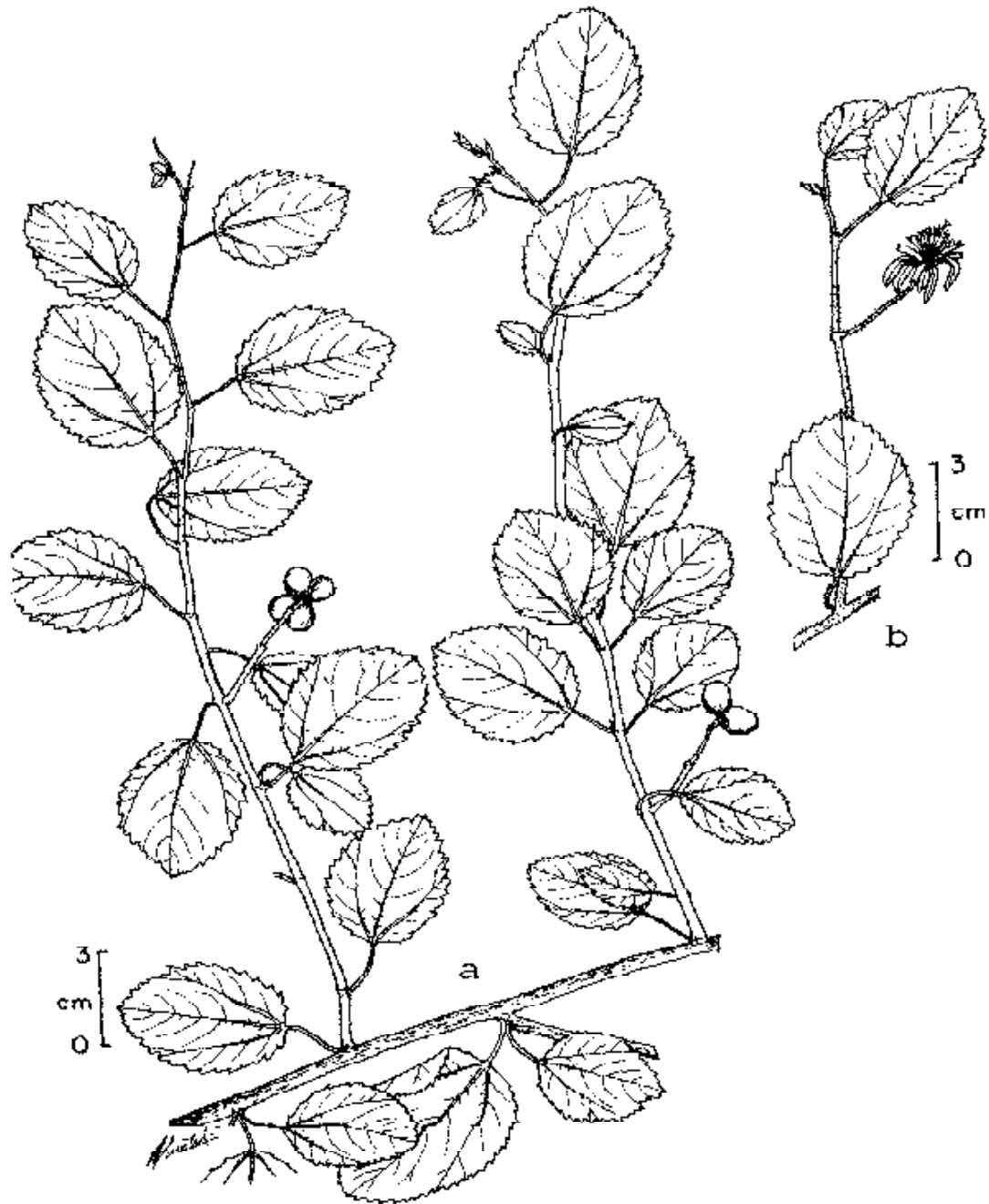


Fig. 5. *Grewia tenax* (Forsk.) Fiori : a. Habit, b. Flowering twig.

Local name : *Kagnasha*.

Erect, annual herbs, 30-60 cm high, glabrous. Leaves 7-12 x 2-3.5 cm, ovate-lanceolate or oblong-lanceolate, acute at apex, crenate-serrate, basal serratures produced into filiform appendages, glabrous except nerves. Petioles 1-1.5 cm long, hairy. Stipules 3-4 mm long, subulate, setaceous. Flowers yellow, subsessile, in leaf-opposed, 1 to 4-flowered, shortly pedunculate, corymbose cymes. Bracts 3-4 mm long, subulate. Sepals 4-5 mm long, linear-oblong, apiculate. Petals 5-6 mm long, with a short, pubescent claw. Stamens 10; filaments glabrous. Capsules 2.5-3 cm long, straight, beaked; beak 2-3 mm long, terminating into 3, 2-bifid lips. Seeds 1-1.5 mm long, truncate at both ends, black.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in sandy habitats in association with *Corchorus depressus* (L.) Vicary, *Tribulus terrestris* L., etc.

*Specimens examined* : Near Sudasari, *Monika* 16579, 16754 (BSJO); Schmari, *Monika* 16616 (BSJO).

## 2. GREWIA L.

*Grewia tenax* (Forssk.) Fiori in Bos. Plant. Legn. Eritr. 246. 1909 & in Agri. Colon. 5 : Suppl. 23. 1912; Naray. & Rao in J. Indian Bot. Soc. 29 : 179. 1950; Bhandari, Fl. Indian Desert 82. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 155. 1987; Daniel & Chandrabose in Sharma & Sanjappa, Fl. India 3 : 511. 1993. *Chadara tenax* Forssk. Fl. Aegypt.-Arab. 105. 1775. *Grewia populifolia* Vahl. Symb. Bot. 1 : 33. 1790; Masl. in Hook. f. Fl. Brit. India 1 : 385. 1874; Duthie, Fl. Gangetic Plain 1 : 111. 1903. *G. betulaefolia* Juss. in Ann. Mus. Natl. Hist. Nat. 4 : 92. t. 2. 1804.

Local name : *Gangan*.

Perennial shrubs, 2-3 m high, with pubescent branches. Leaves 2-4.5 x 1-2.5 cm, ovate-oblong, rounded at base, acute or obtuse at apex, crenate, glabrous above, sparsely stellate hairy beneath, palmately 3 to 5-nerved. Petioles up to 1 cm long, terete. Stipules lanceolate, 4-5 mm long, pubescent. Flowers white, in axillary or leaf-opposed or sometimes terminal, 2 to 3-flowered cymes; peduncles up to 1.5 cm long, terete, glabrous. Bracts usually 3, caducous. Sepals 1.2-1.8 cm long, linear-oblong, tomentose outside, white and glabrous within except with few hairs near the base. Petals linear-oblong, emarginate, glabrous, spreading, attached along the back of the glands; glands 5, orbicular. Stamens many; filaments pinkish-white, unequal, glabrous; anthers white, raised on a glabrous torus with 5, villous teeth at apex. Style longer than the stamens, glabrous; stigma 4-lobed, green. Drupes 2 to 4-lobed, 8-10 mm across, orange when ripe. Seeds 3-4 mm in diam., subglobose, black (Fig.-5; Plate-12/3).

*Fl. & Fr.*: May February.

*Ecology* : Found in gravelly as well as sandy gravel habitats.

*Specimen examined* : Sutto-Bandera road, *Monika* 16640 (BSJO).

## 12. ZYGOPHYLLACEAE

- |  |                       |
|--|-----------------------|
| 1a. Stipules spiny.                      | 1. <i>Fagonia</i>     |
| 1b. Stipules not spiny.                  | 2                     |
| 2a. Petals absent. Stamens 5.            | 2. <i>Seetzenia</i>   |
| 2b. Petals present. Stamens 10-15.       | 3                     |
| 3a. Leaves simple. Fruit capsular.       | 4. <i>Zygophyllum</i> |
| 3b. Leaves compound. Fruit schizocarpic. | 3. <i>Tribulus</i>    |

1. *FAGONIA* Tourn. ex L.

- 1a. Internodes quadrangular; spines longer than leaves. Pedicels as long as capsules. 1. *F. bruguieri*  
 1b. Internodes terete; spines shorter than the leaves. Pedicels twice as long as capsules. 2. *F. schweinfurthii*

1. *Fagonia bruguieri* DC. Prodr. 1 : 704. 1824; Edgew. & Hook. f. in Hook. f. Fl. Brit. India 1 : 425. 1874; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 162. 1987; Bhandari, Fl. Indian Desert 79. 1990; Singh & Singh in Hajra *et al.* Fl. India 4 : 42. 1997. *F. echinella* Boiss. Diagn. Pl. Orient. Nov. ser. 1. 8 : 123. 1849.

Local name : *Dhamaso*.

Perennial herbs, profusely branched, up to 30 cm high, glandular hairy, pale green; branches distinctly sulcate, 4-angled; internodes 2-3 cm long. Basal leaves 3-foliolate, upper unifoliolate or all 3-foliolate; leaflets 5-12 mm long, fleshy, ovate-oblong, sharply mucronate. Petioles 3-4 mm long. Stipular spines longer than the leaves, usually recurved. Flowers ca 10 mm across, pink; pedicels up to 4 mm long. Sepals oblong, persistent, 2-2.5 x 1.2-1.5 mm. Petals spatulate, obtuse, 4-5 mm long. Stamens ca 4 mm long. Capsules ca 4 x 4 mm, pubescent, brownish-green (Plate-12/4).

*Fl. & Fr.*: February-May.

*Ecology* : Very common, found in sandy to gravelly plains in association with *Aerva javanica* (Burm. f.) Juss. ex Schult., *Tribulus* spp. etc. and sometimes forming pure communities.

*Specimens examined* : Near Barna, *Monika* 16508 (BSJO); Along Miajlar- Sundra road, *Monika* 17145 (BSJO).

*Notes* : Variety *rechingeri* Hadidi reported from desertic zones does not occur in DNP.

2. *Fagonia schweinfurthii* (Hadidi) Hadidi ex Ghafoor in Jafri & El Gadi, Fl. Libya 38 : 31. 1977; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 163. 1987; Bhandari, Fl. Indian Desert 80. 1990; Singh & Singh in Hajra *et al.* Fl. India 4 : 44. 1987. *F. indica* Burm. f. var. *schweinfurthii* Hadidi in Rech. f. Fl. Iran 98 : 6. t. 6. 1972.

Local name : *Dhamaso*.

Perennial, decumbent to erect, glandular herbs, up to 50 cm high; internodes 1.5-2.8 cm long, striate, glabrous, terete. Lower leaves trifoliolate, upper ones unifoliolate; leaflets 1-2.5 x 0.2-0.4 cm, linear-lanceolate. Petioles 6-8 mm long, terete. Stipular spines patent, shorter than the leaves, sometimes much reduced. Flowers 8-10 mm across, pinkish-purple; pedicels 7-8 mm long, glabrous. Sepals 3-4 x 1.5-2 mm, ovate, persistent, sparsely glandular outside. Petals 4-6 x 2-3 mm, obtuse. Stamens 4-5 mm long. Ovary ca 1 mm across. Capsules 3-4 x 3-4 mm, globose, softly hairy.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in sandy and gravelly habitats, often forming pure communities and also found in association with *Fagonia bruguieri* DC.

*Specimens examined* : Near Kanoj, *Monika* 16598 (BSJO); Sudasari, *Monika* 16758 (BSJO).

*Notes* : Flower colour which is white in morning, turns to pink in the afternoon.

2. *SEETZENIA* R. Br.

*Seetzenia lanata* (Willd.) Bullock in Kew Bull. 19 : 204. 1965; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 164. 1987; Singh & Singh in Hajra *et al.* Fl. India 4 : 49. 1997. *Zygophyllum lanatum* Willd. Sp. Pl. 2 : 564. 1799. *Z. prostratum* Thunb. Prodr. Fl. Cap. 189. 1800. *Seetzenia africana* R. Br. in Denham & Clapp. Narr. Trav. Africa Bot. App. 231. 1826, *nom illegit.* *S. prostratum* (Thunb.) Eckl. & Zeyth. Enum. Pl. Agric. Austr. 98. 1834. *S. orientalis* Decne. in Ann. Sc. Nat. Bot. ser. 2. 3 : 281. t. 7. 1835; Edgew. & Hook. f. in Hook. f. Fl. Brit. India 1 : 424. 1874; Bhandari, Fl. Indian Desert 86. 1978.

Perennial, prostrate, papillate, glaucous herbs; stem and branches terete; internodes 1.5-2 cm long, articulate, swollen and lanate at nodes. Leaves trifoliolate; central leaflet 5-10 x 2-8 mm, obovate, cuneate, apiculate; lateral ones 3-8 x 1-5 mm, obliquely oblong or subreniform. Petioles 2-4.5 mm long, thick, papillose. Stipules 1-1.5 mm long, triangular, intra-petiolar, hairy. Flowers solitary, axillary, greenish; pedicels 6-8 mm long. Sepals 2-3.5 x 1-1.5 mm, elliptic-lanceolate, acute and incurved at apex. Corolla absent. Stamens 5, 3-4 mm long, alternating the sepals; filaments glabrous. Ovary ribbed, more or less truncate at apex; styles 5; stigmas capitate. Capsules 6-8 x 5-6 mm, ovoid, pentagonal. Seeds 4-4.5 x 1.5-1.8 mm, compressed, ovoid, smooth, brown.

*Fl. & Fr.*: September-March.

*Ecology* : Rare, found in sandy to gravelly habitats in association with *Arnebia hispidissima* (Sieber ex Lehm.) DC., *Blepharis linariaefolia* Pers., etc.

*Specimens examined* : Sudasari R. F., Monika 16687 (BSJO); Near Ganga, Pandey 7818 (BSJO).

3. *TRIBULUS* Tourn. ex L.

- |  |  |
|--|--|
| 1a. Mericarps spinous, not winged.   | 2  |
| 1b. Mericarps winged, not spinous.   | 3  |
| 2a. Mericarps with 2 major divergent spines and 20-30 minor spines; basal pairs of spines always absent. |  |
|  | <b>3. <i>T. rajasthanensis</i></b>                     |
| 2b. Mericarps dorsally tuberculate; spines usually 4.  | <b>4. <i>T. terrestris</i></b>                         |
| 3a. Flowers 6-8 mm across. Wings of mericarps up to 4 mm broad.  | <b>1. <i>T. pentandrus</i> var. <i>pentandrus</i></b>  |
| 3b. Flowers 10-12 mm across. Wings of mericarps 5-8 mm broad.  | <b>2. <i>T. pentandrus</i> var. <i>macropterus</i></b> |

1. *Tribulus pentandrus* Forssk. Fl. Aegypt.-Arab. 88. 1775; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 165. 1987; Bhandari, Fl. Indian Desert 82. 1990; Singh & Singh in Hajra *et al.* Fl. India 4 : 52. 1997. *T. alatus* Del. Fl. Aegypt. Illus. 62. 1813; Edgew. & Hook. f. in Hook. f. Fl. Brit. India 1 : 423. 1874; Bhandari, Fl. Indian Desert 87. 1978. *T. longipetalus* Viv. Pl. Egypt. Dec. 10. t. 2. f. 5. 1831.

var. *pentandrus*

Local name : *Bakdha*.

Annual, prostrate to procumbent, densely hairy, greyish-white herbs. Leaves opposite, up to 7 cm long; leaflets 4-6 pairs, 5-10 x 2-4.5 mm, elliptic-oblong, acute at apex, oblique at base, sessile. Stipules 3-4 mm long, ovate-lanceolate, acute, foliaceous. Flowers 6-8 mm across, yellow, axillary, solitary; pedicels up to 15 mm long. Sepals linear-lanceolate, 4-6 x 1.5-2 mm. Petals 4-6 x 2-3 mm, ovate-oblong, wavy at apex.



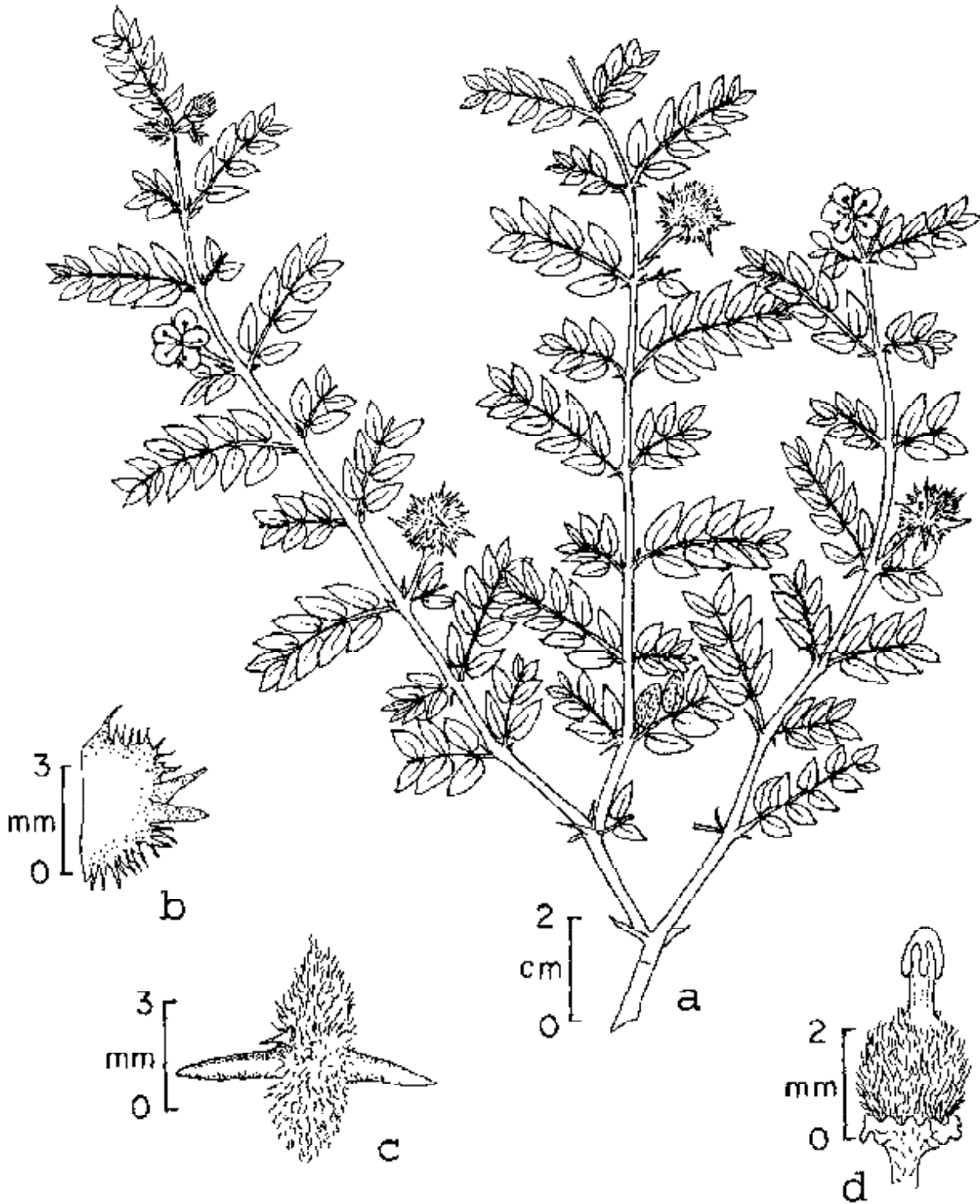


Fig. 6. *Tribulus rajasthanensis* Bhandari & Sharma : a. Habit, b-c. Mericarps, d. Gynoecium.

Stamens 8-10, 3-4 mm long; anthers oblong. Ovary *ca* 1.5 mm across, globose, densely hairy with bulbous-based hairs; style *ca* 1 mm long, stout; stigma 5-rayed. Mericarps 5, pilose, winged; wings 3-4 mm broad, roughly triangular, dentate to serrate. Seeds 2-3, brown.

*Fl. & Fr.*: September-March.

*Ecology* : Common, found in sandy habitats, particularly in plains. *Tribulus terrestris* L., *T. rajasthanensis* Bhandari & Sharma and *Cleome gynandra* L. are the main associates.

*Specimens examined* : Sam, Monika 16544, 16722 (BSJO); Near Ganga, Pandey 7808 (BSJO); DNP enclosure near Miajlar, Pandey 7884 (BSJO).

2. *Tribulus pentandrus* Forssk. var. *macropterus* (Boiss.) Singh & Singh in J. Econ. Taxon. Bot. 6 (1): 159. 1985 & in Hajra *et al.* Fl. India 4 : 52. 1997; Pandey in Shetty & Singh, Fl. Rajasthan 1: 165. 1987. *T. macropterus* Boiss. Diagn. Pl. Or. Nov. ser. 1 (1) : 61. 1843. *T. longipetalus* Viv. subsp. *macropterus* (Boiss.) Maire ex Ozenda & Quezel in Trav. l'Inst. Rech. Sahariennes 14 : 73. 1956; Ghafoor in Nasir & Ali, Fl. West Pakistan 76 : 23. 1974.

Procumbent, densely villous, greyish-green herbs. Leaves 5.5-6 cm long; leaflets 4-6 pairs, 8-10 x 2-3 mm, oblong-elliptic, acute at apex, oblique at base, hairy. Stipules *ca* 3 mm long, ovate, acute. Flowers 1-1.2 cm across, yellow; pedicels more than 1 cm long. Sepals 5-6 x 1-2 mm, lanceolate. Petals 5-6 x 3-4 mm, obovate, slightly emarginate at apex, more or less rounded at base. Stamens 6-9. Mericarps hairy, winged; wings 6-8 mm broad, entire or irregularly dentate.

*Fl. & Fr.*: August-September.

*Ecology* : A dense population of the species can be seen after rains in association with proper variety and *T. terrestris* L. throughout the Park.

*Specimen examined* : Sudasari, Monika 16773 (BSJO).

3. *Tribulus rajasthanensis* Bhandari & Sharma in Bot. Notis. 129 : 367. f. 1. 1977; Bhandari, Fl. Indian Desert 88. f. 30. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 166. 1987; Singh & Singh in Hajra *et al.* Fl. India 4 : 42. 1997.

Local name : *Gokhru*.

Annual or perennial, prostrate to procumbent herbs; branches many from woody root-stock, up to 50 cm long, hirsute. Leaves 2-5 cm long, always unequal at the nodes; leaflets 4-7 pairs, 4-12 x 3-6 mm, oblique, elliptic-oblong to ovate-oblong, pubescent above, villous beneath. Stipules 5-7 x 1-2 mm, subulate, falcate, persistent. Flowers yellow, *ca* 12 mm across, axillary, solitary; pedicels 1-2 cm long. Sepals 5-7 x 1-2 mm, linear-lanceolate, acute, pubescent. Petals 5-7 x 2-5 mm, obovate, cuneate at base. Stamens 10; anthers ovate-oblong, subequal. Ovary *ca* 2 mm across, hairy with bulbous-based hairs; style *ca* 1.5 mm long, cylindrical; stigma pyramidal to triangular. Mericarps 6-7 x 4-5 mm, densely hispid; major spines 2, *ca* 4 mm long; minor spines 20-30, 1-2 mm long (Fig.-6).

*Fl. & Fr.*: July-November.

*Ecology* : Occasional, found in gravelly plains, often forming association with *Tribulus terrestris* L.

*Specimens examined* : Near Kanoi, Monika 16730 (BSJO); Near Miajlar village, Monika 17113 (BSJO).

4. *Tribulus terrestris* L. Sp. Pl. 387, 1753; Edgew. & Hook. f. in Hook. f. Fl. Brit. India 1 : 423, 1874, *pro parte*; Duthie, Fl. Gangetic Plain 1 : 127, 1903; Bhandari, Fl. Indian Desert 89, 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 166, 1987; Singh & Singh in Hajra *et al.* Fl. India 4 : 55, 1997.

Local names : *Gokhru, Kanti.*

Annual, suberect or procumbent herbs; branches sometimes up to 1 m long, silky villous when young, hirsute at age. Leaves opposite, 2-7 cm long, unequal; leaflets 4-8 pairs, 4-11 x 2-7 mm, ovate to elliptic, oblique at base, acute, mucronate at apex. Petioles pilose. Stipules 2-5 x 1-1.5 mm, falcate, lanceolate, hairy. Flowers 8-10 mm across, yellow, solitary, axillary or leaf-opposed; pedicels ca 10 mm long. Sepals 2-4 x 1.5-2 mm, ovate-lanceolate, acute, hirsute, margins scarious and ciliate. Petals 2.5-5 x 1-3 mm, oblong-obovate. Stamens 10, 3-4 mm long; anthers oblong. Ovary ca 1.5 mm across, with stiff, upwardly spreading, bulbous-based hairs; style ca 1 mm long, stout; stigmatic lobes 5-rayed. Fruits 1-1.5 cm across, tuberculate; mericarps 5, 4-8 x 5-7 mm, spiny, each usually with 2 lateral, divergent, acute spines which are inserted about the middle and 2 shorter spines near the base (Plate-21/2).

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Very common, found in sandy habitats in plains as well as on dunes. Common associates are *Cleome viscosa* L., *Tribulus rajasthanensis* Bhandari & Sharma, etc.

*Specimens examined* : Bidna, *Monika* 16517 (BSJO); Sam, *Monika* 16563 (BSJO).

#### 4. ZYGOPHYLLUM L.

*Zygophyllum simplex* L. Mant. Pl. 68, 1767; Edgew. & Hook. f. in Hook. f. Fl. Brit. India 1 : 424, 1874; Bhandari, Fl. Indian Desert 89, f. 31, 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 167, 1987; Singh & Singh in Hajra *et al.* Fl. India 4 : 57, 1997. *Z. portulacoides* Forssk. Fl. Aegypt.-Arab, 88, 1775.

Local name : *Luno, Luni.*

Annual, diffuse, ascending or suberect herbs, 10-20 cm high; branches many, slender, dichotomous, reddish-brown, glabrous. Leaves subsessile, opposite, 1-foliolate, 1-1.8 x 0.1-0.2 cm, cylindrical, obtuse, fleshy. Stipules 2, lanceolate, acute, membranous. Flowers ca 5 mm across, axillary, solitary, yellow; pedicels 2-4 mm long, slender, deflexed in fruits. Sepals 4-5, 1.5-2 x 1-1.5 mm, obovate, obtuse, caducous, cucullate at apex. Petals 5, 2-2.5 x 0.8-1 mm, spatulate, spreading, margins flat. Stamens 8-10, 2-3 mm long, each filament with a bipartite, hyaline scale with slightly notched lobes at its base. Ovary ca 1 mm across, 5-loculed; stigma persistent. Capsules deeply 5-lobed, 2.5-3 mm in diam., obovoid, separating into 5, 3 to 5-seeded cocci. Seeds 0.8-1 x 0.4-0.6 mm, fusiform, smooth, brown (Plate-21/4).

*Fl. & Fr.*: August-January.

*Ecology* : Occasional, found in moist sandy plains and near cultivated fields in association with *Portulaca oleracea* L., *Trianthema triquetra* Rottl. ex Willd., etc.

*Specimens examined* : Schhari, *Monika* 16547 (BSJO); Near Phulia, *Monika* 17150 (BSJO).

*Notes* : Stem colour varies from green to reddish-brown. Pale pink-coloured flowers are also reported in this species.

## 13. GERANIACEAE

*MONSONIA* L.

*Monsonia senegalensis* Guill. & Perr. in Guill. *et al.* Fl. Seneg. Tent. 1 : 131. 1831; Edgew. & Hook. f. in Hook. f. Fl. Brit. India 1 : 427. 1874; Duthie, Fl. Gangetic Plain 1 : 129. 1903; Bhandari, Fl. Indian Desert 91. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 169. 1987; Malhotra in Hajra *et al.* Fl. India 4 : 90. 1997. *Erodium chumbulense* Munro in Wight, Ic. Pl. Ind. Or. 3 (4) : 5. t. 1074. 1846 [as *Monsonia chumbulensis* (Munro) Wight in text]. *Monsonia lawiana* Stocks in Calcutta J. Nat. Hist. 7 : 19. 1847.

Erect, annual herbs; branches diffuse or procumbent, glandular pubescent. Leaves 2-3 x 1.5-2 cm, ovate, repand or toothed along margins, obtuse at apex, subrounded at base, glabrous above, slightly pubescent beneath. Petioles ca 3 cm long, of the radical leaves up to 7 cm long, slender, softly hairy. Stipules lanceolate-subulate, 4-5 mm long, acute, hairy. Flowers pink, ca 2 cm in diam.; peduncles 1 to 2-flowered, sharply deflexed near the apex, slender, hairy, 2-3 cm long, arise from the base. Bracts 2, subulate, hairy. Sepals ca 1 cm long, ovate, awned, densely covered with long hairs. Petals 1-1.2 cm long, 3-nerved, crumpled, scarcely exceeding sepals. Stamens 15, 5-adelphous; filaments dilated and hairy at base. Carpels stipitate, obconic, obliquely truncate, stiff hairy, with 2-3 wrinkles at top, 8-9 mm long; beak 5-8 mm long, rough, hairy.

*Fl. & Fr.*: March-October.

*Ecology*: Rare, found in rocky habitats in association with and under the shade of *Euphorbia caducifolia* Haines.

*Specimen examined*: Along Miajlar road, Shetty 3400 (BSJO).

## 14. SIMAROUBACEAE

*AILANTHUS* Desf. (*nom. cons.*)

*Ailanthus excelsa* Roxb. Pl. Cor. 1 : 24, t. 23. 1795; Bennett in Hook. f. Fl. Brit. India 1 : 518. 1875; Bhandari, Fl. Indian Desert 93. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 176. 1987; Basak in Hajra *et al.* Fl. India 4 : 410. 1997. *Pongelion wightii* Tieghem in Ann. Sci. Nat. Bot. 1 : 277. 1906.

Local name : *Ardu*.

Large, deciduous trees, 10-20 m high, with greenish-white or grey bark. Leaves equally or unequally pinnate, 25-100 cm long, crowded at the end of branches; leaflets 6-14 pairs, alternate or subopposite, oblique at base, acuminate at apex, irregularly serrate, 8-18 x 3-5.5 cm, tomentose when young. Petioles 5-8 cm long; petiolules 1.5-2.5 cm long, with two hairy glands at base. Flowers greenish-yellow, in large, lax, much-branched, hairy panicles. Calyx-lobes ca 1.5 x 1 mm, ovate, triangular. Petals 5, 3-4 mm long, ovate-lanceolate, glabrous. Stamens 10 in male flowers, 2-3 in bisexual flowers and absent in females; filaments glabrous. Ovary sparsely hairy, 2-5 partite. Samaras 4-7 x 1-1.5 cm, oblong to lanceolate, acute at both ends, light brown, twisted at base. Seeds 7-8 x 2-2.5 mm, oblong, glabrous, brown.

*Fl. & Fr.*: December-July.

*Ecology*: Planted near villages. It is a fast growing tree.

*Specimen examined*: Guman Singh-ki-dhani, Monika 16542 (BSJO).

## 15. BURSERACEAE

*COMMIPHORA* N. Jacquin (*nom. cons.*)

*Commiphora wightii* (Arn.) Bhandari in Bull. Bot. Surv. India 6 : 327. 1964 & Fl. Indian Desert 95. f. 34. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 178. 1987; Chithra & Henry in Hajra *et al.* Fl. India 4 : 445. 1997. *Balsamodendron wightii* Arn. in Ann. Nat. Hist. 3 : 86. 1839. *B. mukul* Hook. ex Stocks in Kew J. Bot. 1 : 259. t. 8. 1849; Bennett in Hook. f. Fl. Brit. India 1 : 529. 1875. *Commiphora mukul* (Hook. ex Stocks) Engl. in DC. Monogr. Phan. 4 : 12. 1883.

Local name : *Guggal*.

Much-branched, deciduous shrubs, up to 2 m high, with silvery, papery bark easily peeling; young parts glandular-pubescent; branches knotty and crooked, ending in thorns. Leaves 1 to 3-foliolate; leaflets subsessile, 1-2 x 0.5-0.8 cm, ovate to rhomboid-ovate, glaucous, cuneate at base, almost entire or serrate near the apex, lateral leaflets much smaller when present. Flowers solitary or in 2 to 3-flowered fascicles at the end of branches, red or pinkish-white, sessile. Bracts 2. Calyx tubular-campanulate, glandular hairy; lobes 4-5, triangular. Petals 4-5, 3-5 x 1-1.2 mm, broadly linear, reflexed at apex. Stamens 8, rarely 10, alternating long and short. Ovary oblong-ovoid, attenuated into the style; stigma 2-lobed. Drupes ca 6 mm in diam., ovoid, shortly beaked, red when ripe; mesocarp yellow (Plate-19/4).

Fl.: January – May; Fr.: June – December.

Ecology : Very rare, found in gravelly and rocky habitats forming thick patches of its own.

Specimens examined : 6 km from Khuri, *Monika* 16533, 16682 (BSJO); Near Khuri, *Monika* 16783 (BSJO); Along Jaisalmer road, *Shetty* 3398 (BSJO).

## 16. MELIACEAE

*AZADIRACHTA* A. Juss.

*Azadirachta indica* A. Juss. in Mem. Mus. Hist. Nat. Paris 19 : 221. t. 13. f. 5. 1830; Bhandari, Fl. Indian Desert 96. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 179. 1987. *Melia azadirachta* L. Sp. Pl. 385. 1753; Hiern in Hook. f. Fl. Brit. India 1 : 544. 1875; Duthie, Fl. Gangetic Plain 1 : 150. 1903.

Local name: *Neem*.

Tall, evergreen trees; bark greyish-black, slightly longitudinally furrowed. Leaves imparipinnate, 20-35 cm long; leaflets 7-17, 4-8 x 1.5-1.8 cm, ovate-lanceolate, acute to acuminate at apex, oblique at base, serrate, glabrous. Flowers white, fragrant, in 10-22 cm long, axillary panicles. Bracts caducous. Calyx 3-4 mm long; lobes ovate-suborbicular, puberulous outside, glabrous inside. Petals 5-6 mm long, oblanceolate, puberulous outside, ciliolate. Staminal column 4-5 mm long, dilated at apex. Ovary 3-celled, glabrous; stigma 3-toothed at apex. Drupes 8-15 mm in diam., ovoid-oblong, smooth, yellow when ripe. Seeds ellipsoid, glabrous, whitish-brown, hard.

Fl. & Fr.: December-May.

Ecology: Planted by the local inhabitants near habitations.

Specimen examined: Near Khuri, *Monika* 16618 (BSJO).

## 17. RHAMNACEAE

## ZIZIPHUS Mill.

- |   |                         |
|---|-------------------------|
| 1a. Erect trees. Drupes more than 1.5 cm in diameter.                                       | 1. <i>Z. mauritiana</i> |
| 1b. Diffuse, much-branched shrubs. Drupes less than 1.2 cm in diameter.                     | 2                       |
| 2a. Leaves truncate at the apex and glabrous on the upper surface. Fruits yellow when ripe. | 3. <i>Z. truncata</i>   |
| 2b. Leaves rounded at apex and pubescent above. Fruits red when ripe.                       | 2. <i>Z. nummularia</i> |

1. *Ziziphus mauritiana* Lam. Encycl. 3 : 319. 1789; Bhandari, Fl. Indian Desert 99. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 185. 1987; Bhandari & Bhansali in Singh *et al.* Fl. India 5 : 233. 2000. *Rhamnus jujuba* L. Sp. PL. 194. 1753. *Ziziphus jujuba* (L.) Lam. Lc. 3 : 318. 1789, non Mill. 1768; Lawson in Hook. f. Fl. Brit. India 1 : 632. 1875.

Local name : *Bor*.

Small, much-branched, evergreen trees, 1-3.5 m high; bark dark grey or nearly black, with deep vertical cracks, reddish and fibrous inside; younger parts rusty tomentose; stipular prickles in pairs, 1.5-2 cm long, one of them recurved; nodes slightly enlarged around the leaf-scars. Leaves alternate, suborbicular-ovate to ovate-elliptic, 3-6 x 1.5-3.5 cm, rounded at both ends, entire, pubescent above, tomentose to densely brown or silky-white beneath, 3-nerved at base. Petioles 1-1.5 cm long, pubescent. Flowers in 10 to 12-flowered, axillary fascicles or in short cymes, greenish-yellow or white; pedicels 2-5 mm in flowers. Calyx-lobes glabrous within, tomentose outside. Petals 5, 1-1.5 mm long, spatulate, deflexed within calyx-lobes. Stamens enclosed in the petals. Disc distinctly 10-grooved. Ovary half sunken in disc; styles 2, connate for half of the length. Drupes 1.5-2.8 cm in diam., 1-seeded, globose, yellow-orange when ripe. Seeds ca 1 cm across, compressed, light brown; stone 1 to 2-celled (Plate-21/3).

Fl. & Fr.: October-March.

Ecology : Found in sandy plains in association with *Calotropis procera* (Ait.) R. Br., *Capparis decidua* (Forssk.) Edgew., etc.

Specimens examined : Near Ganga, Monika 16628 (BSJO); Miajlar, Monika 16796 (BSJO); Satto village, Pandey 7887 (BSJO).

2. *Ziziphus nummularia* (Burm. f.) Wight & Arn. Prodr. 162. 1834; Lawson in Hook. f. Fl. Brit. India 1 : 633. 1875; Bhandari, Fl. Indian Desert 99. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 185. 1987; Bhandari & Bhansali in Singh *et al.* Fl. India 5 : 233. 2000. *Rhamnus nummularia* Burm. f. Fl. Ind. 61. 1768. *Ziziphus roundifolia* Lam. Encycl. 3 : 319. 1789; Duthie, Fl. Gangetic Plain 1 : 164. 1903.

Local names : *Bor*, *Bordi*.

Shrubs, 1-2 m high, sometimes tree-like and up to 3.5 m or more tall, with widely divaricate, flexuous, zigzag branches; young branches tomentose; stipular prickles paired, one straight, slender and very sharp, nearly as long as petiole, other much shorter, hooked, bent downwards. Leaves 1.5-1.8 x 0.8-1.5 cm, ovate-orbicular, rounded at both ends, tomentose bothsides, basally 3-nerved and with few prominent lateral nerves. Petioles 5-10 mm long, tomentose. Flowers greenish-white, in axillary, pubescent cymes. Calyx-lobes 1.5-2 mm long, deltoid, acute, keeled near to the base, glabrous within, pubescent without. Petals 1-1.5 mm long, obovate, rounded at apex, margins convolute. Stamens 0.8-1.2 mm long; filaments deflexed. Styles 2, connate



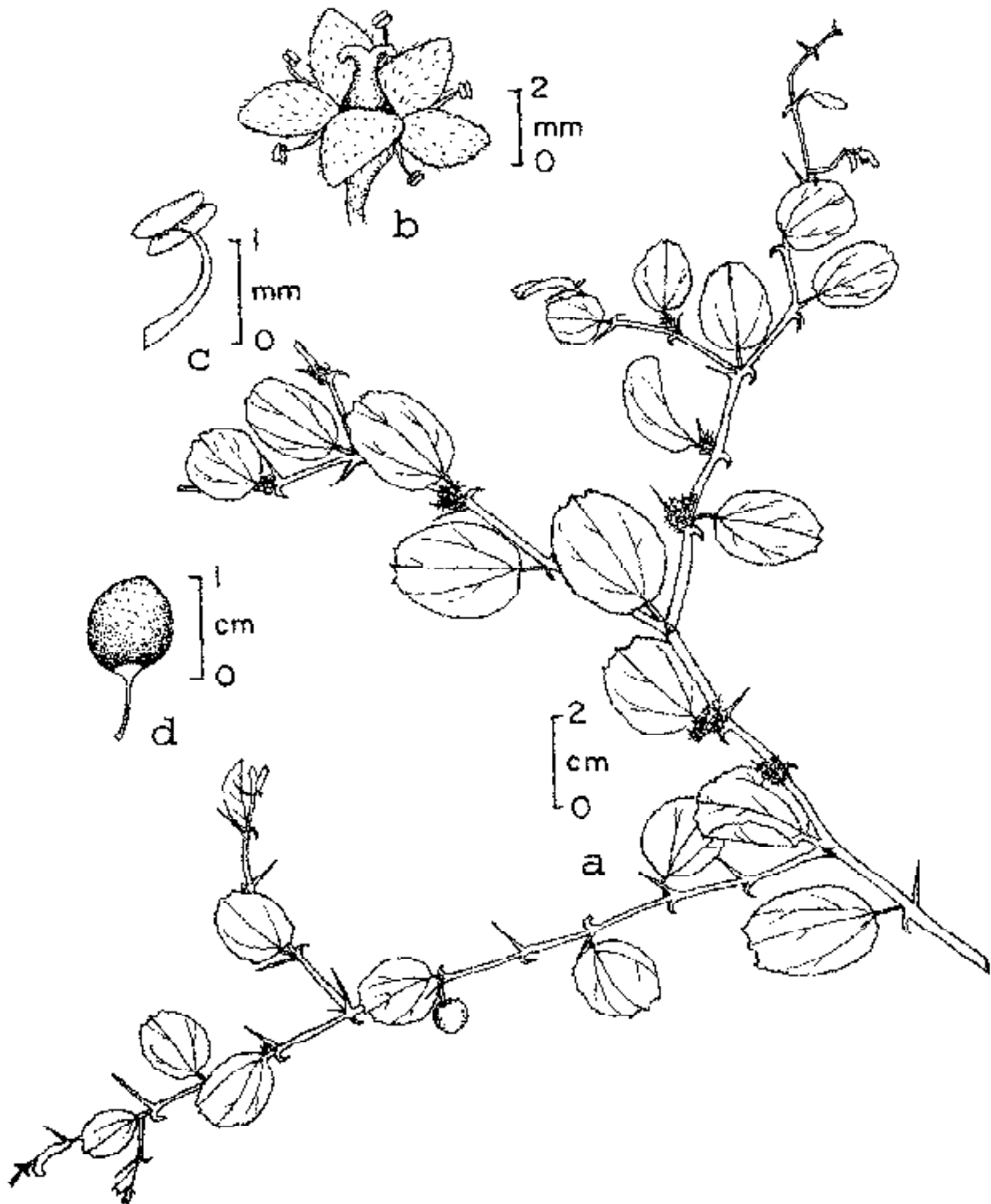


Fig. 7. *Ziziphus truncata* Blatt. & Hallb. : a. Habit, b. Flower, c. Stamen, d. Fruit.

up to the mid portion. Disc 10-lobed, pitted. Drupes 8-10 mm in diam., globose, glabrous, shining red when ripe, 1-seeded.

*Fl. & Fr.*: August - March.

*Ecology* : Common, found in the sandy plains as well as on dunes; also grows in cultivated fields. It often makes association with *Calotropis procera* (Ait.) R. Br., *Capparis decidua* (Forssk.) Edgew., etc.

*Specimens examined* : Nimba, Monika 16511 (BSJO); Miajlar, Monika 16657 (BSJO); Ganga, Pandey 7817 (BSJO).

3. *Ziziphus truncata* Blatt. & Hallb. in J. Bombay Nat. Hist. Soc. 26 : 234. 1918; Bhandari. Fl. Indian Desert 100. 1978; Pandey in Shetty & Singh, Fl. Rajasthan I : 187. 1987; Bhandari & Bhansali in Singh *et al.* Fl. India 5 : 242. 2000.

Small shrubs, with divaricate branches; young parts chestnut-coloured, downy; stipular spines 2, up to 1 cm long, one straight and shorter, other longer and recurved. Leaves alternate, 1.5-3.5 x 1-2.8 cm, coriaceous, serrulate, orbiculate, glabrous above, slightly pubescent beneath, 3-nerved at base, truncate and irregularly dentate at apex. Petioles 3-4 mm long, puberulous. Flowers 3-5 mm across, white, in axillary, sessile, tomentose cymes; pedicels 3-3.5 mm long. Calyx-lobes 2-2.5 mm long, deltoid, acute, pubescent outside, glabrous inside. Petals 1.5-1.8 mm long, spatulate, rounded at apex. Stamens ca 1.5 mm long; filaments acicular. Styles 2, connate, divergent near apex. Disc 10-grooved. Fruits 6-8 mm in diam., globose, glabrous, yellow when ripe, 1-seeded (Fig.-7).

*Fl. & Fr.*: October-March.

*Ecology* : Very rare, found in sandy plains in association with *Capparis decidua* (Forssk.) Edgew., *Ziziphus nummularia* (Burm. f.) Wight & Arn., etc. Endemic to the desert.

*Specimens examined* : Miajlar, Monika 17105 (BSJO); 8 km from Sam along Jaisalmer road, Shetty 2355 (BSJO).

## 18. MORINGACEAE

### *MORINGA* Adans.

*Moringa concanensis* Nimmo ex Dalz. & Gibs. Bombay Fl. 311. 1861; Hook. f. Fl. Brit. India 2 : 45. 1876; Duthie, Fl. Gangetic Plain 1 : 93. 1903; Bhandari, Fl. Indian Desert 102. 1978; Pandey in Shetty & Singh, Fl. Rajasthan I : 196. 1987; Uniyal in Singh *et al.* Fl. India 5 : 515. 2000.

Local name : *Sargu*.

Large trees, 6-8 m tall, with rough, greyish-brown trunk. Leaves 25-50 cm long, usually bipinnate; leaflets 9-15, 1.5-3.5 x 1.5-2.5 cm, broadly elliptic to obovate or suborbicular, rounded at base and apex, darker above, paler beneath, nerves fairly marked. Petiolules up to 2.5 mm long, jointed near the apex. Flowers creamish-white, in divaricate, lax panicles; pedicels 8-10 mm long, puberulous. Bracts ca 1 mm long, caducous. Calyx 8-10 mm long; lobes oblong, whitish, thinly tomentose, reflexed. Petals oblong-spatulate, reddish or pinkish streaked near the base. Stamens 5; filaments hairy at base; staminodes 4-5. Fruits 20-25 cm long, acutely triquetrous, slightly constricted between seeds. Seeds 3-winged, blackish-brown.

*Fl. & Fr.*: Most part of the year.

*Ecology* : Rare, collected only from the sand-dunes near Khuri where it grows in association with *Capparis decidua* (Forssk.) Edgew., *Calotropis procera* (Ait.) R. Br., etc.

*Specimens examined* : 6 km from the Khuri, Monika 16532 (BSJO); Near Khuri along Miajkar road, Shetty 6143 (BSJO).

## 19. FABACEAE

1a. Stamens 1-adelphous.	3. <i>Crotalaria</i>
1b. Stamens 2-adelphous.	2
2a. Stamens in 2 bundles of 5 each.	L. <i>Aeschynomene</i>
2b. Stamens in 2 bundles of 9+1.	3
3a. Pods jointed.	2. <i>Alysicarpus</i>
3b. Pods not jointed.	4
4a. Climbing or twining herbs.	5
4b. Erect or prostrate herbs or undershrubs.	6
5a. Leaves gland-dotted beneath. Pods 1 to 2-seeded.	6. <i>Rhynchosia</i>
5b. Leaves not gland-dotted. Pods more than 2-seeded.	8. <i>Vigna</i>
6a. Anthers apiculate.	5. <i>Indigofera</i>
6b. Anthers mucicous or obtuse.	7
7a. Leaves or leaflets entire.	7. <i>Tephrosia</i>
7b. Leaves or leaflets dentate, toothed or serrate.	4. <i>Cullen</i>

### 1. AESCHYNOMENE L.

*Aeschynomene indica* L., Sp. Pl. 713. 1753; Baker in Hook. f. Fl. Brit. India 2 : 151. 1876; Duthie, Fl. Gangetic Plain 1 : 270. 1903; Bhandari, Fl. Indian Desert 105. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 202. 1987; Sanjappa, Legumes India 75. 1992. *Hedysarum neli-tali* Roxb. Fl. Ind. 3 : 365. 1832. *Smithia aspera* Roxb. Fl. Ind. 3 : 343. 1832. *Aeschynomene kashmiriana* Camb. in Jacq. Voy. Bot. 40, t. 48. 1844.

Erect, annual herbs, up to 1.5 m high; stem terete, warty, glabrous. Leaves imparipinnate, 2-8 cm long, glabrous; leaflets alternate or subopposite, 15-71, 2-7.5 x 2-3 mm, linear-oblong, mucronate, oblique at base, entire, glabrous. Petioles and rachis jointed, slightly glandular hairy. Stipules 6-8 mm long, lanceolate, acuminate, reddish. Flowers yellowish-white, in 1 to 4-flowered, axillary, viscid racemes; peduncles and pedicels 2-3 cm long, with bulbous-based hairs. Bracts 3.5-4.5 mm long, ovate, acuminate, serrate; bracteoles 3-4 mm long, lanceolate. Calyx 4-6 mm long, glabrous; teeth acute. Corolla-standard 7-8 x 4-6 mm, elliptic, entire, purple-veined; wings ca 6 x 3 mm; claw 1-1.5 mm long; keel ca 6 x 2 mm, entire. Stamens 6-7 mm long; anthers yellow. Pods 3-4 cm long, flat, indented on the lower suture, jointed, straight, mucronate. Seeds 4-10, ca 4.5 x 3.5 mm, black, hooked at one end, smooth.

*Fl. & Fr.*: August - November.

*Ecology* : Occasional, found in rather moist sandy habitats in association with *Heliotropium* spp.

*Specimen examined* : Near Daw village, *Monika* 16788 (BSJO).

## 2. *ALYSICARPUS* Desv. (*nom. cons.*)

- |  |                            |
|--|----------------------------|
| 1a. Upper leaves 3-foliolate, the lower ones 1 and 3 foliolate intermixed. | 1. <i>A. heterophyllus</i> |
| 1b. All leaves 1-foliolate.  | 2                          |
| 2a. Stem with spreading hairs. Pods moniliform.                            | 2. <i>A. monilifer</i>     |
| 2b. Stem glabrescent. Pods turgid, not moniliform.                         | 3. <i>A. vaginalis</i>     |

1. *Alysicarpus heterophyllus* (Baker) Jafri & Ali in *Biologia* 12 : 33. 1966; Singh in Shetty & Singh, *Fl. Rajasthan* 1 : 205. 1987; Bhandari, *Fl. India Desert* 99. 1990; Sanjappa, *Legumes India* 78. 1992. *A. vaginalis* (L.) DC. var. *heterophyllus* Baker in Hook. f. *Fl. Brit. India* 2 : 158. 1876.

Erect, diffusely branched herbs, up to 90 cm high, woody at base. Leaves 1 to 3-foliolate; leaflets 3-7 x 0.2-1 cm, middle one longer than the laterals, lanceolate to oblong-lanceolate, acute at apex, rounded at base. Petiolules up to 1 mm long. Stipules ca 4 mm long, scarious, lanceolate. Flowers pale-pink, distantly paired in 6 to 20-flowered racemes; peduncles filiform. Calyx 2.5-3 mm long, equal or longer to first joint of pod; teeth longer than the tube, linear-lanceolate, acute. Pods constricted between seeds, not moniliform; joints 3-5, longer than broad, tetragonal, reticulately veined, pubescent, 1-seeded (Fig-8).

*Fl. & Fr.*: September-November.

*Ecology* : Rare, found in sandy plains.

*Specimen examined* : Near Kanoi village, *Shetty* 3447 (BSJO).

2. *Alysicarpus monilifer* (L.) DC. *Prodr.* 2 : 353. 1825; Baker in Hook. f. *Fl. Brit. India* 2 : 157. 1876; Duthie, *Fl. Gangetic Plain* 1 : 276. 1903; Bhandari, *Fl. Indian Desert* 107. 1978; Singh in Shetty & Singh, *Fl. Rajasthan* 1 : 206. 1987; Sanjappa, *Legumes India* 79. 1992. *Hedysarum moniliferum* L. *Mant.* 1 : 102. 1767.

Perennial or annual, procumbent or prostrate, deep-rooted herbs; branches many, clothed with deciduous, bristly, bulbous-based hairs when young. Leaves 1-foliolate; leaflets 0.8-2.5 x 0.6-1.5 cm, oblong-elliptic to suborbicular, cordate or rounded at base, mucronate at apex, glabrous above, hairy beneath on the nerves. Petioles 2.5-5 mm long. Stipules up to 5 mm long, lanceolate, scarious, acute, closely appressed to the stem. Flowers pinkish-purple, in axillary and terminal, 2 to 10-flowered racemes longer than the leaves. Calyx ca 4 mm long, hairy; tube ca 1.5 mm long; teeth narrow, lanceolate, striate, acute. Corolla 5-6 mm long. Pods up to 2.5 cm long, moniliform, 2 to 8-jointed; joints globose, turgid, 1-seeded, downy with minute, hooked hairs. Seeds oval, flat, smooth, brown.

*Fl. & Fr.*: August-November.

*Ecology* : Occasional, found in the sandy plains and near cultivated fields in association with *Gisekia pharnaceoides* L., *Citrullus colocynthis* (L.) Schrad., etc.

*Specimen examined* : Near Sam, *Monika* 16717 (BSJO).

3. *Alysicarpus vaginalis* (L.) DC. *Prodr.* 2 : 353. 1825; Baker in Hook. f. *Fl. Brit. India* 2 : 158. 1876, *excl. var. heterophyllus*; Duthie, *Fl. Gangetic Plain* 1 : 277. 1903; Bhandari, *Fl. Indian Desert* 108. 1978;

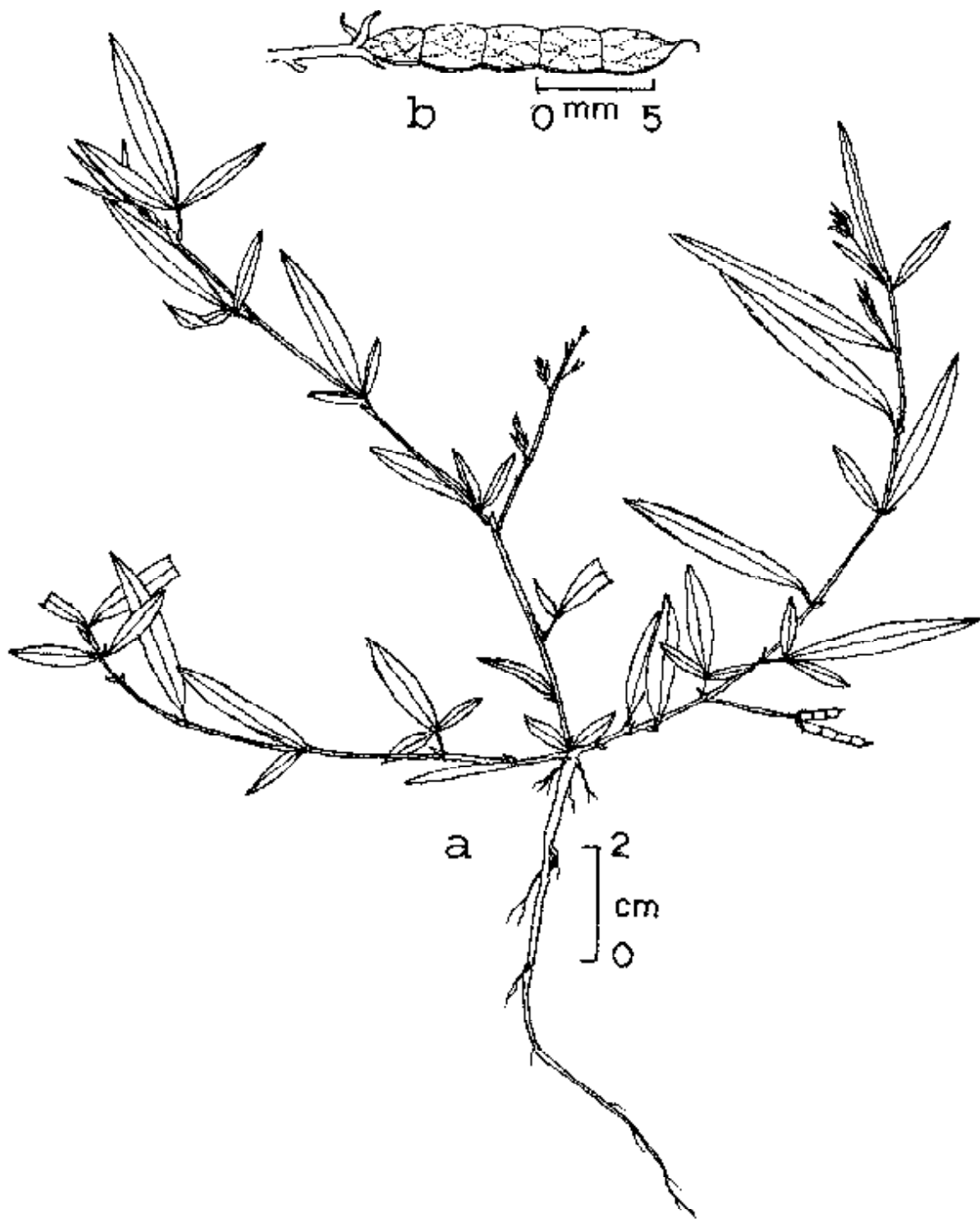


Fig. 8. *Alysicarpus heterophyllus* (Baker) Jafri & Ali : a. Habit, b. Pod.

Singh in Shetty & Singh, Fl. Rajasthan 1 : 208. 1987; Sanjappa, Legumes India 81. 1992. *Hedysarum vaginale* L. Sp. Pl. 746. 1753. *H. nummularifolium* auct. non L. 1753; Willd. Sp. Pl. 3 : 1173. 1802. *H. cylindricum* Lam. Encycl. 6 : 400. 1805. *Alysicarpus cylindricus* (Lam.) Desv. Ann. Linn. Soc. Paris 4 : 301. 1826. *A. rupicola* Edgew. J. Asiat. Soc. Bengal 21 : 170. 1853.

Local name : *Sarui*.

Perennial or annual, procumbent or ascending herbs, 50-70 cm high; stem slender, pubescent with minute, white, spreading hairs mixed with long, brown, appressed, sulcate hairs. Leaves 1-foliolate; leaflets 2-5.5 x 0.4-2 cm, lanceolate or oblong to broadly ovate, obtuse at apex, glabrous above, finely hairy beneath. Petiolules 3-5 mm long, stripped. Stipules 6-8 mm long, ovate-lanceolate, greyish-green, closely appressed to stem. Flowers pink, in axillary, leaf-opposed or terminal, 6 to 12-flowered racemes longer than the leaves. Calyx equalling or little longer to the first joint of pod, 4-5 mm long, straw-coloured; tube 1-1.5 mm long; teeth linear, exceeding the tube. Corolla included. Pods 2-3 x 0.2-0.3 cm, on ca 3 mm long stalk, minutely aculeate, hairy, slender, 4 to 8-jointed; joints turgid, reticulately veined, longer than broad, pubescent with long spreading hairs at apex. Seeds subglobose, brown (Plate-18/3).

Fl. & Fr.: September-November.

Ecology : Occasional, found in sandy plains and as a weed in cultivated fields.

Specimen examined : DNP, Tiwari 872 (BSJO).

### 3. *CROTALARIA* L.

- |  |                          |
|--|--------------------------|
| 1a. Prostrate herbs. Flowers axillary, solitary. Calyx persistent. Pods flattened.     | 2. <i>C. hebecarpa</i>   |
| 1b. Erect herbs or undershrubs. Flowers in racemes. Calyx not persistent. Pods turgid. | 2                        |
| 2a. Leaves simple. Pods silky hairy, 1-seeded.   | 1. <i>C. burhia</i>      |
| 2b. Leaves 3-foliolate. Pods pubescent, 2-seeded.                                      | 3. <i>C. medicaginea</i> |

1. *Crotalaria burhia* Buch.-Ham. ex Benth. in Hook. Lond. J. Bot. 2 : 474. 1843; Baker in Hook. f. Fl. Brit. India 2 : 66. 1876; Duthie, Fl. Gangetic Plain 1 : 202. 1903; Bhandari, Fl. Indian Desert 111. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 216. 1987; Sanjappa, Legumes India 117. 1992.

Local name : *Sinia*.

Undershrubs, up to 1 m high, with numerous, stiff, adpressedly pubescent branches. Leaves variable, subsessile, 1-2.5 x 0.4-0.5 cm, lower larger, upper very small, oblong, pale green, silky hairy. Flowers yellow, in terminal, 6 to 12-flowered, 6-8 cm long racemes. Bracteoles 2, lanceolate. Calyx 6-7 mm long, hairy; tube ca 2 mm long; teeth lanceolate, acute, yellowish-green. Corolla slightly exerted; standard ca 7 x 5 mm, ovate, obtuse, with 1-1.5 mm long, woolly claw and 2 pockets at base; wings ca 6 x 2 mm, oblong; keel ca 7.5 x 5 mm. Stamens 10; anther-lobes heteromorphous. Ovary glabrous or hairy on one side; style ca 5 mm long, slightly swollen at base; stigma oblique. Pods ca 5 x 4 mm, oblong, villous, beaked, 1-seeded. Seeds shining, 2-3 x 1.5-2 mm, obliquely semilunar, compressed, black.

Fl. & Fr.: August-January.

Ecology : Common, found in sandy upland areas forming associations with *Lasiurus scindicus* Henr., *Leptadenia pyrotechnica* (Forssk.) Decne., etc. on stabilized sand-dunes.



*Specimens examined* : Sam, Monika 16515 (BSJO); Near Kanoi, Monika 16607 (BSJO); Near Girab, Monika 17138 (BSJO).

2. *Crotalaria hebecarpa* (DC.) Rudd. in *Phytologia* 54 : 28. 1983; Sanjappa, *Legumes India* 121. 1992. *Hallia hirta* Willd. Sp. Pl. 3 : 1169. 1802, non *Crotalaria hirta* Willd. 1803, nec Leg. 1816, nec Roth 1821. *Goniogyna hebecarpa* DC. Ann. Sci. Nat. Paris 4 : 92. 1825. *G. leiocarpa* DC. Ann. Sci. Nat. Paris 4 : 92. 1825, non *Crotalaria leiocarpa* Vog. 1843. *Heylandia hebecarpa* DC. Ann. Sci. Nat. Paris 4 : 92. 1825, based on same collection as *Goniogyna hebecarpa* DC. *Heylandia leiocarpa* DC. Prod. 2 : 213. Nov. 1825, non *Crotalaria leiocarpa* Vog. 1843. *H. latebrosa* DC. Mem. Legum. 6 : 201. Nov. 1826; Baker in Hook. f. Fl. Brit. India 2 : 65. 1876. *Crotalaria uniflora* Koen ex Roxb. Fl. Ind. 3 : 271. 1832, non Baker 1871. *Goniogyna hirta* (Willd.) Ali in *Taxon* 16 : 463. 1967; Bhandari, Fl. Indian Desert 114. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 234. 1987.

Local name : *Gorakh-buti*.

Annual, much-branched, prostrate herbs; branches dichotomous, radiating, terete, slender, clothed with long hairs. Leaves subsessile, simple, 8-20 x 3-15 mm, ovate, obliquely cordate at base with rounded lobes, subacute at apex, finely hairy on both surfaces. Flowers yellow with reddish lines, axillary, solitary, subsessile. Calyx 2.5-3 mm long, pilose; tube shorter than teeth. Corolla much exerted; standard 5-6 mm long, with a line of long hairs on the back; wings and keel ca 5 mm long. Anthers dimorphic. Pods pale brown, 4-5 x 2-3 mm, silky hairy, slightly flattened, surrounded by persistent calyx at base and tipped by style, 1-seeded (Plate-13/1).

*Fl. & Fr.*: August - November.

*Ecology* : Occasional, found in the sandy plains in moist places.

*Specimens examined* : Mathuo-ki-basti, Monika 16590 (BSJO); Near Sundra, Monika 17164 (BSJO).

3. *Crotalaria medicaginea* Lam. Encycl. 2 : 201. 1786; Baker in Hook. f. Fl. Brit. India 2 : 81. 1876; Duthie, Fl. Gangetic Plain 1 : 207. 1903; Bhandari, Fl. Indian Desert 111. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 218. 1987; Sanjappa, *Legumes India* 124. 1992. *C. neglecta* Wight & Arn. Prodr. 192. 1834. *C. luxurians* Benth. in Hook. Lond. J. Bot. 2 : 578. 1843. *C. medicaginea* Lam. var. *neglecta* (Wight & Arn.) Baker & var. *luxurians* (Benth.) Baker in Hook. f. *l.c.* 2 : 81. 1876.

Local name : *Gugurto*.

Annual, erect, much-branched herbs, up to 70 cm high, with woody root-stock; stem subangular, minutely adpressed hairy. Leaves 3-foliolate; leaflets 1.5-3 x 0.6-1 cm, obovate or obovate-oblong, retuse, glabrous above, more or less silky beneath. Petioles 6-10 mm long; petiolules 1.5-2 mm long. Stipules filiform, 2-3 mm long. Racemes terminal and leaf-opposed, 2 to 15-flowered. Flowers yellow. Bracts linear-subulate, 1-1.2 mm long, minutely pubescent. Calyx 2-3 mm long, campanulate, silky hairy outside; teeth triangular, ca 1.5 mm long, acute. Corolla 4-4.5 mm long. Pods ca 4 mm long, obliquely subglobose, pubescent, beaked with persistent styler base. Seeds 2, 1.5-1.8 mm long, suborbicular, compressed, glabrous, brown.

*Fl. & Fr.*: August-December.

*Ecology* : Found in sandy plains in association with *Cleome viscosa* L., *Cenchrus* spp., *Tribulus terrestris* L., etc.

*Specimen examined* : Near Berisiyala, Monika 16792 (BSJO).

4. *CULLEN* Medik.

*Cullen plicata* (Delile) Stirton in Bothalia 13 : 317. 1981; Sanjappa, Legumes India 132. 1992. *Psoralea plicata* Delile, Fl. Egypt. 252. t. 27. f. 3. 1812; Baker in Hook. f. Fl. Brit. India 2 : 103. 1876; Raizada, Suppl. Duthie, Fl. Gangetic Plain 57. 1976; Singh in Shetty & Singh, Fl. Rajasthan 1 : 252. 1987. *P. odorata* Blatt. & Halib. J. Bombay Nat. Hist. Soc. 26 : 238. 1918; Bhandari, Fl. Indian Desert 123. 1978.

Undershrubs, up to 60 cm high; stem pubescent, gland-dotted, much-branched from base. Leaves 3-foliolate; leaflets 1.5-2.5 x 0.6-2 cm, oblanceolate to obovate or linear-oblong, terminal larger than laterals, irregularly toothed, adpressedly hairy, gland-dotted beneath, prominently veined. Petioles 1.5-2 cm long, argenteo-canescens. Stipules 2-3 mm long, triangular, acute, silvery-white, gland-dotted. Flowers purple, solitary or fascicled in axillary racemes; pedicels ca 1 mm long, hirsute. Bracts minute, ovate, sparsely hairy. Calyx 2.5-3 mm long, silvery hairy outside; tube 1-1.5 mm long; teeth ovate, triangular, acute. Corolla slightly longer than calyx, 3.5-4 mm long; standard broadly obovate, emarginate; wings oblong, oblique. Stamens connate at base. Ovary glabrous; style compressed; stigma minute. Pods 4-4.5 x 2-2.5 mm, ovate, glandular hairy, brown, 1-seeded. Seeds ovate, adherent to pericarp, brown.

*Fl. & Fr.*: August-November.

*Ecology* : Rare, found in gravelly habitats and near stream-beds in association with *Glinus lotoides* L.

*Specimens examined* : Near Sundra, *Monika* 16706 (BSJO); Bandera, *Monika* 17128 (BSJO).

5. *INDIGOFFERA* L.

- |   |                           |
|---|---------------------------|
| 1a. Leaves simple.  | 2                         |
| 1b. Leaves compound.  | 3                         |
| 2a. Leaves ovate-elliptic to cordate. Pods longer than broad, cylindrical-oblong, usually 2-seeded. | 2. <i>I. cordifolia</i>   |
| 2b. Leaves linear. Pods globose, 1-seeded.  | 4. <i>I. linifolia</i>    |
| 3a. Pods quite flat, papery.  | 3. <i>I. hochstetteri</i> |
| 3b. Pods cylindrical, turgid.   | 4                         |
| 4a. Leaves 3-foliolate.   | 6. <i>I. oblongifolia</i> |
| 4b. Leaves more than 3-foliolate.   | 5                         |
| 5a. Leaflets alternate.   | 6                         |
| 5b. Leaflets opposite.  | 1. <i>I. argentea</i>     |
| 6a. Flowers in axillary, sessile or shortly peduncled, head-like spikes shorter than leaves.        | 7                         |
| 6b. Flowers in axillary, elongate racemes shorter than leaves.                                      | 6. <i>I. oblongifolia</i> |
| 7a. Pods 2-seeded.  | 5. <i>I. linnaei</i>      |
| 7b. Pods 3 to 4-seeded.   | 7. <i>I. sessiliflora</i> |

1. *Indigofera argentea* Burm. f. Fl. Ind. 171. 1768, non L. 1771; Bhandari, Fl. Indian Desert 115. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 237. 1987; Sanjappa, Legumes India 184. 1992 & in Hajra *et al.* Fl. India Fasc. 21 : 12. 1995. *I. semitrijuga* Forssk. var. *tetrasperma* DC. Prodr. 2 : 230. 1825. *I. semitrijuga auct.* non Forssk. 1775; Baker in Hook. f. Fl. Brit. India 2 : 98. 1876.

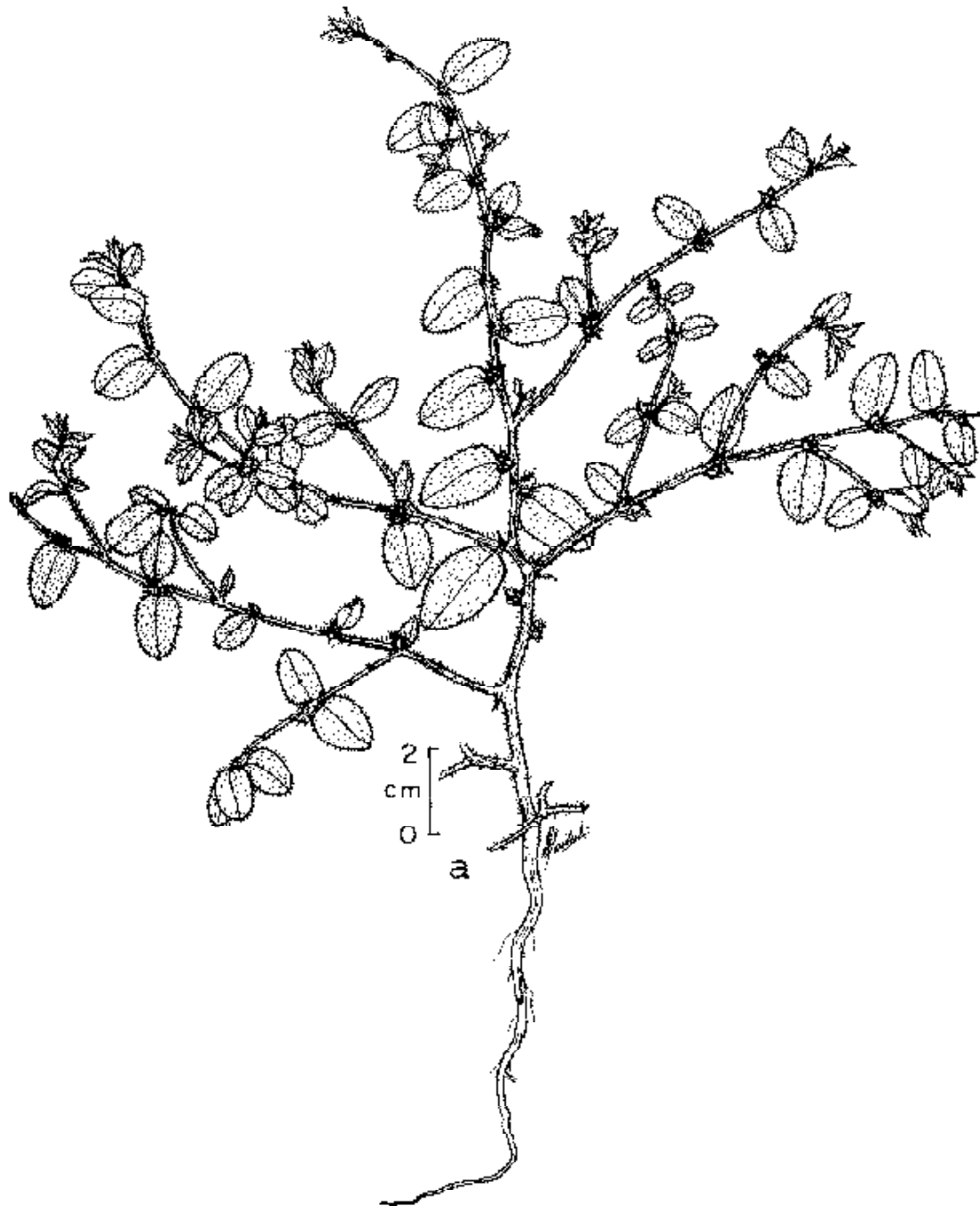


Fig. 9. *Indigofera cordifolia* Heyne ex Roth : a. Habit.

Local name : *Neelo-bekario*.

Perennial undershrubs, 30-60 cm high; branches many, terete, diffuse from base, argenteo-canescens. Leaves 1.5-3.5 cm long; leaflets 3-7, opposite, 3.5-5.5 x 2-3.5 mm, obovate, rounded at base, obtuse at apex, silvery adpressed pubescent on both surfaces. Stipules 2-2.5 mm long, pubescent outside. Petioles 8-10 mm long; petiolules ca 1 mm long. Racemes 1-3 cm long, axillary, 6 to 12-flowered. Flowers pinkish-red, ca 5 mm across. Bracts ca 1 mm long, pubescent, caducous. Calyx 1-1.7 mm long, silvery pubescent outside; teeth linear-lanceolate, longer than the tube. Corolla-standard 4-5 x 4 mm, obovate, canescens outside; wings ca 4 mm long; keel 3-4 mm long. Ovary sparsely hairy. Pods 8-15 x 2-2.5 mm, turgid, mucronate, torulose, adpressed grey pubescent, 4 to 6-seeded. Seeds ca 1 mm in diam., globose-ovoid, reddish-brown, smooth or minutely pitted.

*Fl. & Fr.*: August-January.

*Ecology* : Found in sandy plains and sometimes on stabilized dunes. Main associates are *Heliotropium subulatum* (Hochst. ex DC.) Vatke, *Convolvulus prostratus* Forssk., etc.

*Specimen examined* : Near Miajlar, Monika 16703 (BSJO).

2. *Indigofera cordifolia* Heyne ex Roth, Nov. Pl. Sp. 357. 1821; Baker in Hook. f. Fl. Brit. India 2 : 93. 1876; Duthie, Fl. Gangetic Plain 1 : 250. 1903; Bhandari, Fl. Indian Desert 117. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 239. 1987; Sanjappa, Legumes India 187. 1992 & in Hajra *et al.* Fl. India Fasc. 21 : 45. 1995.

Local name : *Bekar*.

Annual, prostrate or diffuse herbs, clothed with long, white, medifixed hairs. Leaves simple, subsessile, 5-15 x 4-10 mm, broadly ovate-cordate, subobtusate at apex, densely hairy on both surfaces. Petioles 4-5 mm long. Stipules 1-2 x 0.4-0.5 mm, narrowly triangular, pubescent, with ciliate margins. Flowers pinkish-red, subsessile, in 2-5 mm long, 4 to 10-flowered, axillary racemes; pedicels ca 0.5 mm long. Bracts ca 1.5 x 0.5 mm, narrowly triangular. Calyx 3-5 mm long, densely pilose; teeth much longer than tube, linear, acuminate. Corolla-standard 2.5-3.5 x 1-1.5 mm, spatulate, rounded at apex, pilose on back, 7 to 8-nerved; wings ca 2.5 mm long; keel 2-2.5 mm long. Pods cylindrical-oblong, straight, 4-5 mm long, apiculate, torulose when 2-seeded, densely pubescent. Seeds ca 1 mm in diam., irregularly ovoid, verrucose, truncate at one end, light brown (**Fig-9; Plate-20/3**).

*Fl. & Fr.*: August - December.

*Ecology* : Very common in sandy plains in association with *Cenchrus biflorus* Roxb., *Lasiurus scindicus* Henr., etc. Sometimes forming pure community for many kilometers.

*Specimens examined* : Near Sam, Monika 16550 (BSJO); Sudasari, Monika 16756 (BSJO), Pandey 7836 (BSJO).

3. *Indigofera hochstetteri* Baker in Oliver, Fl. Trop. Africa 2 : 101. 1871; Bhandari, Fl. Indian Desert 117. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 241. 1987; Sanjappa, Legumes India 191. 1992 & in Hajra *et al.* Fl. India Fasc. 21 : 83. 1995. *I. anabaptista* Steud. ex Baker in Hook. f. Fl. Brit. India 2 : 102. 1876; Duthie, Fl. Gangetic Plain 1 : 251. 1903.

Local name : *Adio-bekario*.

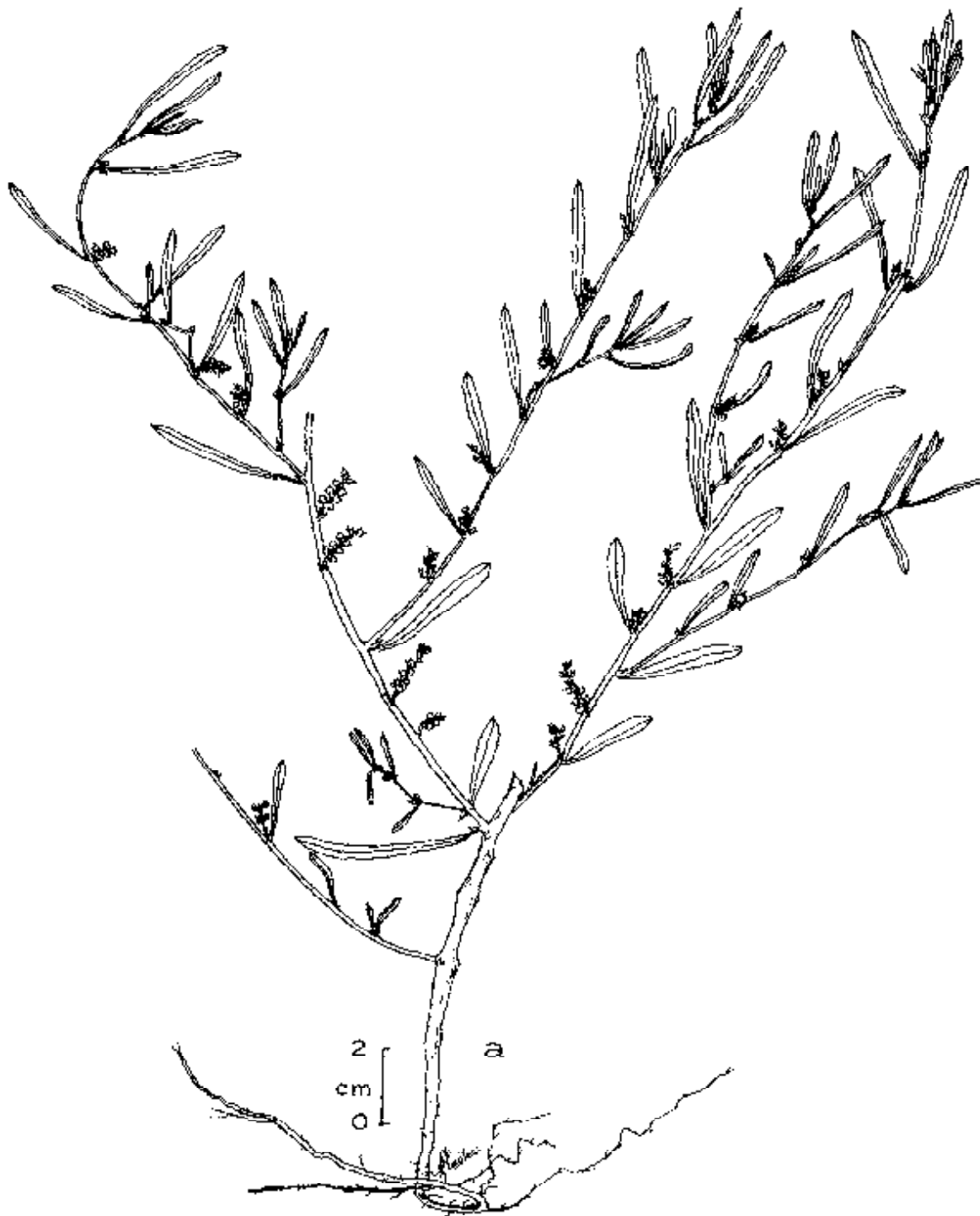


Fig. 10. *Indigofera linifolia* (L. f.) Retz. : a. Habit.

Annual, diffuse or prostrate herbs, 10-25 cm long; branches terete, minutely adpressed hairy. Leaves 2-5 cm long, including 5-8 mm long, canescent petioles; leaflets 3-5, opposite, 1.5-2 x 0.5-0.6 cm, oblanceolate or oblong-lanceolate, rounded at apex, cuneate at base, thinly appressed hairy on both surfaces. Stipules 2-2.2 x 0.4-0.5 mm, linear-lanceolate, filiform, hairy outside. Flowers pinkish-red, in 1-2 cm long, dense, 8 to 20-flowered, axillary racemes shorter than leaves. Bracts 1-2 x 0.4-0.5 mm, lanceolate, hairy outside. Calyx pubescent; tube ca 0.8 mm long; teeth ca 2 mm long, linear-subulate. Corolla-standard 3-3.5 x 1-1.5 mm, densely hairy outside, obovate, mucronate; wings 2.5-3 x 0.5-0.6 mm, glabrous; keel 3-3.5 x 1-1.5 mm, densely hairy outside. Stamens 2-3 mm long; anthers 0.5-0.6 mm long. Ovary sparsely hairy. Pods 8-20 x 3-4 mm, flat, papery, falcate, apiculate, reticulately veined, transversely septate, 5 to 8-seeded, sparsely hairy. Seeds 1-1.5 mm in diam., discoid or somewhat quadrangular with irregular blotches, smooth, reddish-brown.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in sandy plains in association with *Indigofera cordifolia* Heyne ex Roth, *Cleome viscosa* L., etc.

*Specimens examined* : Near Sum, Monika 16549, 16725 (BSJO); Near Kanoi, Monika 16375 (BSJO); Sudasari, Pandey 7836 (BSJO).

4. *Indigofera tinifolia* (L. f.) Retz. Obs. Bot. 4 : 29. 1786 & 6 : 33. t. 2, 1791; Baker in Hook. f. Fl. Brit. India 2 : 92. 1876; Duthie, Fl. Gangetic Plain 1 : 249. 1903; Bhandari, Fl. Indian Desert 118. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 242. 1987; Sanjappa, Legumes India 192. 1992 & in Hajra et al. Fl. India Fasc. 21 : 93. 1995. *Hedysarum tinifolium* L. f. Suppl. 331. 1781. *Sphaeridiophorum tinifolium* (L. f.) Desv. in J. Bot. 3 : 125. t. 6. f. 35. 1813. *Indigofera roxburghii* Tausch in Flora 14 : 171. 1831. *Sphaeridiophorum abyssinicum* Jaub. & Spach, Ill. Pl. Orient. 1. 494. 1857.

Local name : *Lambio-bekario*.

Annual, prostrate or suberect herbs, 20-30 cm high; branches many from the base, angular, densely clothed with bipartite, appressed, silvery hairs. Leaves simple, 15-40 x 3-5 mm, linear to elliptic-lanceolate, acute at apex, cuneate at base, pubescent on upper surface, more or less glabrous on the lower surface. Petioles 1-2 mm long. Stipules 1.5-2 mm long, narrowly triangular, pubescent. Racemes 10-15 mm long, axillary, 5 to 20-flowered, shorter than leaves. Flowers red. Bracts ca 1 x 0.5 mm, triangular, caducous. Calyx campanulate, adpressedly hairy outside; tube 1-2 mm long; teeth linear-subulate, unequal, much longer than tube. Corolla-standard 3-3.5 x 1-2 mm, elliptic, densely hairy outside; wings 2.5-3 x 1-1.5 mm, glabrous; keel 3-3.5 x 1-1.5 mm, glabrous. Ovary ca 1 mm across, globose. Pods 2-3 mm in diam., globose, beaked, white silky hairy, 1-seeded. Seeds ca 1 x 1 mm, more or less globose, minutely tuberculate, dark brown (Fig.-10; Plate-20/4).

*Fl. & Fr.*: August – December.

*Ecology* : Common along road-sides, open plains and near cultivated fields, grows in association with *Corchorus depressus* (L.) Vicary, *Euphorbia clarkeana* Hook. f., etc.

*Specimens examined* : Sudasari R. F., Monika 16574 (BSJO); Near Santhla, Monika 16654 (BSJO); Satto, Pandey 7889 (BSJO).

5. *Indigofera linnaei* Ali in Bot. Notis. 111 : 549. 1958 & in Nasir & Ali, Fl. West Pakistan 100 : 75. 1977; Bhandari, Fl. Indian Desert 118. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 242. 1987; Sanjappa, Legumes India 192. 1992 & in Hajra et al. Fl. India Fasc. 21 : 96. 1995. *Hedysarum prostratum* L. Mant.

Pl. 1 : 102. 1767, non *Indigofera prostrata* Willd. *I. enneaphylla* auct. plur. non L. 1771; Baker in Hook. f. Fl. Brit. India 2 : 94. 1876; Duthie, Fl. Gangetic Plain 1 : 250. 1903.

Prostrate, annual or biennial herbs, clothed with appressed hairs; branches many, terete, 25-50 cm long. Leaflets 5-9, 5-10 x 2-5 mm, obovate, rounded at apex, cuneate at base, appressed pubescent on both surfaces. Petiolules ca 0.5 mm long. Stipules ca 5 mm long, ovate, cuspidate, scarious. Racemes 10-15 mm long, spicate, compact, axillary, 10 to 15-flowered, shorter than leaves. Flowers pinkish-red, sessile. Bracts 1.5-2.5 x 1-1.5 mm, triangular, caducous, scarious. Calyx hairy outside; tube 0.5-1.5 mm long; teeth 2-3 x 0.3-0.5 mm, linear, setaceous. Corolla-standard 3-4 x 1-2 mm, obovate, rounded at apex, strigose on back; wings 3-4 x 1-2 mm, glabrous, shortly ciliate along margins. Pods 4-6 x 1.5-2 mm, straight, oblong, turgid, torulose, appressed grey pubescent, 2 to 3-seeded. Seeds 2-2.5 x 0.8-1 mm, cylindrical, truncate, light brown, with a few dark blotches.

*Fl. & Fr.*: August-November.

*Ecology* : Common, found in the sandy plains in association with *Indigofera cordifolia* Heyne ex Roth, *Convolvulus prostratus* Forssk., *Cenchrus biflorus* Roxb., etc.

*Specimens examined* : Near Sam Forest R. H., Monika 16602 (BSJO); Near Bidna village, Pandey 7822 (BSJO).

6. *Indigofera oblongifolia* Forssk. Fl. Aegypt.-Arab. 137. 1775; Duthie, Fl. Gangetic Plain 1 : 253. 1903; Bhandari, Fl. Indian Desert 119. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 243. 1987; Sanjappa, Legumes India 193. 1992 & in Hajra *et al.* Fl. India Fasc. 21 : 108. 1995. *I. paucifolia* Delile, Fl. Egypt. 107. t. 37. f. 2. 1813; Baker in Hook. f. Fl. Brit. India 2 : 97. 1876. *I. argentea* auct. non Burm. f. 1768, nec L. 1771; Buch.-Ham. ex Roxb. Fl. Ind. 3 : 374. 1832. *Bremontiera amoxylon* DC. var. *burmanni* DC. Prodr. 2 : 353. 1825.

Local name : *Gollia*.

Erect, ashy-grey, twiggy shrubs, up to 1 m high; branches woody, slender, terete, hairy. Leaves 3-5 cm long, including 2-3 mm long petioles; leaflets 3-5, alternate, 15-20 x 3-6 mm, elliptic, oblong or oblanceolate, acute or obtuse at apex, cuneate at base, scabrous above, silvery hairy beneath. Petiolules 1-3 mm long. Stipules 2.5 x 1.2 mm, narrowly triangular. Racemes 3-8 cm long, axillary, many-flowered, longer than leaves. Flowers red. Bracts ca 1 mm long, caducous, hairy. Calyx ca 1.5 mm long, hairy outside; tube 0.4-0.5 mm long; teeth ca 1 mm long, lower lanceolate, upper triangular, acute. Corolla-standard 4.5 x 3-4 mm, obovate, silvery outside; wings 3-4 x 1-2 mm, glabrous, thick, fleshy; keel 4-4.5 x 1.5-2 mm, ciliate along margins. Pods 10-20 x 1.5-2 mm, deflexed, cylindrical, abruptly apiculate, constricted between the seeds, pubescent, pinkish. Seeds 4-8, ca 2 x 1 mm, oblong, 4-gonous, truncate at one end, smooth, shiny, yellowish-brown.

*Fl. & Fr.*: September-March.

*Ecology* : Rare, found in the sandy plains and sometimes on small dunes. Main associates are *Heliotropium subulatum* (Hochst. ex DC.) Vatke, *Tribulus terrestris* L., etc.

*Specimen examined* : Satto-Bandera road, Monika 16666 (BSJO).

7. *Indigofera sessiliflora* DC. Prodr. 2 : 228. 1825; Raizada, Suppl. Duthie, Fl. Gangetic Plain 1 : 54. 1976; Bhandari, Fl. Indian Desert 119. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 243. 1987; Sanjappa, Legumes India 194. 1992 & in Hajra *et al.* Fl. India Fasc. 21 : 120. 1995. *I. tribuloides* Boiss. Fl. Orient. 2 : 189. 1872. *I. trigonelloides* auct. non Jaub. & Spach 1857; Baker in Hook. f. Fl. Brit. India 2 : 94. 1876.



Local name : *Furri-bekar*.

Caespitose, annual herbs; stem and branches prostrate or ascending, angular, appressed hairy. Leaves 2-5 cm long; leaflets 3-7, alternate, 0.3-1.6 x 0.6-1.8 cm, oblanceolate to elliptic, rounded or mucronate at apex, cuncate to rounded at base, appressed hairy on both surfaces. Petioles 8-15 mm long; petiolules 1-2 mm long. Stipules linear, with broad base. Racemes *ca* 8 mm long, axillary, globose and head-like to slightly elongated, 10 to 20-flowered. Flowers reddish-pink, subsessile. Bract 1-2 mm long, caducous. Calyx hairy outside, 3-4 mm; tube *ca* 0.5 mm long; teeth *ca* 2.5 x 0.5 mm, narrowly triangular, hairy. Corolla-standard 3-4 x 1-2 mm, obovate, rounded at apex; wings 2-3 x 0.5-1 mm; keel 3-4 x 1-2 mm, glabrous. Anthers *ca* 0.5 mm long. Pods 8-10 x 2-2.5 mm, linear, straight, spreading, torulose, apiculate, appressed hairy, 2 to 4-seeded. Seeds globose, smooth, shiny, reddish-brown.

*Fl. & Fr.*: July-November.

*Ecology* : Occasional, found in sandy plains in association with *Indigofera tinctoria* Ali, *Cleome gynandra* L., etc.

*Specimen examined* : Sam, Monika 16551, 16601 (BSJO).

#### 6. *RHYNCHOSIA* Lour. (*nom. cons.*)

- |   |                        |
|---|------------------------|
| 1a. Trailing herbs. Flowers in dense capitate racemes. Pods suborbicular. Seeds strophiolate. | 1. <i>R. capitata</i>  |
| 1b. Twining herbs. Flowers in lax racemes. Pods elliptic-lanceolate. Seeds estrophiolate.     | 2                      |
| 2a. Terminal leaflet obcordate, downy bothsides. Pods velvety.                                | 3. <i>R. schimperi</i> |
| 2b. Terminal leaflet rhomboid, glabrous above. Pods glabrescent.                              | 2. <i>R. minima</i>    |

1. *Rhynchosia capitata* (Heyne ex Roth) DC. Prodr. 2 : 386. 1825; Duthie, Fl. Gangetic Plain 1 : 222. 1903; Singh in Shetty & Singh, Fl. Rajasthan 1 : 254. 1987; Sanjappa, Legumes India 237. 1992. *Glycine capitata* Heyne ex Roth, Nov. Pl. Sp. 346. 1821. *Rhynchosia aurea sensu* Baker in Hook. f. Fl. Brit. India 2 : 221. 1876, *pro parte*, non (Willd.) DC. 1825; Bhandari, Fl. Indian Desert 124. 1978.

Local name : *Butti*.

Annual, trailing or creeping herbs; branches many, clothed with white, spreading hairs, winged. Leaves 3-foliolate; leaflets 2-3.5 x 1.8-3 cm, rhomboid-ovate, entire, subacute at apex, minutely pubescent on both surfaces, lateral leaflets slightly shorter than terminal. Flowers yellow, in few to many-flowered, umbellate racemes usually shorter than the leaves; peduncles 3-4 cm long, slender, hairy; pedicels 4-6 mm long, pubescent. Calyx hairy; tube *ca* 2 mm long; teeth 6-8 mm long, linear-subulate, the two upper sepals connate except at the tip. Corolla *ca* 1 cm long. Pods 1-1.5 x 0.9-1.3 cm, compressed, suborbicular, mucronate, hairy, transversely striated with nearly parallel lines. Seeds 2, 5-6.5 x 2-2.5 mm, oblong, compressed, rounded at ends, grey, with minute black dots; strophiole capitate, waxy, light orange.

*Fl. & Fr.*: August-October.

*Ecology* : Rare, found in sandy to gravelly habitats in association with *Boerhavia diffusa* L., *Senna italica* Mill., *Tribulus terrestris* L., etc. The fruits remain buried in the soil.

*Specimen examined* : Near Sudasari, Monika 17072 (BSJO).

2. *Rhynchosia minima* (L.) DC. Prodr. 2 : 385. 1825; Baker in Hook. f. Fl. Brit. India 2 : 223. 1876; Duthie, Fl. Gangetic Plain 1 : 222. 1903; Bhandari, Fl. Indian Desert 124. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 255. 1987; Sanjappa, Legumes India 239. 1992. *Dolichos minimus* L. Sp. Pl. 726. 1753. *Rhynchosia medicaginea* DC. Prodr. 2 : 386. 1825. *R. laxiflora* Camb. in Jacq. Voy. Bot. 44. t. 54. 1844. *R. minima* (L.) DC. var. *laxiflora* (Camb.) Baker in Hook. f. l.c. 2 : 223. 1876.

Annual, twining, much-branched herbs; branches 4-angled, thinly pubescent. Leaves 3-foliolate; leaflets 1.2-5.5 x 1-5 cm, rhomboid-ovate or rhomboid-obovate, acute, slightly pubescent above, glandular-punctate below. Petioles up to 2.5 cm long, glabrescent. Stipules 3-4 mm long, linear-lanceolate. Flowers yellow, in lax, axillary racemes usually longer than leaves. Calyx 3.5-4 mm long, pubescent; teeth linear-subulate, about twice as long as tube. Corolla 5-6 mm long. Pods 1-2 x 0.5-0.6 cm, linear, slightly falcate, flat, glabrous, 2-seeded. Seeds 3.5-4 x 2.5-3 mm, mottled with grey and black, ovate, compressed, pale green, estrophiolate (Plate-13/2).

Fl. & Fr.: August-November.

Ecology : Occasional, found in sandy as well as gravelly soils as a twinner on *Capparis decidua* (Forssk.) Edgew., *Lycium barbarum* L., etc.

Specimens examined : Near Berisiyala, Monika 16681 (BSJO); Miajlar village, Monika 17109 (BSJO); Along Miajlar road, Shetty 3393 (BSJO).

3. *Rhynchosia schimperii* (Hochst. & Steud. ex Steud.) Boiss. Fl. Orient. 2 : 626. 1872; Bhandari & Verdc. in Bull. Bot. Surv. India 12 : 108. 1972; Bhandari, Fl. Indian Desert 126. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 256. 1987; Sanjappa, Legumes India 240. 1992. *Glycine schimperii* Hochst. & Steud. ex Steud. Nom. Bot. 2 (1) : 691. 1840. *R. arenaria* Blatt. & Hallb. J. Bombay Nat. Hist. Soc. 26 : 243. 1918.

Perennial, prostrate or twinning herbs; stem slender, ash-coloured, grey-velvety all over. Leaves 3-foliolate, 2-4.5 cm long; terminal leaflet broadly obovate, 8-19 x 7-18 mm, emarginate, cuneate at base, densely grey tomentose; lateral leaflets shorter than terminal, 5-10 x 4-10 mm, obliquely suborbicular, in other characters like terminal. Petiolules ca 1 mm long. Stipules 1.5-2 mm long, minutely pubescent. Flowers yellow, in 1 to 5-flowered, 3-5 mm long, axillary racemes; pedicels 2-2.5 mm long. Calyx 3.5-4 mm long; tube ca 1.5 mm long; lobes unequal, lower one larger than others, densely hairy at base, acute at apex. Corolla 5-6 mm long; standard suborbiculate, emarginate, pubescent outside; wings up to 5 mm long; keel 5-6 mm long, green. Pods 1.5-2.5 cm long, obliquely cuspidate at apex, narrowed at base, tomentose. Seeds 2, 4.5-5 x 4-4.5 mm, suborbicular, brownish-black, yellow on hilum, glabrous, estrophiolate.

Fl. & Fr.: August-November.

Ecology : Common, found in sandy plains as well as on dunes. It makes association with *Aerva javanica* (Burm. f.) Juss. ex Schult., *Indigofera cordifolia* Heyne ex Roth, etc.

Specimens examined : Near Kanoi, Monika 16596 (BSJO); Along Miajlar road, Monika 17149 (BSJO).

#### 7. *TEPHROSIA* Pers. (nom. cons.)

- |  |                                 |
|--|---------------------------------|
| 1a. Pods distinctly falcate, semilunar or circinate.         | <b>1. <i>T. falciformis</i></b> |
| 1b. Pods nearly straight or slightly curved towards the tip. | 2                               |
| 2a. Flowers axillary, 1 to 6-together.                       | 3                               |

- 2b. Flowers in racemes. 4
- 3a. Leaves simple. 3. *T. strigosa*
- 3b. Leaves imparipinnate. 4. *T. subtriflora*
- 4a. Pods velvety tomentose. 5. *T. villosa*
- 4b. Pods glabrous or pubescent. 2. *T. purpurea*

1. *Tephrosia falciformis* Ramaswami in J. Asiat. Soc. Bengal (n.s.) 12 : 125. 1916; Raizada, Suppl. Duthie, Fl. Gangetic Plain 58. 1976; Bhandari, Fl. Indian Desert 129. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 263. 1987; Sanjappa, Legumes India 256. 1992.

Local name: *Rati-biyani*

Perennial, much-branched shrubs; stem and branches angular, adpressed white silky hairy. Leaves 7-12 cm long; leaflets 5-17, 2.5-5 x 0.3-1.2 cm, narrowly oblanceolate or oblong, mucronate or emarginate at apex, cuneate at base, silvery appressed hairy on both surfaces; terminal leaflet larger than the laterals. Petiolules 2-2.5 mm long, slender, hairy. Stipules ca 3 mm long, linear, persistent. Flowers purple-red, usually in pairs, in 10-30 cm long, lax racemes longer than the leaves. Calyx white, silky; teeth 2-3 mm long, equalling the tube, lanceolate. Corolla-standard 8-10 mm long, orbicular-cordate, silvery-white outside. Style glabrous, incurved. Pods 6-10 cm long, flat, falcate or circinate, slightly pubescent, mucronate at tip, 3 to 5-seeded. Seeds ca 5 mm long, reniform, glaucous, black (Fig.-11; Plate-13/3).

Fl. & Fr.: August-November.

Ecology : Very rare, found in sandy plains.

Specimen examined : Khara Jandha, Shetty 612 (BSJO).

2. *Tephrosia purpurea* (L.) Pers. Syn. Pl. 2 : 329. 1807; Baker in Hook. f. Fl. Brit. India 2 : 112. 1876; Duthie, Fl. Gangetic Plain 1 : 245. 1903; Bhandari, Fl. Indian Desert 131. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 264. 1987; Sanjappa, Legumes India 258. 1992. *Cracca purpurea* L. Sp. Pl. 2 : 752. 1753. *Galega purpurea* (L.) L. Sp. Pl. ed. 2. 2 : 1063. 1763. *Tephrosia leptostachya* DC. Prodr. 2 : 251. t. 2. 1825. *Galega lanceaefolia* Roxb. Fl. Ind. 3 : 387. 1832. *G. diffusa* Roxb. Lc. 3 : 387. 1832. *Tephrosia diffusa* (Roxb.) Wight & Arn. Prodr. 213. 1834. *T. purpurea* (L.) Pers. var. *pubescens* Baker in Oliver, Fl. Trop. Africa 2 : 125. 1871 & in Hook. f. Fl. Brit. India 2 : 113. 1876. *T. wallichii* Grah. ex Fawcett & Rendle, J. Bot. 55 : 35. 1917. *T. hamiltonii* Drumm. ex Gamble, Fl. Madras 320. 1918.

Local name : *Bivnio*.

Erect, much-branched, woody, annual or perennial herbs, up to 1 m high; stem and branches more or less glabrous. Leaves up to 13 cm long, imparipinnate; leaflets 9-15 or more, 1.5-3 x 0.5-2 cm, elliptic-oblong to oblanceolate, mucronate, subcoriaceous, glabrous above, appressed pubescent below. Stipules 6-8 mm long, linear-subulate, reflexed, hairy. Flowers purplish-pink, in 5 to 26-flowered, leaf-opposed or terminal, lax racemes longer than leaves; pedicels 6-7 mm long. Bracts 2-3 mm long, linear. Calyx 3-4 mm long; teeth 2-3 mm long, lanceolate, acuminate, pubescent. Corolla 7-8 mm long; standard pubescent on the back. Style glabrous, flattened; stigma penicillate. Pods 3-6 x 0.4-0.6 cm, linear, turgid, slightly recurved, glabrescent to minutely pubescent. 4 to 8-seeded. Seeds cylindrical, smooth, dark brown.

Fl. & Fr.: July-February.

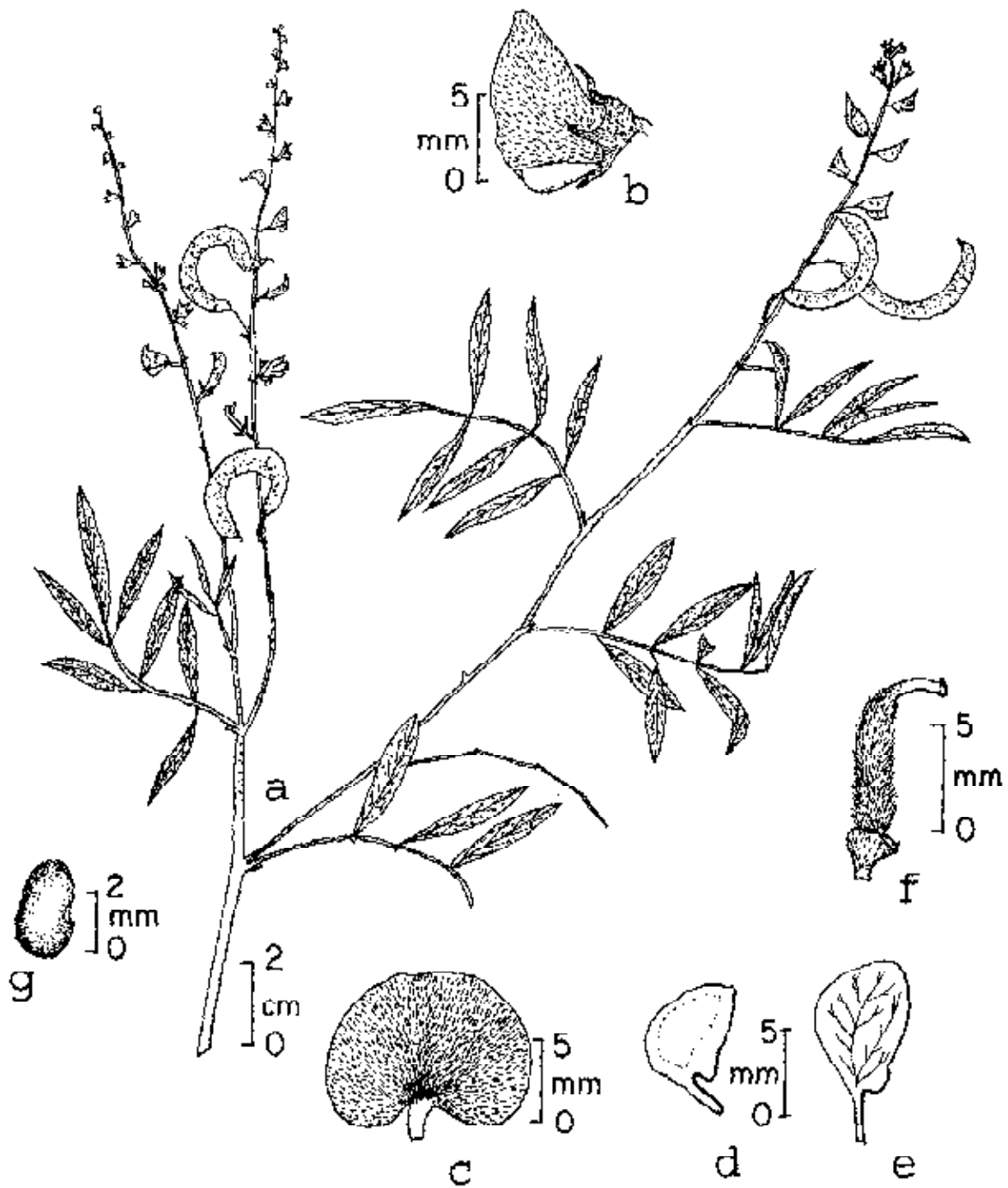


Fig. 11. *Tephrosia falciformis* Ramaswami : a. Habit, b. Flower, c. Petal-standard, d. Petal-keel, e. Petal-wing, f. Gynocccium, g. Seed.

*Ecology* : Found in sandy as well as semi-gravelly areas in association with *Aristida* spp., *Cenchrus* spp., *Indigofera cordifolia* Heyne ex Roth, etc.

*Specimens examined* : Near Berisiyala, *Monika* 16791 (BSJO); 8 km from Dhanana towards Sam, *Shetty* 6121 (BSJO).

*Notes* : The taxon shows teratological variations in inflorescence even in the same population (Shrivastava & Singh, 2002).

3. *Tephrosia strigosa* (Dalz.) Sant. & Mahesh. in J. Bombay Nat. Hist. Soc. 54 (3) : 805. 1957; Bhandari, Fl. Indian Desert 131. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 265. 1987; Sanjappa, Legumes India 259. 1992. *Macronyx strigosus* Dalz. in Hook. Kew J. Bot. 2 : 35. 1850. *Tephrosia tenuis* Wall. ex Dalz. & Gibs. Bombay Fl. 61. 1861; Baker in Hook. f. Fl. Brit. India 2 : 111. 1876; Duthie, Fl. Gangetic Plain 1 : 244. 1903.

Local name : *Jhino-bivniyo*.

Annual, erect, much-branched herbs, 20-30 cm high; stem and branches slender, filiform, appressed hairy. Leaves unifoliate, alternate, subsessile, 4-6 x 0.3-0.4 cm, linear-lanceolate, apiculate, glabrous above, obscurely silky beneath. Petioles 2-2.5 mm long, filiform, hairy. Stipules 2-3 mm long, subulate. Flowers axillary, solitary, violet to bluish-yellow; pedicels 6-10 mm long, hairy, filiform. Calyx 2-3 mm long; teeth shorter than the tube, silky, subequal. Corolla 3.5-4 mm long; standard pubescent outside. Style ca 1 mm long, glabrous. Pods 2.5-3.5 x 0.3-0.4 cm, linear-oblong, flat, thinly appressed hairy, 6 to 10-seeded. Seeds ca 2 mm in diam., suborbicular, smooth, glabrous, dark brown, minutely mottled with light brown (Plate-13/4).

*Fl. & Fr.*: July-November.

*Ecology* : Occasional, found in sandy plains in association with *Indigofera* spp., *Tribulus terrestris* L., etc.

*Specimens examined* : Selhari, *Monika* 16548 (BSJO); Sudasari, *Monika* 16757 (BSJO); North of Munabao, *Pandey* 7911 (BSJO).

4. *Tephrosia subtriflora* Hochst. ex Baker in Oliver, Fl. Trop. Africa 2 : 117. 1871; Gillett in Kew Bull. 13 : 112. 1958; Bhandari, Fl. Indian Desert 132. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 265. 1987; Sanjappa, Legumes India 259. 1992. *T. pauciflora* Grah. ex Baker in Hook. f. Fl. Brit. India 2 : 114. 1876; Raizada, Suppl. Duthie, Fl. Gangetic Plain 59. 1976. *T. multiflora* Blatt. & Hallb. J. Bombay Nat. Hist. Soc. 26 : 239. 1918.

Erect, annual or perennial herbs, 60-70 cm high; branches many from woody base, slender, clothed with spreading hairs. Leaves 6-9 cm long; leaflets 7-11, 1.5-2 x 0.6-0.9 cm, oblong or lanceolate, obtuse at apex, cuneate at base, glabrous above, appressed silky hairy beneath. Petioles 2.5-3 cm long, hairy, grooved. Stipules 4-5 mm long, subulate, silky hairy outside. Flowers pink, 2 to 6-together in leaf axils; pedicels 2-3 mm long. Calyx 2.5-3 mm long, hairy; teeth equal to the tube. Corolla-standard 6-7 mm long, densely silky outside. Ovary hirsute; style glabrous, flattened; stigma penicillate. Pods 4-4.5 x 0.3-0.4 cm, linear, slightly curved, thinly hairy, with spreading hairs, 5 to 8-seeded. Seeds 2-2.5 x 1.5-1.8 mm, ovoid, glabrous, dark brown, mottled.

*Fl. & Fr.*: July - November.

*Ecology* : Found in the sandy plains, forming association with *Tephrosia purpurea* (L.) Pers., *Crotalaria burhia* Buch.-Ham., etc.

*Specimens examined* : Sudasari, *Monika* 16573 (BSJO); Miajlar-Sundra road, *Monika* 17153 (BSJO).

5. *Tephrosia villosa* (L.) Pers. Syn. Pl. 2 : 329. 1807; Baker in Hook. f. Fl. Brit. India 2 : 113. 1876; Duthie, Fl. Gangetic Plain 1 : 245. 1903; Bhandari, Fl. Indian Desert 133. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 266. 1987; Sanjappa, Legumes India 260. 1992. *Cracca villosa* L. Sp. Pl. 752. 1753. *Galega villosa* (L.) L. Syst. Nat. ed. 10. 1172. 1759. *G. hirta* Buch.-Ham. in Trans. Linn. Soc. London 13 : 546. 1822. *Tephrosia incana* Sweet, Hort. Brit. ed. 2. 142. 1830. *Galega incana* Roxb. Fl. Ind. 3 : 385. 1832. *Tephrosia villosa* (L.) Pers. var. *incana* (Roxb.) Baker in Hook. f. l. c. 2 : 113. 1876.

Small, diffuse, perennial herbs, clothed with densely white or greyish, appressed hairs; branches angular. Leaves imparipinnate; leaflets 11-19, 1.5-2 x 0.5-1.2 cm, oblanceolate or obovate, emarginate, mucronate at apex, more or less cuneate at base, glabrescent above, densely silky beneath. Petiolules ca 1 mm long, hairy. Stipules 3-4 mm long, linear-lanceolate, 3-nerved, densely hairy outside. Flowers pinkish-red, fascicled or paired in 10-15 cm long, elongated, spicate racemes. Bracts 1-1.5 mm long, persistent, linear-lanceolate or subulate. Calyx 7-8 mm long, densely hairy outside; teeth much longer than tube. Corolla-standard ca 8 mm long, velvety outside. Style glabrous, flattened; stigma penicillate, silky hairy. Pods 2.5-5 x 0.5-0.8 cm, flat, falcately curved upwards, deflexed, densely velvety-tomentose with spreading hairs, 6 to 8-seeded. Seeds 2.8-3.5 x 2.5-2.8 mm, ovate, glabrous, light brown.

*Fl. & Fr.*: November-March.

*Ecology* : Occasional, found in sandy as well as in the gravelly habitats, usually grows individually.

*Specimen examined* : DNP, *Tiwari* 877 (BSJO).

#### 8. VIGNA Savi (nom. cons.)

*Vigna trilobata* (L.) Verdc. in Taxon 17 : 172. 1968 & in Kew Bull. 24 : 560. 1970; Bhandari, Fl. Indian Desert 133. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 274. 1987; Sanjappa, Legumes India 276. 1992. *Dolichos trilobatus* L. Man. 101.1767. *Phaseolus trilobus* auct. plur. non (L.) Ait. 1789; Baker in Hook. f. Fl. Brit. India 2 : 201. 1876; Duthie, Fl. Gangetic Plain 1 : 224. 1903.

Local name : *Jangli-moth*.

Annual, prostrate or trailing herbs; branches slender, sparsely hairy. Leaves 3-foliolate; leaflets 1.5-4.5 x 1-4.5 cm, ovate-oblong or rhomboid, deeply 3-lobed with spatulate central-lobe; lateral lobes rounded, somewhat entire or shallowly lobed, suborbicular, sparsely hairy. Petioles 4-5.5 cm long, hispid, grooved. Stipules ca 1.5 cm long, foliaceous, produced below the point of attachment. Flowers yellow, subcapitate, in 2 to 4-flowered, axillary racemes 7-15 cm long. Bracts linear-lanceolate. Calyx 3-4 mm long, campanulate; teeth very short, triangular, hairy. Corolla ca 4 mm long. Pods 3-5.5 cm long, cylindrical, curved or straight, glabrous, 6 to 12-seeded. Seeds 2.8-3 mm long, oblong, rounded at ends, reticulate, papillose, brown.

*Fl. & Fr.*: September-November.

*Ecology* : Occasional, found in cultivated fields as a weed in moist sandy places.

*Specimen examined* : Along Sudasari-Khuri road, *Monika* 16688 (BSJO).

## 20. CAESALPINIACEAE

## SENNA Mill.

*Senna italica* Mill. Gard. Dict. ed. 8. no. 2. 1768; Singh, Monogr. Indian Cassiinae 147. 2001. *Cassia senna* L. var.  $\beta$  L. Sp. Pl. 377. 1753. *C. senna* Burm. f. Fl. Ind. 96. t. 33. f. 2. 1768, non L. 1753. *C. italica* (Mill.) Spreng. Bot. Gart. Univ. Halle 21. 1800. *C. obtusa* Roxb. Hort. Beng. 31. 1814, *nom. nud.*; Duthie, Fl. Gangetic Plain 1 : 294. 1903. *C. obovata* Collad. Hist. Cass. 92. t. 15A. 1816, *nom. illegit.*; Baker in Hook. f. Fl. Brit. India 2 : 264. 1878, *pro parte*. *C. italica* (Mill.) Lam. ex Andrews, Fl. Pl. Anglo-Egypt. Sudan 2 : 117. 1952; Bhandari, Fl. Indian Desert 142. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 283. 1987.

Local name : *Bhinda-anwal*.

Perennial, erect or suberect herbs, 30-40 cm high, woody at base; stem and branches pubescent, striate, more or less terete. Leaflets 3-7 pairs, 1.5-3.5 x 0.5-2 cm, obovate-oblong or obovate, rounded at apex, more or less cuneate at base, glabrous above, glaucous beneath. Petioles 2-3 cm long, glabrescent. Stipules 3-6 mm long, ovate-lanceolate, acuminate at apex, oblique at base. Flowers yellow, in axillary, more than 6-flowered racemes longer than the leaves; pedicels 3-4 mm long. Sepals 6-10 mm long, oblong, obtuse, membranous. Petals 7-18 mm long, obovate-oblong, reticulate with darker veins. Stamen 7, unequal; staminodes 3, minute, adaxial. Ovary densely pubescent. Pods 3-4.5 cm long, papery, glabrous, oblong-falcate or reniform, deflexed, septate between seeds, valves with longitudinal crests down the middle of pods over the seeds. Seeds 6-12, 4-5 x 1.5-3.5 mm, obovoid-oblong, dark brown, shining (Fig.-12; Plate-14/1).

Fl. & Fr.: August-January.

Ecology : Commonly found in sandy habitats, often forming association with *Fursetia hamiltonii* Royle, *Cleome viscosa* L., etc.

Specimens examined : Sam, Monika 16510, 16571 (BSJO); Bidna, Monika 16774 (BSJO).

## 21. MIMOSACEAE

- |  |                    |
|--|--------------------|
| 1a. Stamens as many as or twice as many as petals.                                     | 2                  |
| 1b. Stamens more than twice as many as petals.   | 3                  |
| 2a. Flowers in heads. Leaf-rachis and pods prickly.                                    | 3. <i>Mimosa</i>   |
| 2b. Flowers in elongate spikes or spike-like racemes. Leaf-rachis and pods not prickly | 4. <i>Prosopis</i> |
| 3a. Plants unarmed.  | 2. <i>Albizia</i>  |
| 3b. Plants armed with spines.  | 1. <i>Acacia</i>   |

## 1. ACACIA Mill.

- |   |  |
|---|--|
| 1a. Flowers in spikes.                    | 4. <i>A. senegal</i>                         |
| 1b. Flowers in globose heads.             | 2  |
| 2a. Pods spirally contorted or twisted.   | 5. <i>A. tortilis</i> subsp. <i>raddiana</i> |
| 2b. Pods moniliform or flat and straight. | 3  |
| 3a. Pods moniliform, subcompressed.       | 2. <i>A. nilotica</i> subsp. <i>indica</i>   |
| 3b. Pods flat, straight.                  | 4  |



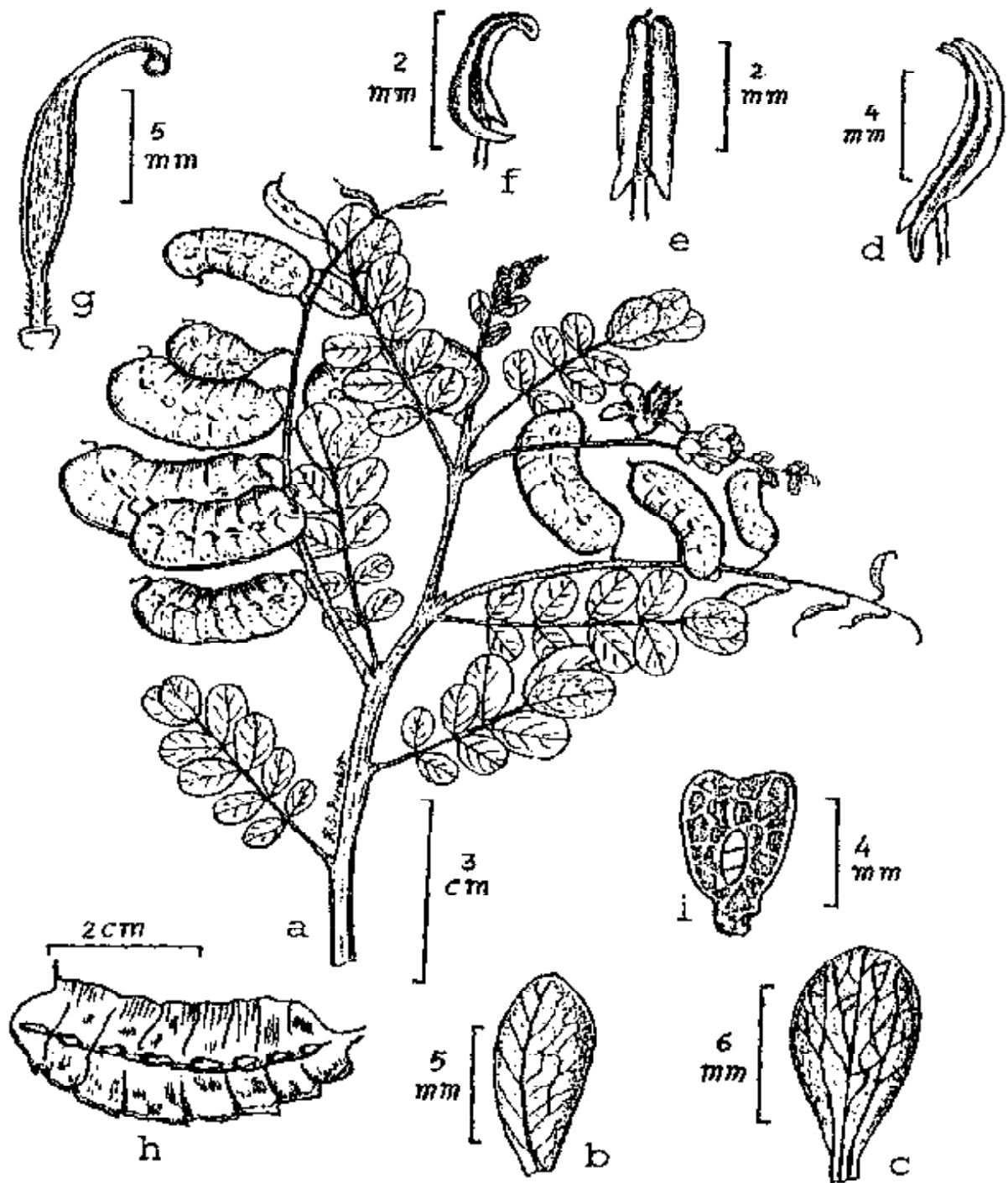


Fig. 12. *Senna italica* Mill. : a. Habit, b. Sepal, c. Petal, d. Large anther, e. Small anther, f. Staminode, g. Gynoeccium, h. Pod, i. Seed.

4a. Medium-sized trees. Pods winged, tapering at both ends.

3. *A. nubica*

4b. Bushy shrubs. Pods not winged, rounded at base, tapering at apex.

1. *A. jacquemontii*

1. *Acacia jacquemontii* Benth. in Hook. Lond. J. Bot. 1 : 499. 1842; Baker in Hook. f. Fl. Brit. India 2 : 293. 1878; Duthie, Fl. Gangetic Plain 1 : 314. 1903; Bhandari, Fl. Indian Desert 146. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 296. 1987; Sanjappa, Legumes India 40. 1992.

Local name : *Bu-bhanwali*.

Erect, much-branched shrubs, up to 2.5 m high; bark greyish-brown; twigs zigzag. Stipular spines paired, 3.5-4.8 cm long, straight, slender, ivory-white, connate at base. Leaves bipinnate, 3-4.8 cm long; pinnae 2-4 pairs, with a gland between the upper pair of pinnae; leaflets 5-10 pairs, sessile, 1.5-3.5 x 0.5-1.2 mm, linear-oblong, obtuse, glabrous. Flowers whitish-yellow, sweet-scented, in axillary, globose heads 1-1.5 cm in diam. Peduncles slender, 2-3 in a fascicle. Bracts 2, inserted in the middle portion of the peduncle. Calyx 1-1.5 mm long; teeth short, deltoid. Corolla 2.5-3 mm long; lobes oblong-ovate. Pods stalked, 5-8 x 0.8-1.5 cm, ovate-oblong, flat, straight, distinctly veined, glabrous, 5 to 8-seeded. Seeds glabrous, compressed, brown.

*Fl. & Fr.*: December - May.

*Ecology* : Occasional, found on sand-dunes as well as in sandy plains in association with *Acacia senegal* (L.) Willd., *Ziziphus nummularia* (Burm. f.) Wt. & Arn., etc.

*Specimen examined* : Near Miajlar, Monika 16646 (BSJO).

2. *Acacia nilotica* (L.) Willd. ex Del. subsp. *indica* (Benth.) Branan in Kew Bull. 12 : 84. 1957; Bhandari, Fl. Indian Desert 147. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 299. 1987; Sanjappa, Legumes India 42. 1992. *A. arabica* (Lam.) Willd. var. *indica* Benth. in Hook. Lond. J. Bot. 1 : 500. 1842. *A. arabica auct.* non (Lam.) Willd. 1806; Baker in Hook. f. Fl. Brit. India 2 : 293. 1878; Duthie, Fl. Gangetic Plain 1 : 314. 1903. *A. nilotica* (L.) Willd. ex Del. var. *indica* (Benth.) A. F. Hill, Bot. Mus. Leaflet. Harvard Univ. 99. 1940.

Local name : *Babul*.

Evergreen trees, 6-12 m high; young branches slightly pubescent; bark fissured, brown. Stipular spines in pairs, straight, 3-5.5 cm long, whitish-brown, glabrous. Leaves bipinnate, with glands on the petiole and between the pinnae especially the upper ones; pinnae 4-11 pairs; leaflets 10-27 pairs, subsessile, 3-5 x 1-2 mm, linear-oblong, subobtusate, glabrous. Flowers yellow, in axillary, pedunculate, fasciculate, globose heads 0.8-1.5 cm in diam. Bracteoles 2, above the middle part of peduncle, ovate, pubescent. Calyx 1-1.2 mm long; teeth short. Corolla 2.5-3 mm long; lobes triangular. Pods 6-22 x 1-1.5 cm, moniliform, subcompressed, constricted at sutures between the seeds, grey pubescent. Seeds 8-12, 6-7 mm in diam., suborbicular, brown, smooth (**Fig.-13; Plate-18/1**).

*Fl. & Fr.*: September - March.

*Ecology* : Common, found usually in sandy plains, sometimes on dunes, in association with *Capparis decidua* (Forssk.) Edgew., *Ziziphus nummularia* (Burm. f.) Wt. & Arn.

*Specimen examined* : Near Nimba, Monika 16629 (BSJO).

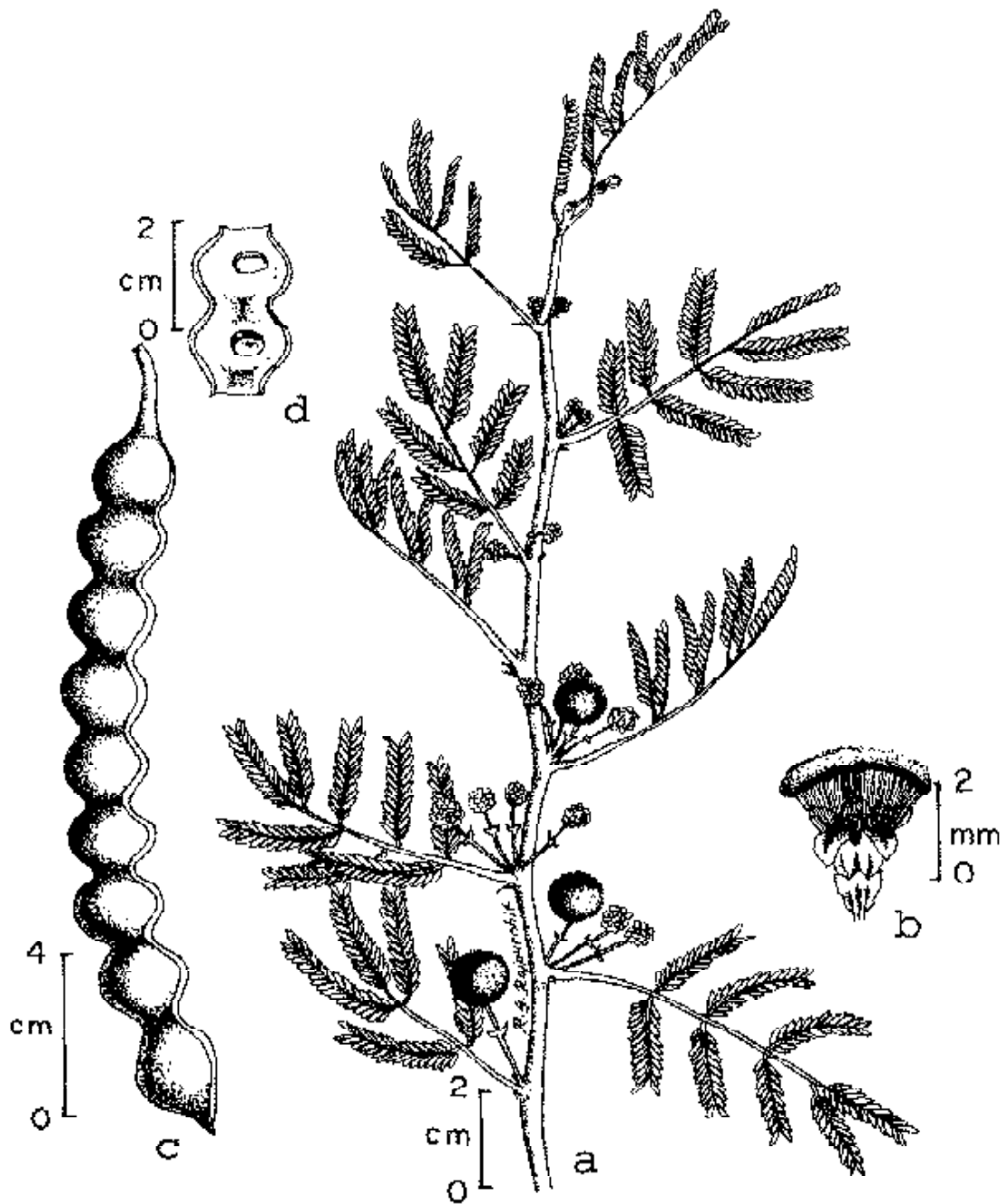


Fig. 13. *Acacia nilotica* (L.) Willd. ex Del. subsp. *indica* (Benth.) Brenan : a. Habit, b. Flower, c. Pod, d. Pod with seeds within.

3. *Acacia nubica* Benth. in Hook. Lond. J. Bot. 1 : 498. 1842; Brennan in Kew Bull. 1953 : 101. 1953 & in Hubbard & Milne-Redhead. Fl. Trop. East Africa (Mimosoideae) 129. f. 17/58. 1959; Singh & Shrivastava in Ind. J. For. 25 (2) : 201. 2002. *A. virchowiana* Vatke in Oesterr. Bot. Zeitschr. 30 : 275. 1880, *pro parte quoad legumina tantum*. *A. merkeri* Harms in E. J. 36 : 208. 1905.

Local name : *Vilayati bavliyo*.

Large shrubs or small trees, 3-5 m high; bark whitish-green to pale green; young branchlets pubescent with spreading hairs. Lenticels dot-like, yellowish-cream. Stipular spines in pairs, equal, 0.8-1.5 cm long, lower 2/3<sup>rd</sup> part pubescent with white hairs, rest part brown, glabrous. Leaf-rachis up to 5 cm long; pinnae 5-8 pairs, 1.5-2 cm long, sessile; leaflets 9-12 pairs, 3-4 x 0.5-1 mm, pubescent, linear-oblong. Flowers fragrant, yellowish-white, in axillary, globose heads ca 1 cm in diam.; peduncles 1.2-1.5 cm long, pubescent. Involucral bracts 2-3, attached below the middle on peduncle, yellowish-white. Calyx-lobes 5, pubescent, ca 2.5 mm long. Corolla 3-3.2 mm long, creamish-yellow, dark yellow at the base; lobes densely ciliate. Anthers 6-7 mm long. Ovary greyish-black, glabrous, 1-1.5 mm long. Pods yellowish-green, straight, flat, tapering at both ends, 6-8 x 1-1.5 cm, 2-valved, 5 to 7-seeded, winged along the sutures; wings 1-2 mm wide. Seeds dark brown, ovate, shortly mucronate at apex (Fig.-14).

*Fl. & Fr.*: August – November.

*Ecology* : Native of East Africa. Widely scattered on the dunes and in sandy plains in Desert National Park and its neighbourhood. Easily distinguishable from other species by its straight, flat, winged pods.

*Specimens examined* : Near Girab, *Monika* 16646, 17136 (BSJO).

4. *Acacia senegal* (L.) Willd. Sp. Pl. 4 : 1077. 1806; Baker in Hook. f. Fl. Brit. India 2 : 295. 1878; Duthie, Fl. Gangetic Plain 1 : 317. 1903; Bhandari, Fl. Indian Desert 148. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 300. 1987; Sanjappa, Legumes India 44. 1992. *Mimosa senegal* L. Sp. Pl. 521. 1753. *Acacia rupestris* Stock ex Boiss. Fl. Orient. 2 : 638. 1853.

Local name : *Kumatiyo*.

Medium-sized trees, 3-6 m high; bark whitish-grey; young branches pubescent. Stipular prickles 3, the two lateral ones straight or slightly curved upwards, the middle one 4-5 mm long, recurved, brown. Leaves bipinnate, 4-6.5 cm long; rachis with a gland at base and one between the upper most pair of pinnae; pinnae 3-5 pairs, 1.2-1.8 cm long, pubescent; leaflets 6-15 pairs, 1.5-5.5 x 1-2.5 mm, subsessile, linear-lanceolate to elliptic-oblong, obtuse, glabrous. Flowers creamy, fragrant, in 5-6 cm long, axillary spikes. Calyx campanulate, glabrous, ca 2 mm long; teeth larger than tube, lanceolate, obtuse. Filaments white; anthers yellow. Pods 6-8 x 1.2-2.5 cm, flat, linear-oblong, rounded or attenuated at tip, sparsely pubescent, 4 to 6-seeded. Seeds ca 1 cm in diam., dark brown, suborbicular, with a horse shoe-shaped depression on either side (Fig.-15; Plate-18/2).

*Fl. & Fr.*: July – February.

*Ecology* : Common, found in sandy plains and sometimes on the dunes, forming association with *Prosopis cineraria* (L.) Drucc, *Acacia jacquemontii* Benth. etc or its own community.

*Specimen examined* : Near Miajlar, *Monika* 16659 (BSJO).

5. *Acacia tortilis* (Forssk.) Heyne subsp. *raddiana* (Savi) Brennan in Kew Bull. 1957 : 87. 1957; Sanjappa, Legumes India 44. 1992. *Acacia raddiana* Savi, Acad. Egiz. Mem. 1. f. A-G. 1830; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 299. 1987.

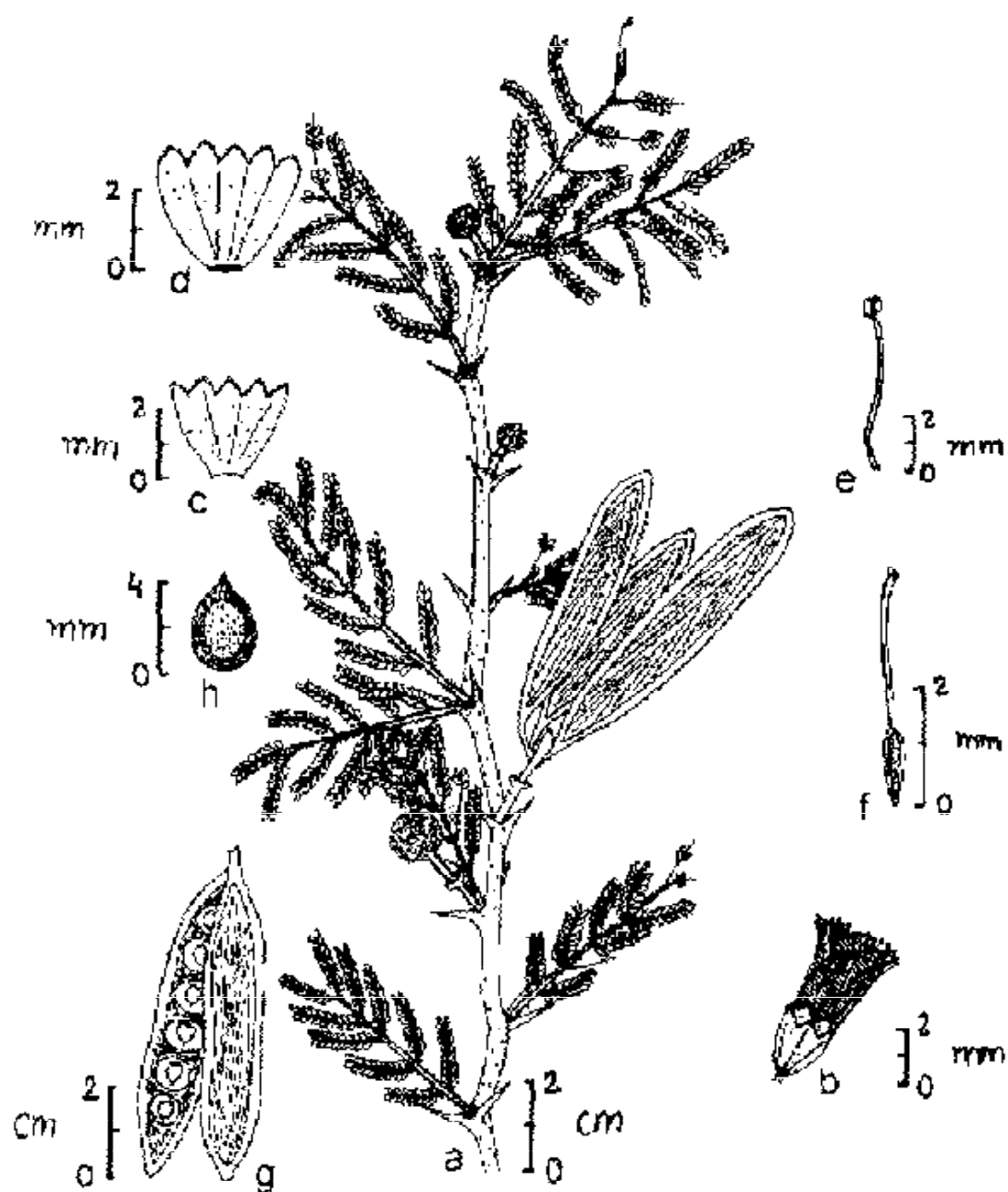


Fig. 14. *Acacia nubica* Benth. : a. Habit, b. Flower, c. Calyx within, d. Corolla within, e. Stamen, f. Gynoecium, g. Pod, h. Seed.

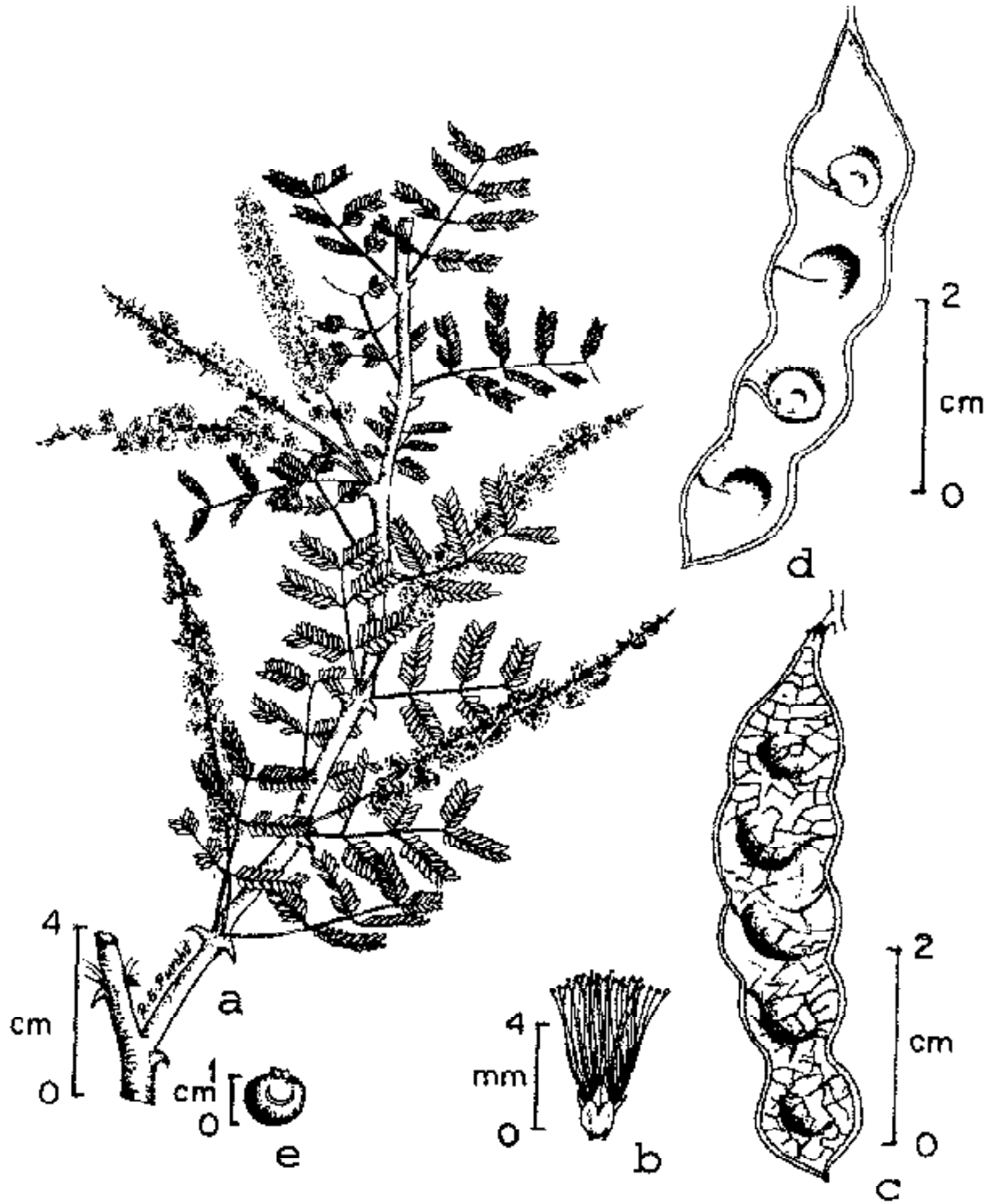


Fig. 15. *Acacia senegal* (L.) Willd. : a. Habit, b. Flower, c. Pod, d. Pod with seeds within, e. Seed.

Small trees, up to 3 m high; branches puberulous when young, glabrous at age, forming flat-topped canopy; bark reddish brown. Stipular spines up to 1 cm long, straight or some slightly recurved at apex, white. Leaves 4-5 cm long, puberulous atleast in young age; pinnae 2-5 pairs; leaflets 6-15 pairs, 4-5 x 1.5-2 mm, oblong to oblanceolate, obtuse at apex, slightly cuneate at base, entire. Flowers white or creamy, in axillary heads ca 1 cm in diam. Pods 5-12 x 0.6-0.7 cm; valves thinly coriaceous, glabrous, constricted between seeds. Seeds 6-7 x 4-5 mm, suborbicular, blackish-brown.

*Fl. & Fr.*: July-December.

*Ecology* : Introduced as a soil binder in the Park area, now it is quite naturalized.

*Specimens examined* : Near Sam, Monika 16610 (BSJO).

## 2. *ALBIZIA* Durazz.

*Albizia lebbek* (L.) Benth. in Hook. Lond. J. Bot. 3 : 86. 1844; Baker in Hook. f. Fl. Brit. India 2 : 298. 1878; Duthie, Fl. Gangetic Plain 1 : 320. 1903; Bhandari, Fl. Indian Desert 148. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 301. 1987; Sanjappa, Legumes India 56. 1992. *Mimosa lebbek* L. Sp. Pl. 516. 1753.

Local name : *Sares*.

Tall, unarmed, deciduous trees; bark greyish-brown; branches pubescent when young, glabrous at age. Leaves bipinnate, 20-35 cm long, with a large gland on petiole near base and other between upper most pair of pinnae; pinnae 2-4 pairs; leaflets 5-10 pairs, 4-5 x 2-2.5 cm, lower leaflets elliptic-oblong, terminal ones obovate-oblong, obtuse to slightly emarginate at apex, oblique at base. Flowers in umbellate heads, greenish to pale yellow, fragrant. Calyx campanulate, hairy. Corolla 6-7 mm long, pubescent outside, glabrous within. Filaments exerted, connate below in to a short tube. Pods 10-35 x 2-5 cm, linear-oblong. Seeds 4-12, ca 10 x 7.5 mm, suborbicular, flattened, shining, glabrous, pale brown.

*Fl. & Fr.*: June-November.

*Ecology* : Planted by the Forest Department in sandy plains near villages.

*Specimen examined* : Bandera R. F., Monika 16525 (BSJO).

## 3. *MIMOSA* L.

*Mimosa hamata* Willd. Sp. Pl. 4 : 1033. 1806; Baker in Hook. f. Fl. Brit. India 2 : 291. 1878; Duthie, Fl. Gangetic Plain 1 : 312. 1903; Bhandari, Fl. Indian Desert 150. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 304. 1987; Sanjappa, Legumes India 68. 1992. *Mimosa armata* Rottl. ex Spreng. Syst. Vcg. ed. 2. 2 : 206. 1825.

Local name : *Jinjani*.

Much branched, prickly shrubs, up to 2 m high. Leaves bipinnate, 2-5 cm long; rachis pubescent, sometimes prickly; pinnae 3-6 pairs, 1.2-2.5 cm long; leaflets 6-10 (14) pairs, sessile, 3-6 x 1.5-2 mm, oblong to ovate, glabrescent above, pubescent beneath, obtuse at apex, rounded at base. Stipules 2-2.5 mm long, subulate, hairy. Flowers pink, in axillary, pedunculate, prickly, globose heads crowded at the end of branches. Bracteoles 1-2, ciliate at apex, spatulate. Calyx 2-2.5 mm long; teeth short. Corolla ca 3 mm long,



divided up to middle; lobes ovate-oblong, acute. Stamens 8. Ovary stalked, pubescent. Pods 4-7.5 x 0.8-1.5 cm, falcate and twisted, 3 to 8-jointed, prickly along sutures. Seeds 5-6 x 3-4 mm, brown (**Plate-14/2**).

*Fl. & Fr.*: August – March.

*Ecology* : Rare, found in sandy to gravelly habitats, forming thickets with *Grewia tenax* (Forssk.) Fiori, *Capparis decidua* (Forssk.) Edgew., etc.

*Specimen examined* : Near Sundra, *Monika* 16708 (BSJO).

#### 4. *PROSOPIS* L.

- 1a. Internodes with conical prickles. Leaflets 7-12 pairs. Petals and ovary glabrous. Pods cylindrical, torulose. **1. *P. cineraria***
- 1b. Internodes without prickles. Leaflets more than 15-pairs. Petals and ovary hairy. Pods compressed, straight or falcate. **2. *P. juliflora***

1. *Prosopis cineraria* (L.) Druce in Rep. Bot. Soc. Exch. Club Brit. Isles 3 : 422. 1914; Bhandari, Fl. Indian Desert 151. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 307. 1987; Sanjappa, Legumes India 71. 1992. *Mimosa cineraria* L. Sp. Pl. ed. 2. 1500. 1763. *Prosopis spicigera* L. Mant. 68. 1767; Baker in Hook. f. Fl. Brit. India 2 : 288. 1878; Duthie, Fl. Gangetic Plain 1 : 309. 1903. *Adenanthera aculeata* Roxb. Fl. Ind. 2 : 371. 1832.

Local name : *Khejari*.

Medium-sized trees, 3-12 m high; bark grey, deep-fissured; branches slender, glabrous, prickly; prickles straight, scattered, 3-5 mm long. Leaves bipinnate, 6-7 cm long; rachis puberulous; pinnae usually 2 pairs; leaflets 7-12 pairs, 1-1.5 x 0.2-0.4 cm, oblong, subsessile, obliquely rounded and mucronate at apex. Flowers yellow, in 7-11 cm long, axillary spikes. Calyx 4-4.5 x 1-1.5 mm, campanulate, faintly 5-toothed. Corolla ca 3 mm long. Stamens 10. Pods 8-20 x 0.5-0.8 cm, pendulous, cylindrical, torulose, attenuated or pointed at apex, pale yellow, glabrous, 10 to 15-seeded. Seeds 4-8 x 2-5 mm, oblong, dull brown, embedded in brown pulp.

*Fl. & Fr.*: March – June.

*Ecology* : Common, found in sandy plains as well as on dunes in association with *Calotropis procera* (Ait.) R. Br., *Capparis decidua* (Forssk.) Edgew., etc.

*Specimen examined* : Barna, *Monika* 16502 (BSJO).

2. *Prosopis juliflora* (Swartz) DC. Prodr. 2 : 447. 1825; Duthie, Fl. Gangetic Plain 1 : 309. 1903; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 307. 1987; Sanjappa, Legumes India 72. 1992. *Mimosa juliflora* Swartz, Prodr. 85. 1788. *Prosopis chilensis sensu* Bhandari, Fl. Indian Desert 151. 1978, non (Molina) Stuntz 1914.

Local name : *Angreji-bavliya*.

Evergreen, large shrubs or small trees, 2-5 m or more high; branches long, sarmentose, younger ones puberulous and armed with divergent, paired or solitary, axillary, 1-3 cm long prickles. Leaves 1-3 at each node, bipinnate, 8-15 cm long; pinnae 1-2 pairs; main rachis ending in a soft bristle; leaflets 15-25 pairs, up

to 15 x 3.5 mm, obliquely oblong, obtuse, puberulous particularly along the margins. Flowers greenish-yellow, in axillary spikes, solitary or in pair at each node. Calyx campanulate, 5-toothed. Petals 5, free, tomentose on the inner surface at apex. Stamens 10, slightly exerted; anthers tipped with deciduous glands. Pods 10-25 x 0.5-1.5 cm, flat, pendulous, subfalcate, yellow. Seeds 10-25, *ca* 5.5 x 3.5 mm, ovoid, compressed, brown.

*Fl. & Fr.*: Almost throughout the year.

*Ecology*: Native of Tropical America. Found in wastelands and near habitations. It has high regeneration capacity and is most hardy species.

*Specimen examined*: Bidna, Monika 16512 (BSJO).

## 22. ROSACEAE

### NEURADA L.

*Neurada procumbens* L. Sp. Pl. 441. 1753; Hook. f. Fl. Brit. India 2 : 368. 1878; Bhandari, Fl. Indian Desert 153. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 308. 1987.

Local name : *Chapari*.

Annual, woody, diffuse or procumbent herbs; stem and branches densely tomentose. Leaves alternate, 1.5-2 x 0.8-1.2 cm, ovate-oblong, with 1-3, obtuse lobes on each side, cuneate or rounded at base, tomentose on both surfaces. Petioles *ca* 10 mm long, densely woolly. Flowers white, axillary, solitary, *ca* 4 mm in diam. Calyx-tube flat, spiny, forming a conical disc with the ripe carpels; teeth 5, triangular, 1.8-2 mm long. Petals 5, 3-7 x 1-2.5 mm, inserted on the throat of calyx-tube, obovate. Stamens 10, inserted in calyx-mouth; filaments short. Carpels 10, united with calyx-tube and also with one-another, with spinescent style at apex. Fruits *ca* 1.5 cm across, orbicular, tomentose.

*Fl. & Fr.*: September – December.

*Ecology*: Rare, found on sand-dunes and in sandy plains. Sometimes vivipary is noted as seeds germinate within carpels on the plant itself.

*Specimen examined*: Near Sam, Shetty 3453 (BSJO).

## 23. VAHLIACEAE

### VAHLIA Thunb. (*nom. cons.*)

*Vahlia digyna* (Retz.) Kuntze, Rev. Gen. Pl. 227. 1891; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 310. 1987. *Oldenlandia digyna* Retz. Obs. 4 : 23. 1786. *Vahlia viscosa* Roxb. Fl. Ind. ed. Carey 2 : 89. 1832; Clarke in Hook. f. Fl. Brit. India 2 : 399. 1878; Duthie, Fl. Gangetic Plain 1 : 331. 1903. *Bistella digyna* (Retz.) Bullock in Act. Bot. Neerl. 15 : 85. 1966; Bhandari, Fl. Indian Desert 158. 1978.

Local name : *Agio*.

Erect, annual, glandular-pubescent herbs, up to 35 cm high. Leaves opposite, sessile, 2-4.5 x 0.4-1 cm, oblong-lanceolate to ovate, subacute at apex, narrowed and amplexicaul at base, glabrescent. Flowers yellow to white, axillary, solitary or geminate, subsessile. Calyx glandular-pubescent; tube *ca* 1.5 mm long,

campanulate-hemispheric, entirely adherent to the ovary; lobes 5, triangular-ovate. Petals 5, free, shorter than calyx-lobes, triangular. Stamens 4-5. Styles 2, dark purple; stigma yellowish. Capsules subglobose, ca 3 mm across, dehiscing at apex. Seeds many, minute, ovoid.

*Fl. & Fr.*: October – January.

*Ecology* : Common, found in moist places near tanks etc in association with *Glinus lotoides* L.

*Specimens examined* : Sudasari, Monika 16692 (BSJO); By the side of pond near Berisiyala, Pandey 7873 (BSJO).

*Notes* : Yellow colour of corolla becomes dull white after anthesis.

## 24. LYTHRACEAE

### AMMANNIA L.

1a. Stem winged above. Petals and style distinct. Stamens 8.

2. *A. desertorum*

1b. Stem not winged. Petals and style absent. Stamens 4.

1. *A. baccifera*

1. *Ammannia baccifera* L. Sp. Pl. 120. 1753; Clarke in Hook. f. Fl. Brit. India 2 : 569. 1879; Duthie, Fl. Gangetic Plain 1 : 350. 1903; Bhandari, Fl. Indian Desert 157. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 321. 1987.

*Local name* : Jal-bhangra.

Annual, erect, glabrous herbs, 20-30 cm high; stem usually reddish, 4-gonous, glabrous, often with horizontal, opposite, axillary branches. Leaves opposite, 2.5-6.3 x 0.8-1.5 cm, sessile, linear-oblong or elliptic, narrowed and sometimes subauriculate at base, subobtusate at apex. Flowers sessile, in many-flowered, short, axillary cymes forming whorls in all axils; pedicels 1-2 mm long. Bracts filiform, shorter than pedicels. Calyx 1.8-2 mm long; teeth 4, broadly triangular, acute. Corolla usually absent or rudimentary. Stamens 4, inserted below the calyx-tube; filaments glabrous; anthers reddish. Capsules ca 2 mm in diam., depressed-globose, red, longer than calyx-teeth. Seeds numerous, hemispheric, black (Fig.-16).

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Occasional, found near water sources in marshy places associated with sedges.

*Specimen examined* : Satto, Monika 17118 (BSJO).

2. *Ammannia desertorum* Blatt. & Hallb. in J. Bombay Nat. Hist. Soc. 26 : 213. 1918; Bhandari, Fl. Indian Desert 157. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 322. 1987.

Erect, annual, scabrous, papillose herbs; stem much-branched, stout, sharply quadrangular and narrowly winged above. Leaves opposite, 2-7 x 0.4-0.8 cm, lanceolate, acute or subobtusate at apex, auricled at base, margins reflexed. Flowers purple, in axillary, 2 to 6-flowered cymes; pedicels 1-2 mm long, stout. Bracteoles subulate, small. Calyx leathery, 8-nerved, ca 2 mm long, enlarging in fruit; teeth 4, broadly triangular, apiculate. Petals 4, 1-1.2 mm long, obovate. Stamens 8, inserted at 1/3<sup>rd</sup> of the tube from base. Style persistent, as long as ovary. Capsules ca 3 x 2 mm, reddish-brown, upper small portion not covered by calyx, pericarp transparent. Seeds many, semiglobose, yellowish-brown.

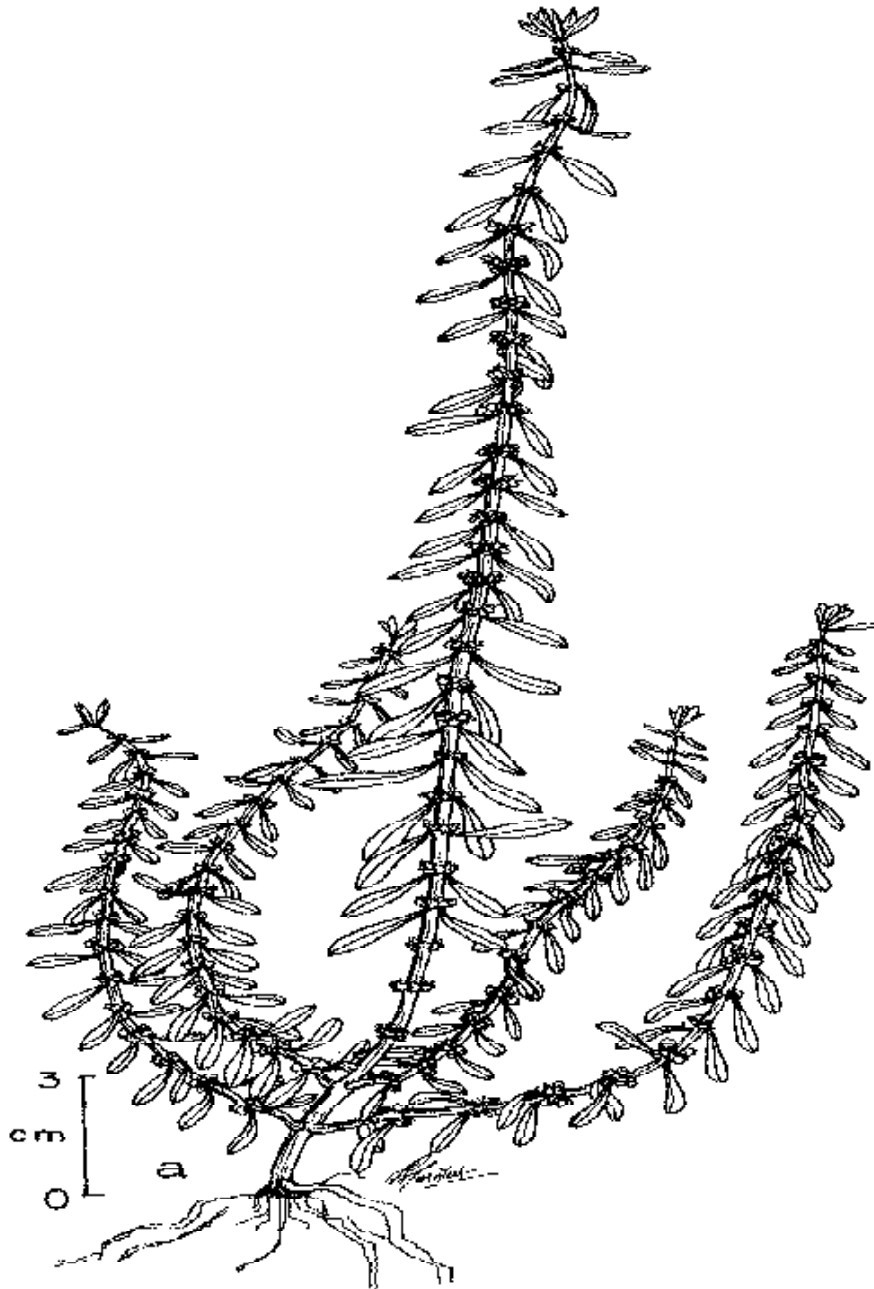


Fig. 16. *Ammanniu baccifera* L. : a. Habit.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Rare, found in moist sandy places near water sources.

*Specimen examined* : DNP, Tiwari 867 (BSJO).

## 25. CUCURBITACEAE

- |   |                        |
|---|------------------------|
| 1a. Bracts conspicuous, stipuliform, fimbriate, at the base of pedicels.                            | 4. <i>Dactyliandra</i> |
| 1b. Bracts neither stipuliform nor fimbriate, either absent or not located at the base of pedicels. | 2                      |
| 2a. Anther-cells flexuous or conduplicate.  | 3                      |
| 2b. Anther-cells straight or curved, not conduplicate.  | 5. <i>Melothria</i>    |
| 3a. Corolla yellow, rotate or if campanulate then 5-partite to the base.                            | 4                      |
| 3b. Corolla white, campanulate, divided less than half way down.                                    | 2. <i>Coccinia</i>     |
| 4a. Petals with 2-3 scales at the base. Male flowers with large, sessile bracts.                    | 6. <i>Momordica</i>    |
| 4b. Petals without scales at the base. Male flowers ebracteate.                                     | 5                      |
| 5a. Connectives produced above the anther-cells into an appendage.                                  | 3. <i>Cucumis</i>      |
| 5b. Connectives not produced above the anther-cells.  | 1. <i>Citrullus</i>    |

### 1. *CITRULLUS* Schrad. ex Eckl. & Zeyh. (*nom. cons.*)

- |   |   |
|---|---|
| 1a. Plants perennial. Leaves crisped. Tendrils simple. Fruit-pulp bitter in taste.                          | 1. <i>C. colocynthis</i>                    |
| 1b. Plants annual. Leaves not crisped. Tendrils 2 to 4-fid. Fruit-pulp not bitter in taste.                 | 2   |
| 2a. Plants softly hairy. Tendrils 2-fid. Fruits more than 15 cm in diam., glabrous. Seeds not marginate.    | 2. <i>C. lanatus</i> var. <i>lanatus</i>    |
| 2b. Plants hispid hairy. Tendrils 3 to 4-fid. Fruits up to 10 cm in diam., sparsely hairy. Seeds marginate. | 3. <i>C. lanatus</i> var. <i>fistulosus</i> |

1. *Citrullus colocynthis* (L.) Schrad. in *Linnaea* 12 : 414. 1838; Clarke in Hook. f. *Fl. Brit. India* 2 : 620. 1879; Duthie, *Fl. Gangetic Plain* 1 : 374. 1903; Bhandari, *Fl. Indian Desert* 161. 1978; Chakravarty, *Fl. India Fasc.* 11 : 20. f. 1-7. 1982; Pandey in Shetty & Singh, *Fl. Rajasthan* 1 : 333. 1987. *Cucumis colocynthis* L. *Sp. Pl.* 1011.1753.

Local name : *Tumbo*.

Perennial, trailing herbs; stem angular, slender, branched, hirsute or scabrid at age. Leaves 3-10 x 2-8 cm, deltoid in outline, cordate, 3 to 5-lobed; lobes obtuse, sinuate-pinnatifid, terminal lobe large, margins crisped. Petioles 3-4 cm long, terete, scabrid or hirsute. Tendrils simple, slender, short, hirsute below, almost glabrous above. Male flowers on 1-1.5 cm long peduncles in the axils of greenish-yellow, spoon-shaped bracts. Calyx-tube 4-5 mm long, broadly campanulate, green, covered with white, hispid hairs; lobes 3-4 mm long. Corolla yellowish-green; lobes 8-10 x 5-6 mm, ovate, 5-nerved from base, acute at apex. Stamens 3. Ovary obovate, hirsute. Fruits globose, 5-7.8 cm long and as much broad, variegated green, mottled with yellowish blotches arranged in undulating bands, pulp yellow and very bitter. Seeds obovate or ovate-oblong, ca 6 x 3 mm, yellowish-brown (Plate-19/3).

*Fl. & Fr.*: May – October.

*Ecology* : Common, found in sandy plains, particularly near cultivated fields in association with *Boerhavia diffusa* L., *Tribulus terrestris* L., etc.

*Specimens examined* : Near Sudasari, *Monika* 16509, 16560 (BSJO); Berisiyala, *Pandey* 7859 (BSJO).

2. *Citrullus lanatus* (Thunb.) Matsumura & Nakai in Cat. Sem. Spar. Hort. Bot. Univ. Imp. Tokyo 1916 : 30. 1916; Bhandari, Fl. Indian Desert 163. 1978; Chakravarty, Fl. India Fasc. 11 : 22. 1982; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 334. 1987. *Momordica lanata* Thunb. Prodr. Pl. Cap. 13. 1794. *Citrullus vulgaris* Schrad. in Eckl. & Zeyher, Enum. Pl. Afr. Austr. 279. 1836; Clarke in Hook. f. Fl. Brit. India 2 : 621. 1879; Duthie, Fl. Gangetic Plain 1 : 375. 1903.

var. *lanatus*

Local name : *Matiro*.

Trailing, annual herbs; stem angular, villous. Leaves 6-15 x 3-12 cm, triangular-ovate in outline, cordate, more or less scabrid, deeply trifid; lobes pinnatifid, obovate, oblong, lanceolate or linear, middle lobe the largest, lateral ones rounded. Petioles 6-12 cm long. Tendrils bifid. Male flowers greenish-yellow, in the axils of spoon-shaped bracts; peduncles villous, 1-5 cm long. Calyx-tube broadly campanulate, villous; lobes narrowly lanceolate. Corolla villous; lobes ovate-oblong. Female flowers greenish-yellow; peduncles 2-6 cm long. Calyx and corolla as in the males. Ovary oblong, lanate; style 4-5 mm long. Fruits large, 15-30 cm in diam., subglobose or oblong-ellipsoid, smooth, green or variegated with longitudinal, irregular dark green bands; pulp sweet, pinkish-red. Seeds black or reddish-brown, 5-10 mm long, compressed.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in sandy plains, often cultivated for its fruits.

*Specimen examined* : Sudasari, *Monika* 16561 (BSJO).

3. *Citrullus lanatus* (Thunb.) Matsumura & Nakai var. *fistulosus* (Stocks) Chakravarty, Fl. India Fasc. 11 : 23. 1982; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 335. 1988. *Citrullus fistulosus* Stocks in Hook. Kew J. Bot. 3 : 74. t. 3. 1851; Bhandari, Fl. Indian Desert 162. 1978. *Colocynthis citrullus* (L.) O. Kuntze var. *fistulosus* (Stocks) Chakravarty in Rec. Bot. Surv. India 17 (1) : 114. 1959.

Local name : *Tindsi*.

Annual, prostrate herbs; stem fistulous, hispid; branches angular, thick, stout, sulcate when dry, pubescent. Leaves 8-12 cm long, broadly ovate in outline, sparingly lobed, hispid, hairy below when young, more or less glabrous above with age. Petioles 6-11 cm long. Tendrils 3 to 4-fid. Male flowers yellow, solitary or geminate, axillary. Calyx 1-1.5 mm long, villous; teeth subulate. Corolla ca 5 x 3 mm, hispid outside. Stamens 3; two anthers 2-celled, one 1-celled, flexuous. Female flowers yellow. Calyx and corolla as in males; disc collar-shaped around the style. Ovary subglobose, hispid. Fruits 4-10 cm across, on thick, downwardly curved stalks, subglobose, depressed at both ends, hairy. Seeds 6-10 x 3-5 mm, black, marked on both sides by an elevated marginal ridge.

*Fl. & Fr.*: July – December.

*Ecology* : Common, found wild in sandy plains, also cultivated for its fruits used as vegetable.

*Specimens examined* : Near Sam, *Monika* 16562 (BSJO); Near Kanoi, *Monika* 16732 (BSJO).

2. *COCCINIA* Wight & Arn.

*Coccinia grandis* (L.) J. O. Voigt, Hort. Suburb. Calc. 59. 1845; Bhandari, Fl. Indian Desert 163. 1978; Chakravarty, Fl. India Fasc. 11 : 24. f. 1-9. 1982; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 335. 1987. *Bryonia grandis* L. Mant. Pl. 1 : 126. 1767. *Coccinia indica* Wight & Arn. Prodr. 347. 1834; Duthie, Fl. Gangetic Plain 1 : 376. 1903. *Cephalandra indica* (Wight & Arn.) Naud. in Ann. Sci. Nat. ser. 5. 5 : 16. 1859; Clarke in Hook. f. Fl. Brit. India 2 : 621. 1879, *excl. syn.*

Local name : *Golo*.

Perennial, scandent, dioecious herbs; stem angular, glabrous. Leaves 3-10 cm long, palmately lobed, base cordate, bright green above, with few, glistening glands beneath, margins minutely denticulate. Petioles 1-2.5 cm long, slender. Tendrils simple, slender. Male flowers white; peduncles 2-6 cm long, subfiliform, striate. Calyx-tube 4-5 mm long, campanulate; teeth 3-4 mm long. Corolla 2-3 cm long. Staminal column 2-3 mm long; anthers 5-6 mm thick. Female-flower peduncles 1-3 cm long, slender. Staminodes 3. Ovary 10-12 x 2-3 mm; stigma densely papillose. Fruits 2-5 x 1-3 cm, rounded at both ends, ellipsoidal, streaked with white when young, scarlet when ripe; pulp red, juicy. Seeds 5-7 x 2-3 mm, yellow, oblong, rounded at apex, notched at the base.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Occasional, found in gravelly habitats and in wastelands among the thickets of *Capparis decidua* (Forssk.) Edgew.

*Specimens examined* : Near Bidna, Monika 16634 (BSJO); Near Sundra, Monika 17163 (BSJO).

3. *CUCUMIS* L.

- |   |   |
|---|---|
| 1a. Fruits smooth, glabrous or pubescent.   | 2                                       |
| 1b. Fruits echinate.  | 3. <i>C. prophetarum</i>                |
| 2a. Annuals. Leaves angular or shallowly lobed. Male flowers fasciculate. Epicarp thin. | 2. <i>C. melo</i> var. <i>momordica</i> |
| 2b. Perennials. Leaves deeply lobed. Male flowers solitary. Epicarp thick.              | 1. <i>C. callosus</i>                   |

1. *Cucumis callosus* (Rottl.) Cogn. in Engl. Das. Pflanzenreich 88 : 129. 1924; Bhandari, Fl. Indian Desert 168. 1978; Chakravarty, Fl. India Fasc. 11 : 31. 1982; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 337. 1987. *Bryonia callosa* Rottl. Neue Schrift. Ges. Nat. Freunde Zu Berlin 4 : 210. 1803. *Cucumis trigonus* Roxb. Fl. Ind. 2 : 722. 1824; Clarke in Hook. f. Fl. Brit. India 2 : 619. 1879; Duthie, Fl. Gangetic Plain 1 : 373. 1903.

Local name : *Kachri*.

Monoecious, prostrate or trailing herbs; stem slender, angular, rough with short, rigid hairs. Leaves 3-7 x 3-6 cm, suborbicular in outline, cordate at base, palmately 5 to 7-lobed; lobes ovate-oblong, narrowed at base, apex rounded, margins dentate or lobulate. Petioles 2-6 cm long, hispid. Tendrils simple, hispid. Male flowers yellow, often solitary; peduncles 0.5-1 cm long. Calyx-tube ca 3 mm long, hispid, narrowly campanulate; lobes subulate. Corolla 6-7 mm long, hispid outside; lobes ovate-oblong. Staminal filaments short; anthers ca 2 mm long, appendages of the connectives shorter than the anthers. Female flowers yellow, axillary; peduncles 2-2.5 cm long. Ovary densely hairy. Fruits rounded, obovoid or ellipsoid, 3-6 x 3-4 cm, longitudinally



variegated with green stripes, pulp bitter when young. Seeds 4-5 x 1.5-2 mm, oblong or ellipsoid, white, margined.

*Fl. & Fr.*: August – November.

*Ecology* : Common, found in sandy plains and in and around cultivated fields.

*Specimen examined* : Near Nimba, *Monika* 1663 (BSJO).

2. *Cucumis melo* L. var. *mumordica* Duthic & Fuller in *Field & Gard. Crops* 2 : 50, t. 49, 1882; Duthic, *Fl. Gangetic Plain* 1 : 372, 1903; Bhandari, *Fl. Indian Desert* 169, 1978; Pandey in Shetty & Singh, *Fl. Rajasthan* 1 : 338, 1987. *C. melo* L. var. *melo sensu* Chakravarty, *Fl. India Fasc.* 11 : 34, 1982, non L. 1753.

*Local name* : *Kachro, Kakrio.*

Prostrate, annual herbs; stem and branches angular, hispid. Leaves 6-10 x 5.5-10 cm, suborbicular or reniform, 3 to 7-lobed; lobes shallowly rounded-cordate at base, more or less dentate, sparsely hairy on both surfaces. Tendrils simple, sparsely hispid. Male flowers yellow, 1-3 on axillary peduncles. Calyx-tube campanulate, 4-5 mm long, hairy; lobes 5-6 mm long, linear-lanceolate, hispid. Corolla-lobes up to 1.8 cm long, ovate-oblong, hispid and glandular outside. Staminal filaments glabrous, appendages of the connectives *ca* 1 mm long. Female flowers axillary, solitary, yellow; peduncles 1-2 cm long. Calyx and corolla same as in male flowers. Ovary pyriform, woolly. Fruits variable in size, usually cylindrical, 10-40 x 5-15 cm, yellow or greenish-yellow with blotches in irregular, longitudinal lines. Seeds 7-10 x 2-3.5 mm, oblong, emarginate, obtuse at apex, subacute at base, pale yellow.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in sandy plains; also cultivated for its fruits with the crop of Bajra and other rainy season crops.

*Specimen examined* : Near Sam, *Monika* 16552 (BSJO).

3. *Cucumis prophetarum* L., *Cent. Pl.* 33, 1755; Clarke in Hook. f. *Fl. Brit. India* 2 : 619, 1879; Duthic, *Fl. Gangetic Plain* 1 : 373, 1903; Bhandari, *Fl. Indian Desert* 169, 1978; Chakravarty, *Fl. India Fasc.* 11 : 35, 1982; Pandey in Shetty & Singh, *Fl. Rajasthan* 1 : 339, 1987.

*Local name* : *Khato-kachario.*

Perennial, prostrate or climbing, hispid herbs; stem slender, angular, sulcate when dry, hispid or bristly with aculeate, white hairs. Leaves 2-4 cm long and as much broad, suborbicular, cordate or truncate at base, margins crisped, scabrous, 3 to 5-lobed. Petioles 2-4 cm long, hirsute with bulbous-based hairs. Tendrils simple, short, filiform, scabrid. Male flowers yellow, fasciculate or solitary on axillary peduncles 4-10 mm long. Calyx campanulate; tube *ca* 4 x 2 mm, densely hispid; lobes 3-4 mm long, linear, spreading. Corolla sparsely villous; lobes ovate-oblong. Staminal filaments filiform; anthers *ca* 2.5 mm long, oblong, hispid, connectives slightly dilated at apex and glandular. Female flowers axillary, solitary, yellow; peduncles 2-5 mm long, enlarging in fruits. Calyx and corolla as in the males. Ovary minutely muriculate. Fruits broadly ovoid, 3-4 x 2-3.5 cm, sparsely echinate, green with longitudinal, 7-10 white stripes, ultimately yellow. Seeds ellipsoid-oblong, pale green, not marginate (*Plate-14/3*).

*Fl. & Fr.*: August – January.

*Ecology* : Common, found in sandy plains, particularly among thickets of shrubs and on fencing of cultivated fields.

*Specimen examined* : Along Miajlar road, Shetty 3395 (BSJO).

#### 4. *DACTYLIANDRA* (Hook. f.) Hook. f.

*Dactyliandra welwitschii* Hook. f. in Oliver, Fl. Trop. Afr. 2 : 557. 1871; Bhandari & Singh in Kew Bull. 19 : 133. 1964; Bhandari, Fl. Indian Desert 170. 1978; Chakravarty, Fl. India Fasc. 11 : 46. 1982; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 340. 1987.

Local name : *Ankh-phootani*.

Annual, monoecious, climbing herbs, with slender, much-branched, scabrid, angular stem furrowed when dry. Leaves 5-8 x 3-5 cm, digitately 3 to 5-lobed, deeply cordate at base; lobes oblong to obovate, obtuse to rounded and mucronate or acute at apex, coarsely dentate or serrate along margins. Petioles angled, as long as the lamina, scabrid. Tendrils simple, slender, sulcate when dry. Bracts sessile, ca 1.5 cm in diam., stipuliform, suborbicular or reniform, shortly setose. Male flowers white, bracteate, solitary, axillary. Female flowers axillary, in fascicles of 3; pedicels 1-1.5 mm long. Bracts minute, deciduous. Hypanthium campanulate, ca 2.5 mm long, hairy and glandular around rim inside. Calyx slightly shorter than corolla, a little longer than wide; teeth 1-1.5 mm long. Corolla-lobes ovate-oblong. Stamens 3, attached at the base of hypanthium, connectives not produced. Ovary ellipsoid, glabrous; stigmatic lobes 2, fleshy. Fruits ca 1.3 cm in diam., ellipsoid-globose, smooth, with green and white blotches. Seeds 8-15, angled and asymmetrical, cissoid, compressed, obliquely narrowed at both ends, truncate at apex, brown.

*Fl. & Fr.*: August – November.

*Ecology* : Rare, found among fencing of cultivated fields and climbing on thickets of shrubs, particularly on *Capparis decidua* (Forssk.) Edgew.

*Specimen examined* : Near Girah, Monika 17137 (BSJO).

#### 5. *MELOTHRIA* L.

*Melothria maderaspatana* (L.) Cogn. in DC. Monog. Phan. 3 : 623. 1881; Duthie, Fl. Gangetic Plain 1 : 379. 1903; Chakravarty, Fl. India Fasc. 11 : 83. 1982; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 345. 1987. *Cucumis maderaspatana* L. Sp. Pl. 1012. 1757. *Mukia scabrella* Arn. in Hook. J. Bot. 3 : 276. 1841; Clarke in Hook. f. Fl. Brit. India 2 : 623. 1879, *excl. syn.* *Bryonia scabrella* L. f. 1781. *Mukia maderaspatana* (L.) M. Roem. Syn. Pepon. 47. 1846; Bhandari, Fl. Indian Desert 175. 1978.

Local name : *Ankh-phutuni-ki-bel*.

Annual, monoecious, scandent or prostrate herbs; stem angular, sulcate, much-branched, hairy. Leaves much variable in shape, size, form and texture, 4-15 x 3-13 cm, ovate or subdeltoid, 3 to 5-lobed or entire, acute, minutely denticulate, upper surface scabrous. Petioles 2-5 cm long, hispid. Tendrils simple, slender, aculeate-hispid. Male flowers yellow, in small fascicles on short, axillary peduncles. Calyx-tube ca 2 x 1 mm, villous or hirsute; lobes ovate-oblong, rounded at apex. Corolla ca 2 mm long, pilose outside. Staminal filaments 0.4-0.5 mm long; anthers oblong, ciliate, connectives produced into a bifid apex. Female flowers

almost sessile, solitary or fasciated. Ovary subglobose, covered with blackish setae. Fruits 4-5 mm in diam., globose, glabrous, green, red when mature. Seeds 2-3.5 x 1-2.5 mm, grey, ovoid-oblong, marginate.

*Fl.*: July – October; *Fr.*: September – December.

*Ecology* : Very common, found in sandy plains and near cultivated fields climbing on bushes and shrubs.

*Specimens examined* : Sam, *Monika* 16599 (BSJO); Near Kanoi, *Monika* 16731 (BSJO).

## 6. MOMORDICA L.

*Momordica charantia* L. Sp. Pl. 1009. 1753; Clarke in Hook. f. Fl. Brit. India 2 : 616. 1879; Duthie, Fl. Gangetic Plain 1 : 369. 1903; Bhandari, Fl. Indian Desert 173. 1978; Chakravarty, Fl. India Fasc. 11 : 89. f. 8-10. 1982; Pandey in Shetty & Singh, Fl. Rajasthan 1 : 346. 1987.

Local name : *Karelo*.

Annual, monoecious, much-branched, prostrate or trailing herbs; stem angular, grooved, hairy. Leaves 5-10 x 4-10 cm, suborbicular or reniform in outline, 5 to 6-lobed, glabrous; lobes ovate-oblong, acute or subacute at apex, constricted at base, coarsely spinous-dentate. Petioles 3-5 cm long, channelled, pubescent. Tendrils simple, slender, pubescent. Male flowers axillary, solitary, yellow. Bracts leafy, ca 6 mm long, subreniform, slightly mucronate, inserted at or below the middle on pedicels. Corolla-lobes obtuse or emarginate. Female flowers on long, slender, axillary pedicels. Bracts inserted at or near the base of pedicels. Stamines 3, glanduliform. Ovary fusiform, ribbed with numerous muricate-tubercles. Fruits 5-16 cm long, muricate-tuberculate, oblong. Seeds 1-1.5 x 0.5-0.8 cm, oblong, compressed, sculptured on surface, sub-tridentate at base and apex, creamish-yellow.

*Fl. & Fr.*: July – November.

*Ecology* : Not common in wild state, usually found in sandy, moist plains near habitations as an escape from cultivation.

*Specimen examined* : Khet Singh-ki-dhani, *Monika* 17135 (BSJO).

## 26. AIZOACEAE

- |   |                      |
|---|----------------------|
| 1a. Style 1.  | 2. <i>Trianthema</i> |
| 1b. Styles 2-5.   | 2                    |
| 2a. Flowers solitary. Operculum of capsules entire, not splitting. Seeds more than 4.               | 1. <i>Sesuvium</i>   |
| 2b. Flowers many, in glomerulate fascicles. Operculum of capsules splitting into 2 valves. Seeds 4. | 3. <i>Zaleya</i>     |

### 1. SESUVIUM L.

*Sesuvium sesuvioides* (Fenzl.) Verdc. in Kew Bull. 12 : 349. 1957; Raizada, Suppl. Duthie, Fl. Gangetic Plain 85. 1976; Bhandari, Fl. Indian Desert 183. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 354. 1987. *Diplochonium sesuvioides* Fenzl. Nov. Stirp. Dec. 7 : 58. 1839 & in Ann. Wien. Mus. 2 : 292. 1839. *Trianthema hydaspicum* Edgew. in J. Linn. Soc. Bot. 6 : 203. 1862; Clarke in Hook. f. Fl. Brit. India 2 : 661. 1879.

Annual, prostrate, succulent herbs; stem cylindrical, crystalline-papillose. Leaves alternate to opposite, 2-4.5 x 0.5-1.2 cm, linear or obovate-oblong, fleshy, obtuse at apex, more or less cuneate at base, entire. Petioles 3-8 mm long. Flowers pinkish-purple, axillary, solitary or in clusters, sessile. Perianth-tube obconic, prominently longitudinally nerved, as long as the lobes; lobes 5, triangular-elongate, acute, green outside, pink inside, dilated at the base, producing 5 dorsal horns at sinus. Stamens 5-7, free; anthers pink. Ovary bilocular; beak elongate-conical, hollow; styles 2, white. Capsules 4-6 mm long, dehiscent by a conical cap. Seeds 6-9 in each locule, rugose, dark brown.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in moist places in association with *Trianthema triquetra* Rottl. ex Willd., *Zaleya govindia* (Buch.-Ham. ex G. Don) Nair, etc.

*Specimen examined* : Near Sehmar, *Monika* 16615 (BSJO).

*Notes* : Stem colour varies from green to pinkish or yellowish-green.

## 2. *TRIANTHEMA* L.

*Trianthema triquetra* Rottl. ex Willd. in Ges. Nat. Fr. Neue Schr. 4 : 181. 1803; Bhandari, Fl. Indian Desert 184. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 355. 1987. *Trianthema crystallina* auct. plur. non Vahl 1790; Clarke in Hook. f. Fl. Brit. India 2 : 660. 1879; Duthie, Fl. Gangetic Plain 1 : 385. 1903.

Local name : *Lunki*.

Prostrate, succulent, annual herbs; branches many, radiating, terete, often reddish and papillose. Leaves 0.8-1.8 x 0.3-0.4 cm, linear or lanceolate, glabrous, succulent, dilated at petiolar base into a semi-amplexicaul sheath. Petioles ca 3 mm long. Flowers pink, axillary, solitary or in clusters of 2-5. Perianth longitudinally ribbed, 5-cleft upto half way down; tube obconical; lobes ovate-triangular, obliquely erect, recurved. Stamens 5, shorter than the perianth-lobes and alternate; anthers purplish. Ovary obconical, turbinate, depressed above centrally around the excentric style. Capsules enclosed within perianth-tube; operculum thick, usually falling off with a single seed, the other seeds remaining in the basal part of the capsule. Seeds orbicular, concavo-convex, faintly ribbed, brownish-black.

*Fl. & Fr.*: August – December.

*Ecology* : Occasional, found in moist sandy plains in association with *Zaleya govindia* (Buch.-Ham. ex G. Don) Nair.

*Specimens examined* : Near Sudasari, *Monika* 16564 (BSJO); Along Miajlar road, *Monika* 17139 (BSJO).

*Notes* : Stem colour becomes dark pink on maturity.

## 3. *ZALEYA* Burm. f.

*Zaleya govindia* (Buch.-Ham. ex G. Don) Nair in Bull. Bot. Surv. India 8 : 86. 1966; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 356. 1987. *Trianthema govindia* Buch.-Ham. ex G. Don, Gen. Syst. 3 : 72. 1834. *T. pentandra* auct. non L., 1767; Clarke in Hook. f. Fl. Brit. India 2 : 660. 1879; Duthie, Fl. Gangetic Plain 1 : 386. 1903.

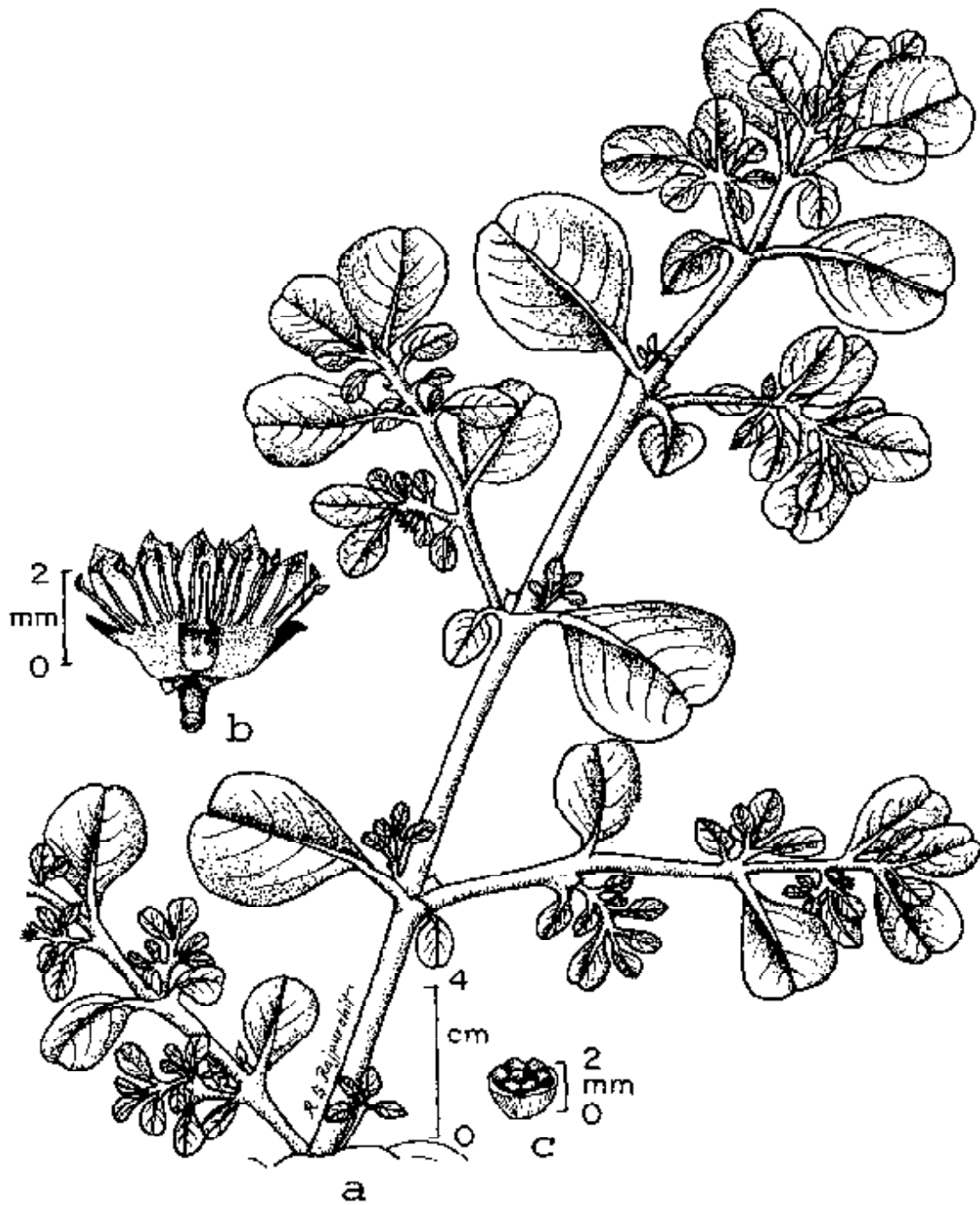


Fig. 17. *Zaleya govindia* (Buch.-Ham. ex G. Don) Nair : a. Habit, b. Flower, c. Portion of fruit with seeds.

Local name : *Santhi*.

Annual, slightly succulent, prostrate or decumbent herbs; stem slender, subwoody at base; branches papillose when young. Leaves 2-3.5 x 0.8-2 cm, opposite, oblanceolate or elliptic, obtuse at apex, cuneate or rounded at base, minutely papillose on both surfaces, papillae prominent on midrib and petiole. Petioles 5-10 mm long, membranous, winged and sheathing at the base. Flowers pink, 3-10 in axillary clusters, sessile. Bracts triangular, acuminate, entire. Perianth lobes 5, pink inside, each with a subapical green horn. Stamens 5; anthers and filaments pink. Styles 2, pink. Capsules 4-5 mm long, red; operculum top saucer-shaped, edges sharp and prolonged into 2-5, irregular teeth, yellowish-brown. Seeds 4, subreniform, corrugated, black (Fig.-17).

*Fl. & Fr.*: August-December.

*Ecology* : Rare, found in sandy to gravelly habitats in association with *Trianthema triquetra* Rottl. ex Willd.

*Specimens examined* : Near Sudasari, *Monika* 16564 (BSJO); Sam, *Monika* 16714, 16720 (BSJO); Tejaraon, *Pandey* 7895 (BSJO).

*Notes* : Stem colour varies from green to dark pink.

## 27. MOLLUGINACEAE

- |   |                   |
|---|-------------------|
| 1a. Plants viscid-glandular hairy. Leaves subopposite. Ovary bicarpillary.                                  | 3. <i>Linum</i>   |
| 1b. Plants glabrous or hairy, but not viscid. Leaves whorled or opposite. Ovary 3 to 5-carpellate.          | 2                 |
| 2a. Raphids distinct in leaves and sepals. Carpels free.  | 1. <i>Gisekia</i> |
| 2b. Raphids absent. Carpels united.   | 3                 |
| 3a. Plants stellately pubescent. Flowers in axillary clusters. Seeds distinctly strophiolate.               | 2. <i>Glinus</i>  |
| 3b. Plants glabrous. Flowers in terminal or axillary pedunculate cymes. Seeds not or minutely strophiolate. | 4. <i>Mollugo</i> |

### 1. GISEKIA L.

*Gisekia pharnaceoides* L. Mant. Alt. 2 : 562. 1771; Clarke in Hook. f. Fl. Brit. India 2 : 664. 1879; Duthie, Fl. Gangetic Plain 1 : 388. 1903; Bhandari, Fl. Indian Desert 179. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 357. 1987.

Local names : *Morang, Chapari*.

Diffuse or prostrate herbs; stem pale, terete or ridged below the nodes. Leaves usually opposite, sessile or obscurely petiolate, 2-3.5 x 0.4-0.5 cm, linear or linear-lanceolate or oblanceolate-spathulate, obtuse at apex, cuneate at base, more or less fleshy. Flowers greenish-white to pink, in pedunculate, umbelliform, crowded to lax, 10 to 30 flowered cymes. Calyx-lobes 5, 2-2.5 mm long; fruiting calyx with membranous margins, often with a mucro behind the tip. Stamens 5; filaments dilated at the base; anthers pink. Carpels 5, membranous, surrounded by sepals, densely covered with warts. 1-seeded. Seeds compressed, rounded on the back, subreniform, black (Fig.-18).

*Fl. & Fr.*: August - November.

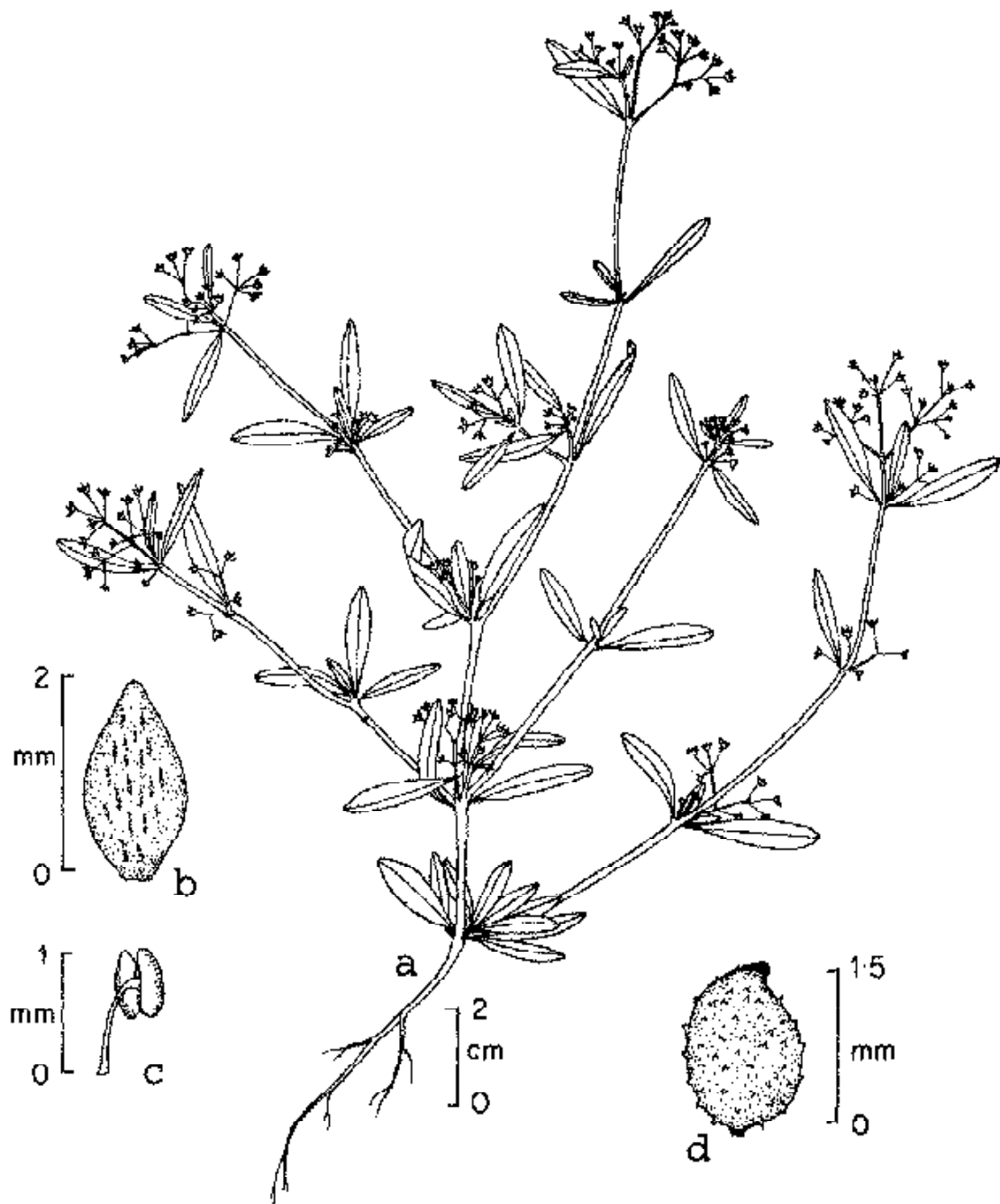


Fig. 18. *Gisekia pharnaceoides* L. : a. Habit, b. Sepal, c. Stamen, d. Seed.

*Ecology* : Common, found in moist sandy plains in association with *Cleome gynandra* L., *Tribulus pentandrus* Forssk., etc.

*Specimens examined* : Sam, Monika 16616 (BSJO); Near Kanoi, Monika 16747 (BSJO).

*Notes* : Great variations have been noticed in the size of plant, leaves and flowers; colour of stem and leaves varies from green to pinkish-green and flower colour varies from white to pink.

## 2. *GLINUS* L.

*Glinus lotoides* L. Sp. Pl. 463, 1753; Bhandari, Fl. Indian Desert 179, 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 358, 1987. *Mollugo hirta* Thunb. Prodr. Pl. Cap. 24, 1794; Clarke in Hook. f. Fl. Brit. India 2 : 662, 1879; Duthie, Fl. Gangetic Plain 1 : 386, 1903.

Local name : *Bakda*.

Annual, prostrate, densely stellate-pubescent herbs; branches radically spreading, greyish-green. Leaves opposite or apparently verticillate, petiolate, 1-2.5 x 0.3-0.5 cm, elliptic-obovate or suborbicular, obtuse at apex, cuneate at base, stellate pubescent on both surfaces. Flowers greenish-white, in axillary fascicles; pedicel 2-4 mm long. Perianth-segments 4-8.5 mm long, free, acute to acuminate or mucronate, keeled; inner lobes with broad membranous edges. Stamens 10-15, sometimes up to 20; staminodes 0-7, two prolonged at the apex forming outer stamens. Ovary ovoid, glabrous; carpels 3-5, with as many stigmas. Capsules ovoid, enclosed within enlarged calyx. Seeds many, subreniform, faintly tuberculate, dark brown.

*Fl. & Fr.* : Almost throughout the year.

*Ecology* : Common in dried muddy water bodies in association with *Bergia suffruticosa* (Delile) Fenzl., *Cyperus rotundus* L., etc.

*Specimens examined* : Near Girab, Monika 16528 (BSJO); Tejaraon, Monika 16677 (BSJO); Berisiyala, Pandey 7867 (BSJO).

## 3. *LIMEUM* L.

*Limeum indicum* Stocks ex T. Anders. in J. Linn. Soc. Bot. 5 (Suppl. 1) : 30, 1860; Clarke in Hook. f. Fl. Brit. India 2 : 664, 1879; Raizada, Suppl. Duthie, Fl. Gangetic Plain 84, 1976; Bhandari, Fl. Indian Desert 180, 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 359, 1987.

Much-branched, prostrate, perennial herbs; branches divaricate, spreading radially, glandular-pubescent at least when young. Leaves subopposite, 2-5 x 1-2 cm, broadly elliptic or rotundate, mucronate, entire, glandular pubescent, on drying white papillose. Petioles 3-8 mm long, dilated at the base. Flowers white or cream, crowded in sessile or subsessile, axillary cymes. Bracts small, linear, glandular. Calyx-lobes ca 2 mm long, ovate, acute, glandular, membranous along margins. Petals ca 1.6 mm long, clawed, obliquely toothed at apex. Stamens 6-7, in two whorls; filaments dilated and slightly united at the base, 2 outer stamens longer and free. Stigmas 2. Fruits subglobose, 2-seeded, separating into 2, one-seeded cocci. Seeds ca 1.2 x 1.5 mm, smooth, concavo-convex, yellowish-brown.

*Fl. & Fr.* : August – October.



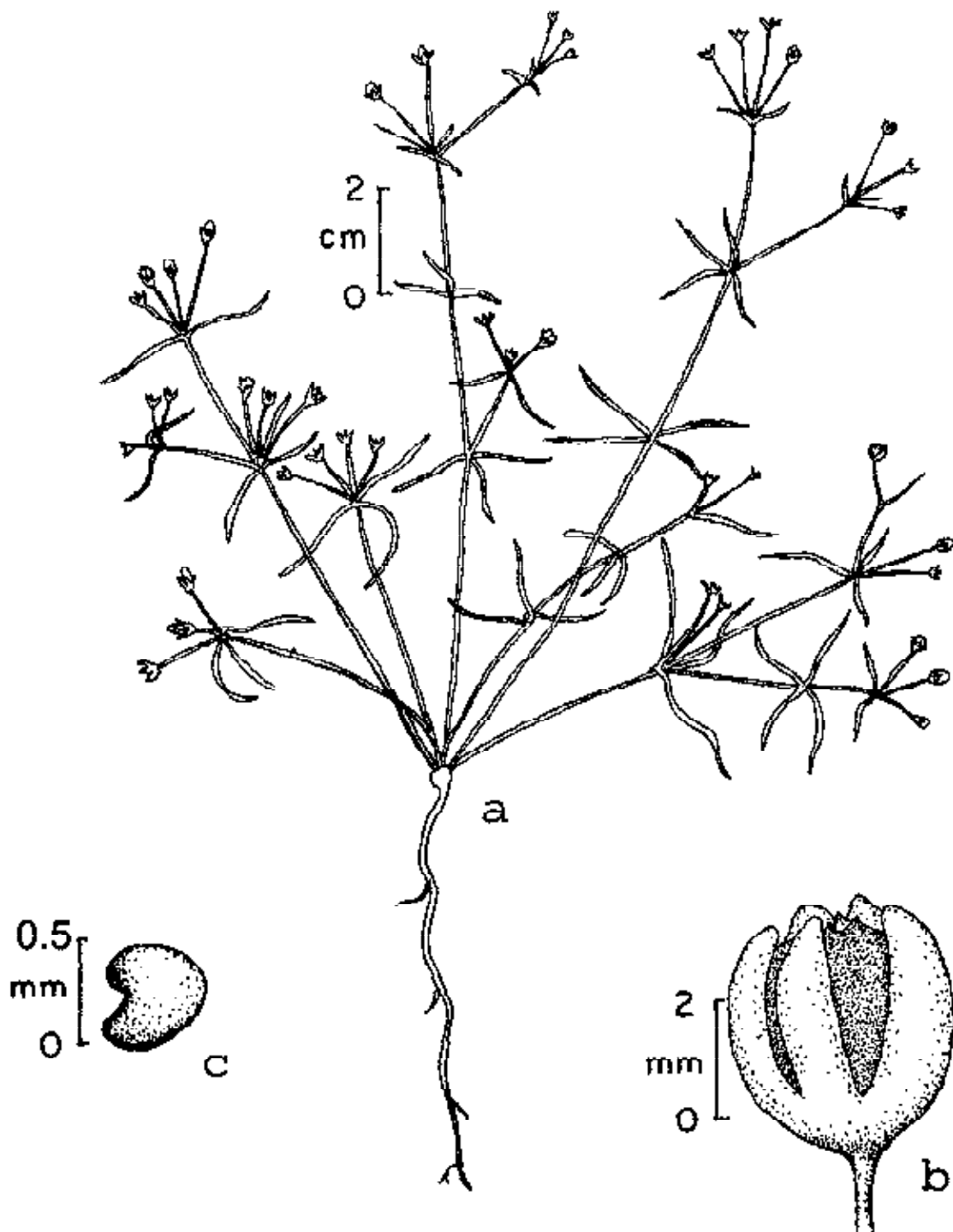


Fig. 19. *Mollugo cerviana* (L.) Seringe : a. Habit, b. Fruit, c. Seed.

*Ecology* : Common, found in sandy to gravelly habitats in association with *Cleome gynandra* L., *Crotalaria hebecarpa* (DC.) Rudd., *Zaleya govindia* (Buch.-Ham. ex G. Don) Nair, etc.

*Specimens examined* : Sudasari R. F., *Monika* 16577 (BSJO); Sam, *Monika* 16727 (BSJO); Ganga, *Pandey* 7819 (BSJO).

#### 4. MOLLUGO L.

- 1a. Unbranched herbs. Leaves radical only. Inflorescence cymosely branched. Seeds minutely strophiolate, more or less granular. **2. *M. nudicaulis***
- 1b. Umbellately branched herbs. Leaves cauline and radical both. Inflorescence umbelliform. Seeds not strophiolate, smooth. **1. *M. cerviana***

1. *Mollugo cerviana* (L.) Seringe in DC. Prodr. 1 : 392. 1824; Clarke in Hook. f. Fl. Brit. India 2 : 663. 1879; Duthie, Fl. Gangetic Plain 1 : 387. 1903; Bhandari, Fl. Indian Desert 182. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 359. 1987. *Pharnaceum cerviana* L. Sp. Pl. 273. 1753.

Local name : *Chiriya-ro-khet*.

Erect, annual, glabrous herbs; stems many, pale, filiform, with thickened nodes; branches umbellate. Leaves 1-2 x 0.1-0.3 cm, sessile, glaucous; basal leaves in rosette, spatulate, obtuse; cauline ones in whorls, linear. Flowers white, in axillary or terminal, trichotomously branched umbellate cymes. Peduncles ca 1.5 cm long. Perianth-segments 5, 1.5-2 mm long, margins membranous, white. Stamens 5. Stigmas 3, short. Capsules broadly ellipsoid, glabrous, equalling to perianth-lobes in length. Seeds many, compressed, smooth, more or less triangular in outline, glabrous, brown (Fig.-19).

*Fl. & Fr.*: July - November.

*Ecology* : Common, found in moist sandy plains in association with *Indigofera cordifolia* Heyne ex Roth, *Tribulus terrestris* L., etc.

*Specimens examined* : Mathuo-ki-Basti, *Monika* 16736 (BSJO); Ganga, *Pandey* 7812 (BSJO).

2. *Mollugo nudicaulis* Lam. Encycl. 4 : 234. 1797; Clarke in Hook. f. Fl. Brit. India 2 : 664. 1879; Duthie, Fl. Gangetic Plain 1 : 388. 1903; Bhandari, Fl. Indian Desert 182. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 1 : 360. 1987.

Annual, erect, glabrous herbs, with rosette of basal leaves and erect, cymosely branched, leafless inflorescence 30-40 cm high. Leaves only radical, more or less adpressed to the ground, 1.5-4.5 x 0.5-1.2 cm, oblong-spathulate, entire, rounded at apex, narrowed to a sessile base, glabrous. Flowers white, pedicellate, in terminal, paniculate cymes of several, axillary, forked branches arising from the crown; pedicels 1-1.5 cm long. Perianth-lobes 5, ca 2.5 x 1.2 mm, ovate-oblong, dorsally brownish-green. Stamens 3-7. Carpels 3; styles 3, short. Capsules ellipsoid or subglobose, brown. Seeds many, reniform, granular, brownish-black.

*Fl. & Fr.*: September - November.

*Ecology* : Occasional, found in moist sandy plains in association with *Cleome gynandra* L., *Tribulus terrestris* L., etc.

*Specimen examined* : Near Berisiyala, *Monika* 16795 (BSJO).

## 28. RUBIACEAE

- 1a. Flowers white, sessile, in axillary clusters. Seed one in each cell of the ovary. 1. *Borreria*  
 1b. Flowers pink, subsessile, in lax terminal cymes. Seeds numerous in each cell of the ovary. 2. *Kohautia*

1. *BORRERIA* G. F. W. Meyer (*nom. cons.*)

*Borreria articularis* (L. f.) F. N. Will. in Bull. Herb. Boiss. ser. 2. 5 : 956. 1905; Bhandari, Fl. Indian Desert 187. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 369. 1987. *Spermacoce hispida* L. Sp. Pl. 102. 1753; Hook. f. Fl. Brit. India 3 : 200. 1881; Duthie, Fl. Gangetic Plain 1 : 429. 1905. *S. articularis* L. f. Suppl. 119. 1781. *Borreria hispida* (L.) K. Schum. in Engl. & Prantl, Pflanzenfam. 4 (4) : 144. 1891, non Spruce ex K. Schum. 1888.

Annual, procumbent, hispid herbs; branches 3-4 from the base, radiating, 4-angled, hairy along the angles. Leaves opposite, sessile, 2.5 x 0.8-1.8 cm, elliptic-lanceolate, subacute at apex, prolonged into a short, dilated petiole at the base, entire. Stipules hispid, connate with leaf-bases forming membranous, hispid, fimbriate cup with 4-6 bristles. Flowers white or lilac, sessile, in 4 to 7-flowered, axillary cluster in each sheath. Calyx-lobes 4, linear-lanceolate, reflexed, persistent. Corolla-lobes 4, valvate, hispid outside at apex, acute. Stamens 4; filaments short, attached on throat of the tube. Style ca 4 mm long; stigma bilobed, capitate. Capsules ellipsoid, ca 5 mm long, rounded at both ends, hispid, ventrally dehiscent. Seeds 2-3 x 1-1.5 mm, ellipsoid or oblong, more or less rounded at both ends and on the back, with a longitudinal, deep groove on the flat face, finely granulate, brown (Plate-14/4).

*Fl. & Fr.*: August - October.

*Ecology*: Occasional, found in grassy wastelands in association with *Cenchrus* spp., *Panicum antidotale* Retz., *Tribulus terrestris* L., etc.

*Specimen examined*: Miajlar village, *Monika* 17112 (BSJO).

2. *KOHAUTIA* Cham. & Schldl. (*nom. cons.*)

*Kohautia aspera* (Heyne ex Roth) Brem. in Verh. Kon. Ned. Akad. Wet. Nat. 48 (2) : 113. 1952; Bhandari, Fl. Indian Desert 189. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 375. 1987. *Hedyotis aspera* Heyne ex Roth, Nov. Pl. Sp. 94. 1821. *Oldenlandia aspera* (Heyne ex Roth) DC. Prodr. 4 : 428. 1830; Hook. f. Fl. Brit. India 3 : 68. 1880; Duthie, Fl. Gangetic Plain 1 : 415. 1905.

*Local name*: *Dhankar*.

Erect, annual herbs, 30-40 cm high; stem and branches terete, scabrid with small, whitish dots. Leaves sessile, opposite, 3-6 x 0.3-0.5 cm, linear-lanceolate, acute, glabrous or slightly papillose along margins, revolute-margined. Stipules white, membranous, minutely ciliate, with 2-5 bristles at the apex. Flowers pale-blue or pink, subsessile, 2-4 fascicled in lax, terminal cymes. Calyx 2-2.2 mm long; teeth ca 1 mm long, triangular-subulate. Corolla infundibuliform, 4-5 mm long; tube 3-3.5 mm long, slender, hairy inside on broader part; lobes 1-1.5 mm long, obtuse. Stamens 4, included, inserted at the apex of tube. Style 1.5-2 mm long, filiform; stigmas 2, linear. Capsules 3-3.2 x 4-5 mm, globose, didymous, loculicidal, scabrid with white points. Seeds smooth, angled, brown.

*Fl. & Fr.*: July – October.

*Ecology* : Rare, found in sandy plains in association with *Cleome gynandra* L., *Euphorbia granulata* Forssk., etc.

*Specimens examined* : Near Ganga, *Monika* 16566 (BSJO); Ganga, *Pandey* 7813 (BSJO).

## 29. ASTERACEAE

- |   |                     |
|---|---------------------|
| 1a. Involucre bracts spinescent or aristate.  | 2                   |
| 1b. Involucre bracts neither spinescent nor aristate.   | 5                   |
| 2a. Plants armed with spinous leaves. Heads 1-flowered, crowded in spinous, globose, compound heads.  | <b>4. Echinops</b>  |
| 2b. Plants unarmed, if armed than not on the leaves. Heads many-flowered, simple.   | 3                   |
| 3a. Heads homogamous, dioecious (male or female or female and bisexual separate, but on the same plant). Involucral bracts of female heads united into an ovoid, 2-beaked utricle clothed with hooked spines. | <b>10. Xanthium</b> |
| 3b. Heads heterogamous. Involucral bracts neither united nor forming an utricle, but free.  | 4                   |
| 4a. Glabrous or scabrous herbs. Florets purple.   | <b>1. Amberboa</b>  |
| 4b. White woolly herbs. Florets white or pale yellow.   | <b>3. Dicomma</b>   |
| 5a. Heads homogamous, either male, female or bisexual.  | 6                   |
| 5b. Heads heterogamous, outer florets usually female, inner ones bisexual or male.  | 8                   |
| 6a. Florets all ligulate in a head.   | <b>6. Launaea</b>   |
| 6b. Florets all tubular in a head or sometimes outer florets ligulate.  | 7                   |
| 7a. Florets purple, tubular only. Anther-base obtuse, not tailed.   | <b>9. Vernonia</b>  |
| 7b. Florets yellow, ligulate and tubular both. Anther-base sagittate, tailed.   | <b>7. Pulicaria</b> |
| 8a. Ray florets 2 to many seriate.  | <b>5. Eclipta</b>   |
| 8b. Ray florets 1-seriate.  | 9                   |
| 9a. Anther-base sagittate. Pappus simple, bristly. Leaves alternate or radical.   | <b>2. Blumea</b>    |
| 9b. Anther-base not sagittate. Pappus plumose. Leaves opposite atleast in lower region.   | <b>8. Tridax</b>    |

### 1. *AMBERBOA* (Pers.) Less. (*nom. cons.*)

*Amberboa ramosa* (Roxb.) Jafri in Scientist 3 : 29. 1959; Hajra in Hajra *et al.* Fl. India 12 : 153. f. 44. 1995. *Carduus ramosus* Roxb. Fl. Ind. 3 : 407. 1832. *Microlonchus divaricatus* DC. Prodr. 6 : 562. 1838. *Tricholepis procumbens* Wight. Ic. Pl. Ind. Or. 3 (4) : 12. t. 1139. 1846. *Volutarella divaricata* Benth. in Benth. & Hook. f. Gen. Pl. 2 : 476. 1873, *pro parte*; Hook. f. Fl. Brit. India 3 : 383. 1881; Duthie, Fl. Gangetic Plain 1 : 486. 1905. *V. ramosa* (Roxb.) Sant. Pl. Saurashtra 22. 1953. *Oligochaeta ramosa* (Roxb.) Wagenitz in Verroffent. Geobot. Inst. 37 : 323. 1962; Bhandari, Fl. Indian Desert 206. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 425. 1987.

Local name : *Uni-kantelo*.

Annual, procumbent, dichotomously branched herbs, up to 40 cm high; stem and branches angled, striate, glabrous. Leaves variable; lower leaves oblong, obovate or lyrate; upper ones sinuately pinnatifid.

entire or slightly toothed, glabrous. Heads 1.5-2.3 x 1-1.5 cm, ovoid-oblong, pubescent, pale purple; peduncles grooved. Involucral bracts 1.3-1.7 cm long, elliptic-oblong, spinescent; outer bracts smaller, recurved; inner bracts longer, erect. Corolla 1.2-1.5 cm long; lobes 3 mm long, linear-lanceolate, acute. Achenes 4-4.8 x 1.2-1.7 mm, sharply angled, often pitted between the angles. Pappus hairs numerous, 0.9-1.2 cm long, unequal, inner ones longer than the outer, greyish-brown.

*Fl. & Fr.*: October – March.

*Ecology* : Occasional, found in gravelly and sandy plain habitats. Common associates are *Boerhavia diffusa* L., *Cleome scaposa* DC., *Tragus roxburghii* Panigrahi, etc.

*Specimens examined* : Near Khuri, *Monika* 16781 (BSJO); Sudasari, *Pandey* 7843 (BSJO).

## 2. *BLUMEA* DC. (*nom. cons.*)

*Blumea lacera* (Burm. f.) DC. in Wight, *Contrib. Bot. Ind.* 14. 1834; Hook. f. *Fl. Brit. India* 3 : 263. 1881; Duthie, *Fl. Gangetic Plain* 1 : 453. 1905; Bhandari, *Fl. Indian Desert* 194. 1978; Singh in Shetty & Singh, *Fl. Rajasthan* 1 : 396. 1987; Kumar in Hajra *et al.* *Fl. India* 13 : 128. 1995. *Conyza lacera* Burm. f. *Fl. Ind.* 180. t. 59. f. 1. 1768.

Erect, annual, much-branched, glandular-pubescent, aromatic herbs, 30-40 cm high. Leaves 2.5-5 x 0.9-2 cm, obovate-oblong or elliptic-oblong, entire or dentate, obtuse at apex, attenuated at base into a short petiole or sessile, glandular hairy on both surfaces. Heads crowded at the end of branches, yellow, pedunculate, in terminal corymbose panicles and/or in axillary, spiciform panicles combined into compound panicles. Involucral bracts ca 2.5 mm long, linear, acute, glandular hairy on back, ciliate on margins, reflexed at maturity. Corolla of bisexual florets tubular, hairy, 3-4 mm long, 5-lobed; lobes triangular; corolla of female florets 2-3 mm long, glabrous. Achenes 1-1.5 mm long, oblong, hairy, brown. Pappus 3-3.5 mm long, white.

*Fl. & Fr.*: November – April.

*Ecology* : Common, found in sandy plains in damp places in wastelands in association with *Cleome viscosa* L., *Heliotropium subulatum* (Hochst. ex DC.) Vatke, *Tribulus terrestris* L., etc.

*Specimen examined* : Berisiyala, *Monika* 16538 (BSJO).

## 3. *DICOMA* Cass.

*Dicoma tomentosa* Cass. in Bull. Sci. Soc. Philom. Paris 12. 1818; Hook. f. *Fl. Brit. India* 3 : 387. 1881; Duthie, *Fl. Gangetic Plain* 1 : 487. 1905; Bhandari, *Fl. Indian Desert* 197. 1978; Singh in Shetty & Singh, *Fl. Rajasthan* 1 : 408. 1987; Rao in Hajra *et al.* *Fl. India* 13 : 171. 1995. *D. lanuginosa* DC. in Wight, *Contrib. Bot. Ind.* 26. 1834.

Local name : *Vajradanti*.

Erect, annual herbs, 20-40 cm high; stem woody, terete, velvety. Leaves 2-6 x 0.5-1 cm, linear to obovate, obtuse-apiculate or subacute, entire or slightly denticulate, clothed on both surfaces by cottony wool, sessile. Heads yellowish-white, 1-1.5 cm across, solitary, axillary or leaf-opposed and terminal, shortly peduncled. Involucral bracts linear-lanceolate, 1-2 cm long, ending in a yellow spinous point, glabrous, unequal, arranged in many imbricating rows. Corolla tubular, 6-7 mm long; tube 3-3.5 mm long; lobes ca

3 mm long. Stamens 5; anther-base sagittate, lobes tailed at base, connectives acute. Achenes up to 3 mm long, lanceolate-subulate, 10-ribbed, truncate at apex, densely silky villous. Pappus 6-7 mm long; outer pappus slender, barbellate, tawny; inner ones slightly longer than outer.

*Fl. & Fr.*: October – May.

*Ecology* : Common, in gravelly habitats in association with *Blepharis linariaefolia* Pers., *Seetzenia lanata* (Willd.) Bullock ,etc.

*Specimens examined* : Sudasari, *Monika* 16572, 16767 (BSJO), *Pandey* 7833 (BSJO); Near Sam, *Shetty* 3454 (BSJO).

#### 4. *ECHINOPS* L.

*Echinops echinatus* Roxb. Fl. Ind. 3 : 447. 1832; Hook. f. Fl. Brit. India 3 : 358. 1881; Duthie, Fl. Gangetic Plain 1 : 480. 1905; Bhandari, Fl. Indian Desert 198. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 408. 1987; Hajra in Hajra *et al.* Fl. India 12 : 178. 1995.

Local name : *Unt-kantela*.

Thistle-like, deep-rooted, annual herbs, 30-90 cm high, branched from base; branches scabrid, wide spreading. Leaves 10-20 x 3-7 cm, sessile, oblong, glabrous or slightly scabrous above, whitish woolly beneath, deeply pinnatifid, amplexicaul at base; lobes triangular, spinescent; spines pale, 1-2.5 cm long. Heads 1-flowered, clustered in involucre compound heads forming spherical balls with many stout spines, 4-5 cm across, white, pale bluish when young. Outer involueral bracts 6-8, oblanceolate, glabrous, ciliate and scarious-margined; inner ones ca 8 mm long, connate up to the middle; middle ones spatulate and some of them produced into spines. Corolla 1-1.2 cm long; lobes pale pink, linear, acute, equalling the tube. Anthers greyish-black, tail fimbriate. Achenes obconic, ca 4 mm long, silky villous. Pappus short, cylindric, forming ca 3 mm long, cylindric brush above the achenes (Plate-15/1).

*Fl. & Fr.*: March – September.

*Ecology* : Rare, found in gravelly habitats and near habitations in moist wastelands in association with *Heliotropium subulatum* (Hochst. ex DC.) Vatke, *Peristrophe paniculata* (Forssk.) Brummitt, etc.

*Specimen examined* : Keshav Singh-ka-Talab, *Monika* 16540 (BSJO).

#### 5. *ECLIPTA* L. (*nom. cons.*)

*Eclipta prostrata* (L.) L. Mant. Pl. 2 : 286. 1771; Bhandari, Fl. Indian Desert 177. 1990; Chowdhery in Hajra *et al.* Fl. India 12 : 381. 1995. *Verbesina prostrata* L. Sp. Pl. 902. 1753. *V. alba* L. Sp. Pl. 902. 1753. *Eclipta erecta* L. Mant. Pl. 2 : 286. 1771; Duthie, Fl. Gangetic Plain 1 : 468. 1905. *E. alba* (L.) Hassk. Pl. Jav. Rar. 528. 1848; Hook. f. Fl. Brit. India 3 : 304. 1881; Bhandari, Fl. Indian Desert 198. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 409. 1987

Local name : *Jal-bhangro*.

Decumbent or prostrate herbs, often rooting at the lower nodes; stem adpressed pubescent; branches striate. Leaves simple, opposite, 3-6 x 0.5-2 cm, elliptic-oblong or lanceolate, mucronate, cuneate at base,

entire or shallowly toothed or undulate, pubescent, subsessile. Heads white, axillary, solitary or 2-3 fascicled on 5-6 cm long, axillary or terminal peduncles. Involucral bracts in 2 series, ovate-lanceolate, acute, 3-6 mm long, pubescent. Ray florets female or sterile, in 2-3 series, 2 dentate; ligule ca 4 mm long, spreading, entire, white; corolla-tube short, sparingly pubescent above. Disc florets tubular, bisexual, numerous; corolla campanulate, 1-1.5 mm long, sparingly pubescent apically. Stamens 4-5. Achenes dark brown, oblong, dorsiventrally compressed and sharply angled, tuberculate. Pappus a ring of thick, ciliate, partially or completely united scales, forming a cone at the top of the achene.

*Fl. & Fr.*: September – December.

*Ecology*: Common, found in marshy habitats near water reservoirs, associated with some marshy sedges.

*Specimen examined* : Near Singhdar, Monika 16669 (BSJO).

*Notes* : According to the Art. 57.2 of ICBN, "the author who first unites taxa bearing names of equal priority must choose one of them, unless an autonym is involved (Art. 57.3)" Linnaeus in 1753 simultaneously published the names *Verbesina alba* and *V. prostrata*. Later (1771) he published *Eclipta erecta* (a superfluous name because *V. alba* is cited in synonymy) and *E. prostrata*, based on *V. prostrata*. The first author to unite these taxa was Roxburgh (*Fl. Indica* 3 : 348. 1832), who did so under the name *Eclipta prostrata* (L.) L., which is, therefore, to be used as correct name for this taxon.

#### 6. LAUNAEA Cass.

- 1a. Heads terminal, on paniculately branched flowering stem. Achenes 6-7 mm long. 2. *L. resedifolia*  
 1b. Heads solitary or in clusters on the nodes of branches. Achenes up to 4 mm long. 1. *L. procumbens*

1. *Launaea procumbens* (Roxb.) Ramayya & Rajagopal in *Kew Bull.* 23 : 465. 1969; Bhandari, *Fl. Indian Desert* 204. 1978; Singh in Shetty & Singh, *Fl. Rajasthan* 1 : 423. 1987; Mangain & Rao in Hajra *et al.* *Fl. India* 12 : 309. 1995. *Chondrilla nudicaulis* L. *Mant.* 273. 1767. *Prenanthes procumbens* Roxb. *Fl. Ind.* 3 : 404. 1832. *Launaea nudicaulis* (L.) Hook. f. *Fl. Brit. India* 3 : 416. 1881, non Lees 1832; Duthie, *Fl. Gangetic Plain* 1 : 494. 1905.

Local name : *Jangli-gobhi, Rookhadi.*

Perennial or annual, much-branched herbs, 30-40 cm high; stem erect, profusely branched, glabrous. Leaves mostly radical, cauline few or absent, 10-20 x 2-4 cm, sessile, glabrous, sinuately lobed or pinnatifid, with irregular lobes having white, cartilaginous teeth. Heads yellow, cylindric, 1-2 x 0.3-0.5 cm, solitary or in clusters, arranged racemosely along the branches on short, bracteate pedicels. Involucral bracts 2-3 seriate; outer 1.5-4 x 0.5-1 mm, ovate, glabrous; inner 7-10 x 1-2 mm, linear-oblong, glabrous. Achenes pale yellow, 2-3.5 mm long, outer ones flattened, truncate at base and slightly curved, inner ones columnar, both thickly ribbed. Pappus 6-7 mm long, soft, deciduous, white.

*Fl. & Fr.*: March – September.

*Ecology* : Common, found in wet sandy plains in association with *Cleome gynandra* L., *Mollugo cerviana* (L.) Seringe, etc.

*Specimen examined* : Near Khuri, Monika 16780B (BSJO).

2. *Launaea resedifolia* (L.) Kuntze, Rev. Gen. Pl. 1 : 351. 1891 (*sphalm. Launaya*); Raizada, Suppl. Duthie, Fl. Gangetic Plain 81. 124. 1976; Bhandari, Fl. Indian Desert 205. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 424. 1987; Mangain & Rao in Hajra *et al.* Fl. India 12 : 309. 1995. *Scorzonera resedifolia* L. Sp. Pl. 1198. 1753. *Zollukoferia chondrilloides* DC. Prodr. 7 : 183. 1838. *Launaea chondrilloides* (DC.) Hook. f. Fl. Brit. India 3 : 415. 1881.

Perennial herbs, with milky sap, 20-40 cm high; stem dichotomously branched, terete, sulcate, woody at base. Radical leaves rosulate, 3-15 x 0.2-3.5 cm, lanceolate in outline, runcinate-pinnatifid, lobes acutely and deeply toothed and spinous towards margins; cauline leaves pinnatifid, half-amplexicaul at base, sessile; those on fork of peduncles ovate, entire, bract-like. Heads yellow, solitary, in terminal panicles formed by dichotomous flowering branches, campanulate, 1.5-2.5 x 0.5-0.8 cm. Involucral bracts in 3 series, subacute, entire, more or less ciliolate at tip; outer ones broadly deltoid-ovate or ovate-lanceolate, 4-9 x 2-3 mm; inner ones oblong-lanceolate, 15-20 x 3-4 mm. Corolla-tube glandular pubescent. Anthers sagittate at base. Stigma bifid, equal to corolla-tube or slightly exserted. Achenes 5-6 mm long, slender, toothed at base, greyish-black, strongly ribbed; ribs papillose. Pappus 11-12 mm long, smooth, unequal.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Rare, found in sandy plains in shady places.

*Specimen examined* : 6 km from Khuri, *Monika* 16683 (BSJO).

#### 7. *PULICARIA* Gaertn.

- 1a. Leaves crisped with recurved margins. Achenes glabrous, 0.5-0.6 mm long. Pappus about 3 times longer than achenes. **2. *P. crispa***
- 1b. Leaves entire, flat-margined. Achenes hairy, more than 1 mm long. Pappus about twice as long as the achenes. **1. *P. angustifolia***

1. *Pulicaria angustifolia* DC. Prodr. 5 : 479. 1836; Hook. f. Fl. Brit. India 3 : 299. 1881; Duthie, Fl. Gangetic Plain 1 : 465. 1905; Bhandari, Fl. Indian Desert 208. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 429. 1987; Pant in Hajra *et al.* Fl. India 13 : 33. 1995.

*Local name* : *Soneli*.

Annual herbs, with woody root-stock, up to 60 cm high, branched from base, pubescent. Leaves sessile, 1-5 x 0.3-1 cm, linear-oblong to obovate-oblong, base narrowed, entire or serrulate, glandular-pubescent bothsides. Heads yellow, up to 1 cm in diam., on slender, pubescent, terminal peduncles. Outer involucral bracts ca 2 mm long, linear-oblong, green, pubescent, glandular; inner ones ca 3 mm long, scarious, acute, with few hairs at apex. Ray florets ligulate; ligule up to 6 mm long. Achenes ca 1.5 mm long, ellipsoid or oblong, terete or scarcely quadrangular, with few, scattered hairs. Pappus ca 3 mm long, 2-seriate; outer row forming a setulose-laciniate cup; inner row of white barbellate hairs (**Plate-15/2**).

*Fl. & Fr.*: October- March.

*Ecology* : Common, found in sandy plains and as a weed in cultivated fields.

*Specimens examined* : Near Girab, *Monika* 16651 (BSJO); Between Miajlar and Satto, *Monika* 17117 (BSJO).



2. *Pulicaria crispa* (Forssk.) Benth. & Hook. f. Gen. Pl. 2 : 336. 1867; Hook. f. Fl. Brit. India 3 : 299. 1881; Duthie, Fl. Gangetic Plain 1 : 466. 1905; Bhandari, Fl. Indian Desert 209. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 430. 1987; Pant in Hajra *et al.* Fl. India 13 : 33, f. 11. 1995. *Aster crispus* Forssk. Fl. Aegypt.-Arab. 150. 1775.

Local name : *Dholo-ligru*.

Perennial, erect, much-branched herbs, 30-70 cm high; stem terete, leafy throughout, densely tomentose; branches striate. Leaves sessile, 1-3.8 x 0.2-1.5 cm, linear-lanceolate, oblong-obovate or subspathulate, amplexicaul or auriculate at base, margins recurved and undulate-crisped, woolly tomentose bothsides, obtuse at apex. Heads yellow, 5-15 mm in diam., hemispherical, solitary at the end of paniculate branches. Involucral bracts multiseriate, linear, acute, thinly woolly, scarious-margined, recurved at tip, outer ones shorter. Achenes 5-9 mm long, oblong-ellipsoid, glabrous, black. Pappus thrice as long as achenes, outer ones forming fimbriated cup, inner ones antrorsely scabrid.

*Fl. & Fr.*: Throughout the year.

*Ecology* : Common, found in sandy plains, sometimes as a weed of cultivation in association with *Cleome gynandra* L., *Heliotropium strigosum* Willd., etc.

*Specimen examined* : Near Berisiyala, Monika 16699 (BSJO); Near Sam, Shetty 3460 (BSJO).

#### 8. TRIDAX L.

*Tridax procumbens* L. Sp. Pl. 900. 1753; Hook. f. Fl. Brit. India 3 : 311. 1881; Duthie, Fl. Gangetic Plain 1 : 475. 1905; Bhandari, Fl. Indian Desert 212. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 439. 1987; Chowdhery in Hajra *et al.* Fl. India 12 : 418. 1995.

Annual or perennial, straggling herbs, up to 60 cm high, hirsute. Leaves 2-7 x 0.8-2.5 cm, ovate-elliptic or ovate-lanceolate, acute, pinnatisect, cuneate at base, glandular hairy on both surfaces. Petioles short, densely hairy. Heads 12-15 mm in diam., solitary, terminating *ca* 20 cm long, slender, sparsely hairy peduncles. Outer involucral bracts ovate, acute or subacuminate, herbaceous, hairy; inner ones oblong, pubescent on back, slightly longer than the outer, scarious. Ray florets ligulate; ligule yellow, deeply 3-partite. Corolla-tube hairy. Achenes 1.8-2 mm long, oblong, silky hairy, black. Pappus bristles unequal, plumose, aristate (Plate-15/3).

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in sandy plains and gravelly habitats among thickets of shrubs and undershrubs; also found as a weed in cultivated fields in close association with *Pulicaria crispa* (Forssk.) Benth. & Hook. f., *Cyperus rotundus* L., etc.

*Specimen examined* : Along Miajlar-Sundra road, Monika 17144 (BSJO).

#### 9. VERNONIA Schreb. (*nom. cons.*)

*Vernonia cinerascens* Sch.-Bip. in Schweinf. Beitr. Aethiop. 162. 1867; Hook. f. Fl. Brit. India 3 : 237. 1881; Duthie, Fl. Gangetic Plain 1 : 441. 1905; Bhandari, Fl. Indian Desert 212. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 441. 1987; Uniyal in Hajra *et al.* Fl. India 13 : 364. 1995.

Perennial, much-branched undershrubs, 40-60 cm high; branches terete, rigid, greyish-white adpressed hairy mixed with sessile glands. Leaves sessile, alternate, 2-5.5 x 0.6-1.5 cm, obovate-spathulate, obtuse at apex, attenuated at base, entire or dentate in the upper half, pubescent-punctate on both surfaces. Heads purple or pink, 5-6 mm in diam., in divaricate corymbose panicles; pedicels 3-10 mm long. Involucral bracts 3-4 seriate, oblong or lanceolate, hairy on the back; outer most *ca* 1 mm long; inner ones *ca* 3.5 mm long. Anther-base obtuse. Achenes *ca* 2.5 mm long, oblong, silky, 5-angled, 8 to 10-ribbed, densely silky, glandular, slightly tapering at base. Pappus hairs white, in two rows, outer shorter, rigid; inner longer, as long as corolla, barbellate.

*Fl. & Fr.*: September – December.

*Ecology* : Rare, found in sandy plains among thickets of shrubs and undershrubs.

*Specimen examined* : Along Miajlar road, Shetty 6142 (BSJO).

### 10. XANTHIUM L.

*Xanthium indicum* Koen. ex Roxb. Fl. Ind. 3 : 601. 1832; Chowdhery in Hajra *et al.* Fl. India 12 : 427. 1995. *X. strumarium* L. Sp. Pl. 987. 1753, *pro parte*; Hook. f. Fl. Brit. India 3 : 303. 1881; Duthie, Fl. Gangetic Plain 1 : 467. 1905; Bhandari, Fl. Indian Desert 214. 1978; Singh in Shetty & Singh, Fl. Rajasthan 1 : 443. 1987.

Perennial, foetid-smelling, unarmed, erect herbs, up to 1 m high; stem stout, sulcate, rough, hairy. Leaves 7-12 x 5-10 cm, ovate-suborbicular or deltoid, often shallowly 3 to 5-lobed, subacute at apex, cuneate and 3-nerved at the base, unequally coarsely dentate. Petioles 6-12 cm long. Heads greenish-yellow, in axillary and terminal racemes; bisexual heads in upper part of inflorescence and females in lower region. Involucre bracts 10-15 mm long, connate into an ellipsoid, 3-locular body covered with hooked bristles and with 2-dentate beak at the apex of each cell. Female florets apetalous. Style-arms included. Achenes 2 in each head, 10-11 mm long, oblong-ovoid, compressed, glabrous, those of bisexual florets sterile and enclosed within pales.

*Fl. & Fr.*: September – January.

*Ecology* : Common, found in sandy plains in wet habitats near habitations, in association with *Amaranthus* spp.

*Specimen examined* : Near Sundra, Monika 17169 (BSJO).

## 30. SALVADORACEAE

### SALVADORA L.

- 1a. Leaves elliptic-lanceolate or linear-lanceolate. Panicles compact, axillary, shorter than the leaves; flowers sessile. Corolla-lobes erect. Ripe fruits yellow. 1. *S. oleoides*
- 1b. Leaves elliptic or ovate. Panicles lax, axillary and terminal, often nodding, longer than the leaves; flowers pedicelled. Corolla-lobes reflexed. Ripe fruits red. 2. *S. persica*

1. *Salvadora oleoides* Decne. in Jacq. Voy. Bot. 140. t. 144. 1844; Clarke in Hook. f. Fl. Brit. India 3 : 620. 1882; Duthie, Fl. Gangetic Plain 2 : 29. 1911; Bhandari, Fl. Indian Desert 215. 1978; Singh in Shetty

& Singh, Fl. Rajasthan 2 : 467. 1991; Rao & Chakraborti in Hajra & Sanjappa, Fl. India Fasc. 22 : 5. 1996. *S. stocksii* Wight, Ill. Ind. Bot. 2 : 229. 1850 & Icon. Pl. Ind. Orient. 4 : 18. t. 1621B. 1850.

Local name : *Kharo-jal*.

Much-branched, evergreen shrubs or small trees, 2-3 m tall, with short, bent or twisted trunk, drooping branches and grey bark. Leaves opposite, 5-10 x 1-1.5 cm, linear-lanceolate or elliptic-lanceolate, acute at apex or mucronate, cuneate at base, coriaceous, whitish-green, glabrous. Flowers sessile, greenish-white, in axillary, compact, paniculate spikes ca 4 cm long, often clustered and shorter than leaves. Bracts acute. Calyx persistent, cup-shaped, 4-lobed; lobes ca 1 mm long, rounded, as long as petals. Corolla 1.5-2.5 mm long, deeply cleft; lobes obovate-oblong, obtuse. Stamens 4, 1-1.5 mm long, epipetalous, alternating with corolla-lobes. Berries 4-6 mm across, globose or ovoid-globose, yellow when ripe, red or brown when dry. Seed 1, black.

*Fl. & Fr.*: March-June.

*Ecology* : Common, found in sandy and gravelly plains in association with *Capparis decidua* (Forssk.) Edgew. and *Calotropis procera* (Ait.) R. Br., sometimes forming small woodland colony of its own.

*Specimen examined* : Near Girab, *Monika* 16526 (BSJO).

2. *Salvadora persica* L. Sp. Pl. 122. 1753; Clarke in Hook. f. Fl. Brit. India 3 : 619. 1882; Duthie, Fl. Gangetic Plain 2 : 28. 1911; Bhandari, Fl. Indian Desert 216. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 467. 1991; Rao & Chakraborti in Hajra & Sanjappa, Fl. India Fasc. 22 : 5. t. 1 & 4. f. 3. 1996. *Galenia asiatica* Burm. f. Fl. Ind. 88. t. 31. f. 1. 1768. *Salvadora indica* Wight, Ill. Ind. Bot. 2 : 229. t. 181. 1850.

Local names : *Meethu-jul*, *Pilu*.

Much-branched, evergreen shrubs or small trees, 3-5 m tall; bark thin, grey; branches drooping or spreading, terete, glabrous, more or less glaucous, the two opposite branches arise symmetrically at an angle of 45° to the main axis. Leaves opposite, decussate, 5-8 x 2-4 cm, elliptic-lanceolate or ovate, obtuse at apex and often mucronate, fleshy. Petioles 1-2 cm long. Stipules minute, connected by a line. Flowers greenish-yellow, 2-3 mm long, in 5-15 cm long, axillary or terminal, lax, compound panicles; pedicels 1-2.5 mm long. Bracts ovate, caducous. Calyx light yellow, 1-2 mm long, cleft half way down; lobes ovate to rounded, glabrous, less than half the length of petals. Corolla deeply cleft, persistent; lobes 2-2.5 mm long, oblong, obtuse, reflexed. Stamens 4, 1-2 mm long, smaller than corolla, epipetalous. Berries 5-6 mm across, globose, smooth, red when ripe, 1-seeded. Seeds 2-3.5 mm in diam., subglobose, smooth, brown.

*Fl. & Fr.*: Throughout the year.

*Ecology* : Common, found in sandy plains in association with *Capparis decidua* (Forssk.) Edgew. or forming its own community.

*Specimens examined* : Near Bandera, *Monika* 1665 (BSJO).

### 31. ASCLEPIADACEAE

- |  |   |
|--|---|
| 1a. Plants erect.  | 2 |
| 1b. Plants twining or climbing.  | 4 |
| 2a. Shrubs or undershrubs. Leaves sessile to subsessile or absent. Follicles smooth. | 3 |

- 2b. Herbs. Leaves petiolate. Follicles with soft spine-like processes. **3. *Odontanthera***  
 3a. Leaves broadly ovate, 10-20 x 6-12 cm. Sap milky. Corolla 2-3 cm across. **1. *Calotropis***  
 3b. Leafless plants; leaves, if present then, linear or linear-lanceolate, up to 7 x 0.4 cm, soon fall down and plant becomes leafless. Sap watery. Corolla 3-5 mm across. **2. *Leptadenia***  
 4a. Leaves deeply cordate at base, acuminate. Corolla with red eye. Follicles softly echinate. **5. *Pergularia***  
 4b. Leaves rounded or subcordate at base, acute or obtuse. Corolla without red eye. Follicles not echinate, but smooth. **4. *Pentatropis***

### 1. *CALOTROPIS* R. Br.

*Calotropis procera* (Ait.) R. Br. in Ait. f. Hort. Kew. ed. 2. 2 : 78. 1811; Hook. f. Fl. Brit. India 4 : 18. 1883; Duthie, Fl. Gangetic Plain 2 : 48. 1911; Bhandari, Fl. Indian Desert 219. 1978; Jagtap & Singh, Fl. India Fasc. 24 : 11. 1999. *Asclepias procera* Ait. Hort. Kew. ed. 1. 1 : 305. 1789. *Calotropis hamiltonii* Wight, Contrib. Bot. Ind. 53. 1834. *C. procera* (Ait.) R. Br. subsp. *hamiltonii* (Wight) Ali in Notes Royl. Bot. Gard. Edinb. 38 (2) : 287. f. 1C-D. 1980; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 475. 1991.

Local name : *Aakdo*.

Large shrubs or sometimes taking the shape of a small tree; stems many, woody at base, nodes slightly swollen, internodes terete, cottony pubescent when young. Leaves sessile, opposite, decussate, 10-20 x 6-12 cm, broadly ovate or ovate-oblong, acute at apex, cordate and auricled at base, velvety on both surfaces, thick. Flowers purplish-white, in many-flowered, axillary or terminal, sub-umbellate cymes; peduncles 5-12 cm long, terete, cottony pubescent; pedicels in pairs, terete, 1-2.5 cm long. Calyx 5-lobed, divided almost up to base; lobes 2-4.5 x 1.5-2.5 mm, ovate, acute, glabrous inside, cottony outside near the base. Corolla divided up to 2/3<sup>rd</sup> way down, rotate; lobes 5, ovate, acute, white with purple tips, glabrous. Staminal corona-lobes 5, fleshy, completely adnate to staminal column except the back slightly curved away, 4-7 x 2-5 mm, slightly pubescent along the margins, purplish. Gynostegium 5-6 mm long. Follicles in pairs, 6-9 x 3-6 cm, ellipsoid. Seeds ca 5 x 3.5 mm, broadly ovate, acute, minutely tomentose, light brown; coma 2-3 cm long, silky white.

*Fl. & Fr.*: Almost throughout the year

*Ecology* : Very common, found in the sandy plains as well as on dunes and in gravelly habitats in association with *Capparis decidua* (Forssk.) Edgew., *Ziziphus nummularia* (Burm. f.) Wight & Arn. etc. In plains, it also forms thick populations of its own. It has high regeneration capacity and may be planted by uprooting large shrubs or by cuttings.

*Specimens examined* : Near Sudasari, Monika 16504 (BSJO); Sam, Pandey 7802 (BSJO).

### 2. *LEPTADENIA* R. Br.

*Leptadenia pyrotechnica* (Forssk.) Decne. in Ann. Sci. Nat. ser. 2. 9 : 269. 1838; Bhandari, Fl. Indian Desert 223. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 480. 1991; Jagtap & Singh, Fl. India Fasc. 24 : 259. 1999. *Cynanchum pyrotechnicum* Forssk. Fl. Aegypt.-Arab. 53. 1775. *Leptadenia spartium* Wight, Contrib. Bot. Ind. 48. 1834; Hook. f. Fl. Brit. India 4 : 64. 1883; Duthie, Fl. Gangetic Plain 2 : 63. 1911.

Local name : *Khimp*.

Much-branched, often leafless, erect shrubs; stem terete, green, twiggy, sparsely hairy when young, glabrous at age, branches divaricating. Leaves soon deciduous, usually absent, present on young shoots only, subsessile, opposite, decussate, 1-7 x 0.2-0.4 cm, linear-lanceolate or linear, acute at apex, puberulous on both sides. Petioles terete, up to 2 mm long. Flowers yellow, small, in lateral, umbellate, pubescent cymes; peduncles terete, 8-10 mm long, pubescent; pedicels 1-1.5 mm long. Calyx 1-1.5 mm long, divided up to half way down, pubescent; lobes ovate-deltoid, acute. Corolla 2-3 mm long, funnel-shaped, divided nearly to the middle; tube 1-1.2 mm long, glabrous outside, pubescent inside; lobes 5, ovate-oblong, obtuse, thickened towards the apex. Corolline-corona uniseriate, of five scales inserted at the mouth of corolla-tube, alternating with corolla-lobes. Staminal-corona uniseriate, annular, at the base of staminal column. Stamens 5. Ovary ca 1 mm long, glabrous, many-ovuled. Gynostegium ca 2 mm long. Follicles 10-14 x 0.4-0.8 cm, terete, lanceolate, slightly narrowed at base, glabrous. Seeds ca 8 mm long, narrowly lanceolate, glabrous; coma up to 3.5 cm long.

*Fl. & Fr.*: August-March.

*Ecology* : Very common, found in sandy plains as well as on the dunes. It is a good soil-binder. Main associates are *Aerva javanica* (Burm. f.) Juss. ex Schult. and *Crotalaria burhia* Buch.-Ham. ex Benth. It is a hardy pioneer species stabilizing sand-dunes with its associates.

*Specimens examined* : Near Saito, *Monika* 16639 (BSJO), Miajlar, *Monika* 17102 (BSJO).

### 3. ODONTANTHERA Wight

*Odontanthera varians* (Stocks) Mabberley in Manilal, Bot. Hist. Hort. Malab. 89. 1980 & in Taxon 29 : 606. 1980; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 482. 1991. *Mastostigma varians* Stocks in Hook. f. Icon. Pl. 5 : 9. t. 863. 1852. *Glossanema varians* (Stocks) Benth. ex Hook. f. Fl. Brit. India 4 : 16. 1883; Bhandari, Fl. Indian Desert 222. 1978; Jagtap & Singh, Fl. India Fasc. 24 : 25. 1999.

Local name : *Dodha*.

Perennial, erect herbs, 10-20 cm high; stem much-branched from the base, terete, pubescent. Leaves 1.5-6.5 x 0.5-4.5 cm, opposite, decussate, elliptic or ovate, subacuminate or acute at apex, repand or entire, fleshy, hairy on both surfaces. Petioles 0.5-1.8 cm long, terete, pubescent, with 3-6 minute glands on the stem near the base of petiole. Flowers yellow, in 4 to 8-flowered, axillary, subsessile, umbellate cymes; pedicels terete, 1-4 mm long, pubescent. Calyx-lobes 5, 3-4 x 1-1.2 mm, divided nearly up to the base, linear, acute, ciliate, pubescent. Corolla campanulate, 4-6 mm long; lobes 5, 3-4 mm long, oblong, glabrous. Corolline corona-lobes uniseriate, attached to the base of corolla, 1-1.5 x 0.8-1 mm, elliptic, entire, membranous. Stamens 5, ca 1.5 mm long. Style truncate at apex, fleshy. Gynostegium ca 3.5 mm long. Follicles usually single, 3.5-5 x 1-1.5 cm, ellipsoid, apex beaked, base attenuate, covered with soft, short spines ca 5 x 1 mm. Seeds many, 5-6 x 3-4 mm, ovate, flat, acute, sinuate-dentate at broader end, brown; coma silky white (Plate-15/4).

*Fl. & Fr.*: August-November.

*Ecology* : Rare, found in sandy to gravelly plains.

*Specimen examined* : Near Tejaraon, *Pandey* 7900 (BSJO).

*Note* : Some workers use the generic name *Glossonema* Decne. instead of *Odontanthera* Wight. The date of publication of both the genera is 1838. However, *Glossonema* Decne. was published in the month of the June and *Odontanthera* Wight in the month of January. According to the law of priority of ICBN, the latter was published earlier. As such, the same has been accepted here, following Mahberley (1980).

#### 4. *PENTATROPIS* Wight & Arn.

*Pentatropis nivalis* (J. F. Gmel.) Field & Wood in Kew Bull. 38 : 215. 1983; Jagtap & Singh, Fl. India Fasc. 24 : 39. 1999. *Asclepias nivalis* J. F. Gmel. in Linn. Syst. Nat. ed. 13. 2 (1) : 444. 1791. *Pentatropis spiralis sensu* Decne. in Ann. Sci. Nat. ser. 2. 9 : 327. t. 11E. 1838, non *Asclepias spiralis* Forssk. 1775; Hook. f. Fl. Brit. India 4 : 19. 1883; Bhandari, Fl. Indian Desert 224. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 483. 1991. *Pentatropis cynanchoides* R. Br. in Salt. Voy. Abyss. App. 64. 1814; Duthie, Fl. Gangetic Plain 2: 52. 1911.

Local name : *Akadi-bel*.

Perennial, twining shrubs; stem slender, terete, more or less pubescent when young, becoming glabrous at age. Leaves opposite, decussate, 2-4.5 x 1.5-2 cm, elliptic, oblong or ovate, obtuse or slightly mucronate at apex, rounded at base, glabrous above, minutely pubescent beneath. Petioles 4-8 mm long, terete, softly pubescent. Flowers greenish-yellow, in lateral, umbellate cymes; peduncles 1.5-8 mm long, terete; pedicels 6-12 mm long, filiform, pubescent. Bracts ca 1.5 x 1 mm, subulate, acute, pubescent. Calyx 5-lobed, divided up to the base; lobes 1.5-2 x 0.5-1 mm, ovate-lanceolate, acute, pubescent. Corolla rotate, divided nearly to the base; lobes 8-12 mm long, narrowly linear from a triangular base, glabrous outside, minutely pubescent inside. Staminal corona-lobes 1-1.5 mm long, deltoid-ovate, arising above the base of staminal column, slightly shorter than the column, but adnate to the column. Follicles 5-8 x 0.8-1.5 cm, lanceolate, tapering at apex, glabrous. Seeds ca 6 x 4 mm, ovate, flat, rounded at apex, minutely crenate and cuncate at base, brown; coma ca 2 mm long.

*Fl. & Fr.*: October-May.

*Ecology*: Rare, found in sandy and gravelly plains as a twinner on *Capparis decidua* (Forssk.) Edgew. and other shrubs. It sometimes occurs on field-fences.

*Specimens examined* : Near Satto, Monika 16639 (BSJO); Near Singhdar, Monika 17120 (BSJO).

#### 5. *PERGULARIA* L.

*Pergularia daemia* (Forssk.) Chiov. in Result. Sci. Miss. Stefan-Paoli Somal. Ital. 1 : 115. 1916; Bhandari, Fl. Indian Desert 225. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 484. 1991; Jagtap & Singh, Fl. India Fasc. 24 : 41. 1999. *Asclepias daemia* Forssk. Fl. Aegypt.-Arab. 51. 1775. *Cynanchum extensum* Jacq. Misc. Aust. Bot. 2 : 353. 1781. *Daemia extensa* (Jacq.) R. Br. in Mem. Wern. Soc. 1 : 50. 1811; Hook. f. Fl. Brit. India 4 : 20. 1883; Duthie. Fl. Gangetic Plain 2 : 52. 1911.

Local name : *Gaderia-ri-bel*.

Perennial, twining undershrubs; stem and branches terete, slender, pubescent with bulbous-based, spreading hairs mixed with thin, short hairs. Leaves 4-12 x 2.5-9 cm, broadly ovate, acuminate, cordate at base, glabrous above, velvety pubescent beneath, entire. Petioles 3-6 cm long, pubescent. Flowers greenish-yellow, in drooping, lateral, corymbose cymes; pedicels 2-2.5 cm long, filiform, pubescent. Bracts ca 1.5 mm

long, lanceolate, acute, pubescent. Calyx-lobes 2.5-3 x 0.8-1 mm, ovate-lanceolate, acute. Corolla narrowly campanulate; lobes 5-6 x 3-3.5 mm, ovate-oblong, acute, ciliate. Staminal corona biscriate; outer membranous, 5-lobed. 4-5 mm long, subquadrate, completely adnate to the base of staminal column; inner lobes 5-6 mm long, with subulate horns curved over staminal column. Follicles 5-8 x 1-1.5 cm, reflexed, lanceolate, narrowed at apex into a long beak, densely soft spiny. Seeds 6-8 mm long, ovate, truncate at apex, crenate at the base, densely pubescent, brown; coma 2-3.5 cm long, silky white (Plate-16/1).

*Fl. & Fr.*: August-December.

*Ecology* : Common, found mostly in gravelly habitats of wastelands, climbing on bushes, shrubs and fences of fields.

*Specimen examined*: Along Miajlar-Sundra road, *Monika* 17152 (BSJO).

### 32. GENTIANACEAE

#### *ENICOSTEMA* Blume (*nom. cons.*)

*Enicostema axillare* (Lam.) Raynal in *Adansonia* 9 : 75. 1969; Bhandari, *Fl. Indian Desert* 205. 1990; Parmar in Shetty & Singh, *Fl. Rajasthan* 2 : 495. 1991. *Gentiana verticillata* L. *Syst. Nat.* ed. 12. 200. 1767, *pro parte*, non L. 1759. *G. axillaris* Lam. *Ill. Gen.* 1 (2) : 487. 1793. *Exacum hyssopifolium* Willd. *Sp. Pl.* 1 : 640. 1798. *Enicostema littorale auct.* non Blume 1826; Clarke in Hook. f. *Fl. Brit. India* 4 : 101. 1883; Duthie, *Fl. Gangotri Plain* 2 : 73. 1911. *E. verticillatum* (L.) Engl. *Pflan. Ostafri. C.* 313. 1895, non Baill. 1891. *E. hyssopifolium* (Willd.) Verdoorn in *Bothalia* 7 : 462. 1961; Bhandari, *Fl. Indian Desert* 230. 1978.

Local name : *Nawri*.

Erect, perennial, glabrous herbs, with many subquadrangular branches from the base, 20-30 cm high. Leaves opposite, decussate, 2-7 x 0.3-0.6 cm, sessile, linear-lanceolate or narrowly oblong, acute or obtuse at apex, glabrous, 3-nerved. Flowers white, sessile or subsessile, in axillary clusters at each node. Corolla tubular, 5-7 mm long; lobes 2-3 mm long, lanceolate, acute. Stamens inserted at the middle of the corolla-tube, with small, double-hooded, scaly glands at the base; anthers acute. Ovary 1-celled, glabrous; stigma capitate, bilobed. Capsules 3-4.5 mm long, ellipsoid-oblong, apiculate, septically 2-valved, glabrous. Seeds many, minute, subglobose, foveolate, brown.

*Fl. & Fr.*: June-December.

*Ecology* : Rare, found in moist sandy plains in association with *Cleome viscosa* L., *Digera muricata* (L.) Mart., *Tribulus terrestris* L., etc.

*Specimen examined* : Near Sundra, *Monika* 16767 (BSJO).

### 33. BORAGINACEAE

- 1a. Leaves amplexicaul or cordate at base. Calyx 0.8-1 cm long, accrescent; lobes cordate or hastate at base. Corolla purplish-blue. Anthers connivent into a cone; connectives much produced, twisted together at apex. **4. *Trichodesma***
- 1b. Leaves narrowed at base. Calyx up to 7 mm long, not accrescent; lobes linear-lanceolate, not cordate at base. Corolla white or yellow. Anthers not connivent into a cone; connectives obtuse or apiculate, not twisted.

- 2a. Straggling shrubs. Corolla densely waxy woolly inside. Nutlets usually 2. Faucal appendages (scales) present. **3. *Sericostoma***
- 2b. Erect herbs or undershrubs. Corolla not waxy woolly inside. Nutlets usually 4. Faucal appendages (scales) absent. **3**
- 3a. Roots with reddish-purple stain. Flowers dark yellow, in secund spikes or racemes. Corolla-lobes obtuse. Ovary deeply lobed; style gynobasic. **1. *Arnebia***
- 3b. Roots without stain. Flowers white or yellow, in terminal scorpioid cymes. Corolla-lobes distinctly caudate-acuminate if yellow coloured. Ovary not lobed; style terminal. **2. *Heliotropium***

### 1. *ARNEBIA* Forssk.

*Arnebia hispidissima* (Sieber ex Lehm.) DC. Prodr. 10 : 94. 1846; Clarke in Hook. f. Fl. Brit. India 4 : 176. 1883; Duthie, Fl. Gangetic Plain 2 : 27. 1911; Bhandari, Fl. Indian Desert 231. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 501. 1991. *Achusa asperrima* Del. Fl. d'Eg. III. 55. 1813, *nom. nud.* *Lithospermum hispidissimum* Sieber ex Lehm. Ic. Nov. Stirp. t. 39. 1821. *Arnebia asperrima* (Del.) Hutch. & Dalz. Fl. West Trop. Afr. ed. 1. 2 : 201. 1931.

Local name : *Rambui*.

Erect or decumbent, annual or perennial, much-branched herbs, 20-30 cm high; branches diffuse from woody base, clothed with long, whitish, spreading, bulbous-based hairs. Leaves alternate, sessile, 2-8 x 0.2-0.8 cm, linear-lanceolate, acute, attenuated at base, densely covered with bulbous-based, white, stiff hairs. Flowers yellow, sessile, in simple, many-flowered, secund spikes or spicate racemes. Bracts foliaceous, 5-8 mm long, linear-lanceolate, hispid. Calyx-lobes 6-7 mm long, lanceolate, acute, unequal, hispid. Corolla pubescent outside; tube ca 8 mm long; lobes ca 3 mm long, oblong, obtuse. Stamens inserted much below the mouth of corolla; anthers oblong. Nutlets 4, 1.5-2.5 mm long, ovoid, broadest at base, tuberculated, brown (Plate-18/4).

Fl. & Fr.: March-August.

Ecology : Occasional, found in sandy plains, usually in isolated patches or in association with *Dicoma tomentosa* Cass., *Blepharis linariuefolia* Pers., *Euphorbia granulata* Forssk., etc.

Specimens examined : Sudasari, Monika 16684, 16762 (BSJO); Along Miajlar road, Shetty 6144 (BSJO).

### 2. *HELIOTROPIMUM* L.

- 1a. Inflorescence ebracteate. **2**
- 1b. Inflorescence bracteate; bracts sometimes much reduced. **4**
- 2a. Leaves sessile to subsessile, lanceolate to linear-lanceolate. Nutlets tuberculate. **3**
- 2b. Leaves petiolate, elliptic-oblong to obovate. Nutlets densely pilose and minutely verrucose. **2. *H. europaeum* var. *lasiocarpum***
- 3a. Corolla yellowish; lobes caudate-acuminate, inflexed in corolla-tube when young, later patent. **7. *H. subulatum***
- 3b. Corolla white; lobes ovate or roundish, obtuse, erect. **1. *H. bacciferum***
- 4a. Corolla ca 2.5 mm long, sparsely hairy within just above the corolla base. Stigma subcapitate; stigmatic ring fleshy, thick. **5. *H. rariflorum***



- 4b. Corolla more than 2.5 mm long, slightly or densely hairy within only at the throat. Stigma elongate, conical, stigmatic ring thin. 5
- 5a. Thinly hairy, decumbent or prostrate herbs. Flowers sessile, closely set in 2-3 cm long spicate inflorescence. 6
- 5b. Scabridly hairy, prostrate or erect herbs. Flowers subsessile to pedicellate, distantly set in 3-5 cm long spicate inflorescence. **6. *H. strigosum***
- 6a. Leaves 1.8-2 cm long, thinly covered with sharp, tubercle-based trichomes. Bracts 3-4 mm long. Fruits glabrous. **3. *H. marifolium* var. *marifolium***
- 6b. Leaves up to 1 cm long, densely covered with trichomes (not tubercle-based). Bracts 1-2 mm long. Fruits densely covered with short, stout trichomes throughout. **4. *H. marifolium* var. *wallichii***

1. *Heliotropium bacciferum* Forssk. Fl. Aegypt.-Arab. 38. 1775; Bhandari, Fl. Indian Desert 233. 1978, excl. syn. *H. undulatum* Vahl 1790; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 507. 1991.

Local name : *Kali-bui*.

Erect, perennial herbs, woody at base; stem pubescent, atleast in young stage, scabrous at age. Leaves 1.5-3.5 x 0.2-0.8 cm, subsessile, lanceolate, tapering at both ends, clothed with white, stiff, bulbous-based hairs, margins crenulate. Flowers dull white, ebracteate, two-ranked in solitary or paniculately branched spikes up to 2.5 cm long. Calyx ca 3 mm long, divided up to the base; lobes linear-lanceolate, densely hairy outside, nearly glabrous or sparsely hairy inside. Corolla tubular, 3-4 mm long, hairy outside; tube slightly swollen at base; lobes 1-2 mm long, crisped. Stamens inserted at the middle of corolla-tube; anthers ca 1 mm long, subsessile. Style ca 1 mm long; stigma conical, shortly bifid at apex, minutely pubescent. Fruits 1.5-2 mm in diam., globose; nutlets 4, in 2 pairs, verrucose on back, glabrous, brownish-black.

Fl. & Fr.: August-May.

Ecology : Common, found in sandy to gravelly habitats, usually in association with *Fagonia schweinfurthii* (Hadidi) Hadidi ex Ghafoor and *Eragrostis minor* Host.

Specimens examined : Near Satto, Pandey 7885 (BSJO), Monika 16645 (BSJO); Berisiyala, Monika 16781 (BSJO); Miajlar, Pandey 7908 (BSJO).

2. *Heliotropium europaeum* L. var. *lasiocarpum* (Fish. & Mey.) Kazmi in J. Arn. Arbor. 51 : 176. 1970; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 508. 1991. *H. lasiocarpum* Fish. & Mey. Index Sem. Hort. Petrop. 4 : 38. 1837. *H. eichwaldii* Steud. ex DC. var. *lasiocarpum* (Fish. & Mey.) Clarke in Hook. f. Fl. Brit. India 4 : 150. 1883. *H. eichwaldii* auct. non Steud. ex DC. 1845; Duthie, Fl. Gangetic Plain 2 : 92. 1911. *H. ellipticum* auct. plur. non Ledeb. 1831, non R. Br. 1810; Bhandari, Fl. Indian Desert 234. 1978.

Erect, annual herbs, 20-35 cm high; stem and branches greyish, densely hairy with soft, bulbous-based hairs. Leaves 2-6 x 0.8-3.5 cm, elliptic-ovate or obovate, subacute at apex, truncate or slightly attenuate at base, softly hairy on both surfaces. Petioles 2-3.5 cm long, terete, pubescent. Flowers white, 2-ranked in terminal or axillary, binate or trinate, 2-6 cm long spikes. Calyx divided up to the base, densely hairy on bothsides, becoming pale brown in fruits; lobes 2-2.5 mm long, ovate-lanceolate, acute. Corolla tubular; tube ca 3.5 mm long, narrowed at the throat, slightly glandular hairy outside, glabrous inside; lobes up to 1 mm long, orbicular-oblong, margins crisped. Style conical, bifid at apex; stigma absent. Nutlets 4, ca 2 mm long, densely pubescent, minutely verrucose, brownish-black (Plate-16/2).

*Fl. & Fr.*: November-April.

*Ecology* : Occasional, found in sandy plains as well as a weed in cultivated and fallow fields.

*Specimen examined* : Sudasari, Monika 16769 (BSJO).

3. *Heliotropium marifolium* Koen. ex Retz. Obs. Bot. 2 : 8. 1781; Clarke in Hook. f. Fl. Brit. India 4 : 152. 1883; Bhandari, Fl. Indian Desert 234. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 509. 1991. *H. scabrum* Retz. Lc.2 : 8. 1781; Clarke in Hook. f. Lc. 4 : 152. 1883; Duthie, Fl. Gangetic Plain 2 : 93. 1911.

var. *marifolium*

Perennial, much-branched, decumbent or prostrate herbs; stem thinly adpressed hairy; branches spreading from the base. Leaves alternate or rarely opposite, 1.5-2 x 0.2-0.5 cm, lanceolate to elliptic-lanceolate, acute, obtuse at base, scabrous with tubercle-based, sharp trichomes. Petioles 1-1.5 mm long. Flowers white, closely set in short, axillary and terminal, 2-5 cm long spikes. Bracts 3-4 mm long, lanceolate, foliaceous. Calyx 2.5-3 mm long, appressed hairy; lobes lanceolate, slightly enlarging in fruit. Corolla 2-3.5 mm long, throat densely hairy. Stamens inserted below or at the middle of the corolla-tube; anthers ca 0.8 mm long, lanceolate. Ovary ovoid, glabrous; stigma 0.4-0.5 mm long, elongate-conic, with ca 0.3 mm wide stigmatic disc. Fruits subglobose or 4-lobed, depressed, glabrous or pubescent at the tip; nutlets 4, rounded on back.

*Fl. & Fr.*: September-March.

*Ecology* : Occasional, found in wastelands and near cultivated fields in association with *Amaranthus viridis* L., *Euphorbia* spp., etc.

*Specimens examined* : Near Nimba, Monika 16519A (BSJO); Sudasari, Pandey 7841 (BSJO).

4. *Heliotropium marifolium* Koen. ex Retz. var. *wallichii* Clarke in Hook. f. Fl. Brit. India 4 : 152. 1883; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 510. 1991. *H. scabrum* Retz. var. *wallichii* (Clarke) Gamble Fl. Madras 2 : 897. 1923. *H. marifolium* Koen. ex Retz. subsp. *wallichii* (Clarke) Kazmi in J. Arn. Arbor. 51 : 155. 1970.

Small, annual, decumbent or prostrate herbs; branches many from the base. Leaves sessile, 4-8 x 1-2 mm, lanceolate, subacute, densely covered with white trichomes usually non-tubercled. Spikes 2-3 cm long. Bracts 1-1.5 x 0.8-1 mm. Flowers dirty white. Calyx ca 2 mm long, hairy throughout. Corolla-throat slightly hairy. Fruits 2-3 mm in diam., densely covered with short trichomes throughout; nutlets 4, brownish-black.

*Fl. & Fr.*: September-March.

*Ecology* : Rare, found in wastelands in gravelly habitats. Main associates are *Cleome scaposa* DC., *Heliotropium* spp., etc. This taxon finds distribution in the east of Aravalli in Rajasthan. Reported for the first time from desertic zones.

*Specimen examined* : Near Nimba, Monika 16519B (BSJO).

5. *Heliotropium rariflorum* Stocks in Hook. Kew J. Bot. 4 : 174. 1852; Clarke in Hook. f. Fl. Brit. India 4 : 152. 1883; Bhandari, Fl. Indian Desert 236. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 511. 1991.

Perennial, much-branched undershrubs, woody at base, 50-60 cm high; bark whitish-brown, of thin flakes; branches hoary with appressed hairs. Leaves subsessile, 2-3.5 x 0.2-0.4 cm, linear-lanceolate, subacute at apex, narrowed at base, more or less revolute-margined, appressed hairy on both surfaces. Petioles ca 1.5 mm long. Flowers white, distantly arranged in terminal or extra-axillary, slender, bracteate, 2-7 cm long spikes. Bracts 5-9 mm long, lanceolate, hairy. Calyx hairy, persistent, divided up to the base, up to 2 mm long; lobes linear-lanceolate, subacute, strigose, ciliate. Corolla ca 2.5 mm long, papillate and hairy outside; tube cylindric, with numerous moniliform hairs in throat; lobes ovate, obtuse. Stamens inserted above the middle in the corolla-tube; filaments short, papillate; anthers ovate, acuminate. Ovary ovoid; stigma subcapitate, like a depressed cone. Fruits 4-lobed, ca 2 mm across; nutlets 4, covered with appressed hairs.

*Fl. & Fr.*: September-March.

*Ecology*: Common, found in gravelly habitats and in rock outcrop areas.

*Specimens examined*: Satto-Bandera road, *Monika* 16667 (BSJO); Near Sundra, *Monika* 17161 (BSJO); Bandera village, *Pandey* 7914 (BSJO).

6. *Heliotropium strigosum* Willd. Sp. Pl. 1 : 743. 1798; Clarke in Hook. f. Fl. Brit. India 4 : 151. 1883; Bhandari, Fl. Indian Desert 212. 1990; Duthie, Fl. Gangetic Plain 2 : 93. 1911; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 511. 1991.

Annual, erect or decumbent, rigid, scabridly appressed hairy herbs, 15-30 cm high; branches many, terete. Leaves sessile, 1.5-2.5 x 0.2-0.4 cm, linear-lanceolate, acute, appressed hairy. Flowers white, in 3-5 cm long, lax, bracteate spikes, lower ones pedicelled, upper ones sessile. Calyx 2-3 mm long, sparsely hairy, falling with the fruit. Corolla tubular, glabrous. Fruits ca 1.5 mm long, ovoid, 4-lobed, depressed at the top, dark brown; nutlets 4, conical, rounded on the back, glabrous or sparsely hairy.

*Fl. & Fr.*: August-December.

*Ecology*: Common, found in moist sandy plains in association with *Mollugo cerviana* (L.) Seringe.

*Specimens examined*: Sam, *Monika* 16553, 16724 (BSJO); Near Kanoi, *Monika* 16734 (BSJO).

7. *Heliotropium subulatum* (Hochst. ex DC.) Vatke, Oesterr. Bot. Zeitschr. 25 : 166. 1875; Duthie, Fl. Gangetic Plain 2 : 91. 1911; Bhandari, Fl. Indian Desert 237. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 512. 1991. *Tournefortia subulata* Hochst. ex DC. Prodr. 9 : 528. 1845. *Heliotropium zeylanicum* auct. plur. non Lam. 1789; Clarke in Hook. f. Fl. Brit. India 4 : 148. 1883.

Erect, perennial, much-branched, scabridly hairy herbs, 30-60 cm high; stem terete, bristly with bulbous-based hairs mixed with glandular hairs. Leaves sessile, 3-7 x 0.3-1.5 cm, elliptic-lanceolate, acute, tapering at base, densely hairy like stem on both surfaces, entire or undulate and somewhat revolute-margined. Flowers dirty white, sessile, 2-ranked but apparently uniseriate, in 7-40 cm long, terminal, ebracteate spikes. Calyx-lobes 1-1.5 mm long, ovate, acute, pubescent, ciliate on margins. Corolla-tube ca 3.5 mm long, slightly swollen above; lobes 2-3 mm long, inflexed when young, caudate-acuminate on maturity, glabrous. Stamens inserted in the swollen part of the corolla-tube; anthers ca 1 mm long, sessile, bifid at apex. Ovary glabrous; style glabrous, ca 2 mm long; stigma slightly shorter than style. Fruits ca 2 mm in diam., minutely tuberculate, separating first in pairs, later free in 4 nutlets (**Plate-16/3**).

*Fl. & Fr.*: October-April.

*Ecology* : Common, found in typical sandy undulating plains in association with *Farsetia hamiltonii* Royle.

*Specimens examined* : Near Chittori, *Monika* 16652 (BSJO); Near Daw, *Monika* 16798 (BSJO).

### 3. *SERICOSTOMA* Stocks ex Wight

*Sericostoma pauciflorum* Stocks ex Wight. Icon. 4 (2) : 15. t. 1377. 1848; Clarke in Hook. f. Fl. Brit. India 4 : 175. 1883; Raizada, Suppl. Duthie, Fl. Gangetic Plain 159. 1976; Bhandari, Fl. Indian Desert 238. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 514. 1991.

Perennial, much-branched, straggling undershrubs; stem woody at base; branches rigid, clothed with white, adpressed or spreading hairs. Leaves opposite, or alternate in lower region, sessile, 1-3.5 x 0.2-0.4 cm, linear or lanceolate, subobtuse, clothed with white, bulbous-based, stiff hairs on both surfaces, ciliate. Flowers white, in terminal or leaf-opposed, 3 to 6-flowered, subscorpioid racemes. Calyx-lobes 5, 2 outer slightly larger than other 3, ovate-lanceolate, acute, ciliate. Corolla-throat waxy-villous with silky hairs; lobes oblong-rounded, strongly nerved, obtuse at apex, slightly crisped on margins. Stamens inserted at the sinus of corolla; anthers oblong. Ovary 4-lobed; style undivided; stigma capitate, sub-bilobate. Nutlets 2, ca 2.5 x 1.5 mm, ovoid-oblong, with a short sublateral stalk, keeled on the ventral side, acuminate at apex, tuberculated on the back, brown, included in the persistent calyx.

*Fl. & Fr.*: August-November.

*Ecology* : Common, found in sandy plains and on small stabilized dunes in association with *Cenchrus biflorus* Roxb., *Crotalaria burhia* Buch.-Ham. ex Benth., *Panicum antidotale* Retz., etc.

*Specimens examined* : Near Sipla, *Monika* 16541 (BSJO); Near Miajlar, 16704 (BSJO).

### 4. *TRICHODESMA* R. Br. (*nom. cons.*)

*Trichodesma indica* (L.) R. Br. Prodr. Fl. Nov. Holl. 496. 1810; Clarke in Hook. f. Fl. Brit. India 4 : 153. 1883; Duthie, Fl. Gangetic Plain 2 : 94. 1911, *pro parte*; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 515. 1991. *Borago indica* L. Sp. Pl. 137. 1753.

Erect or diffuse, annual, much-branched, hispid herbs. Leaves 3-5.5 x 0.6-1.5 cm, linear-lanceolate to ovate-oblong, obtuse, subcordate and amplexicaul at base, pubescent above and villous beneath with bulbous-based and simple hairs, margins more or less revolute, coriaceous. Flowers purplish-white, solitary and leaf-opposed; pedicels up to 1.5 cm long. Calyx 8-10 mm long, enlarged in fruit, hispid; lobes lanceolate, acute, auricled. Corolla 10-13 mm long; tube ca 6 mm long, thinly hairy outside; lobes ovate-deltoid. Stamens forming a pointed cone, hairy on lateral sides; connectives produced and twisted together. Fruits pyramidal, 4-ribbed; nutlets ca 4 mm long, oblong, with smooth, shining back and rugose, more or less margined inner faces, brown.

*Fl. & Fr.*: August-December.

*Ecology* : Common, found as a weed of wastelands and road-sides in association with *Amaranthus viridis* L., *Cleome viscosa* L., etc. Reported first time from desertic conditions.

*Specimen examined* : Sam, *Monika* 16620 (BSJO).

## 34. EHRETIACEAE

## CORDIA L.

*Cordia gharaf* (Forssk.) Ehrenb. ex Asch. Sitz. Ges. Naturf. Freun. Berlin 1879 (4) : 46. 1879; Bhandari, Fl. Indian Desert 240. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 519. 1991. *Cornus gharaf* Forssk. Fl. Aegypt.-Arab. 95. 1775. *Cordia rothii* Roem. & Schult. Syst. Veg. 4 : 798. 1819; Clarke in Hook. f. Fl. Brit. India 4 : 138. 1883; Duthie, Fl. Gangetic Plain 2 : 85. 1911.

Local name : *Goondi*.

Medium-sized trees or large shrubs; stem sparsely pubescent when young, older lenticelled; bark greyish, deeply furrowed. Leaves opposite or subopposite, 5-12 x 2-3.5 cm, oblanceolate-oblong, entire, obtuse or rounded at apex, cuneate at base, more or less pubescent on both surfaces, scabrid and rough at length. Petioles up to 2 cm long, obscurely grooved. Flowers white, small, in short, axillary or terminal, corymbose cymes; peduncles 1-2.5 cm long; pedicels 3-5 mm long. Calyx 4-5 mm long, pubescent outside, silky hairy within, oblong-campanulate; lobes small, obtuse. Corolla 7-8 mm long; lobes oblong, obtuse, more or less equal to tube, reflexed. Stamens inserted on the corolla-throat; filaments glabrous except with few, long hairs near the base. Style-arms narrowly clavate, bipartite. Fruits 9-12 mm long, ovoid, apiculate by persistent style-base, seated on saucer-shaped accrescent calyx, glabrous, yellow when ripe, with gelatinous edible pulp, usually 1-seeded.

Fl. & Fr.: March-June.

Ecology : Rare, found in gravelly and somewhat rocky habitats, probably planted.

Specimen examined : DNP, Shetty 3385 (BSJO).

## 35. CONVULVULACEAE

- |  |                       |
|--|-----------------------|
| 1a. Pollens spinulose.   | 3. <i>Ipomoea</i>     |
| 1b. Pollens smooth.  | 2                     |
| 2a. Style 1, entire; stigma filiform.  | 1. <i>Convolvulus</i> |
| 2b. Styles 2, free or united at base; stigmas capitate, orbiculate or peltate. | 3                     |
| 3a. Corolla-lobes imbricate. Stamens and styles exserted.                      | 2. <i>Cressa</i>      |
| 3b. Corolla-lobes induplicate-contorted. Stamens and styles included.          | 4. <i>Seddera</i>     |

## 1. CONVULVULUS L.

- |  |  |
|--|--|
| 1a. Plants twining. Flowers numerous (more than 4) in densely hairy, axillary, pedunculate, involucrate heads. | 1. <i>C. auricomus</i> var. <i>volubilis</i>   |
| 1b. Plants prostrate. Flowers 1-3, axillary, or in axillary, pedunculate, bracteate clusters.                  | 2  |
| 2a. Flowers sessile or subsessile, in axillary clusters.   | 2. <i>C. prostratus</i> var. <i>prostratus</i> |
| 2b. Flowers condensed at the end of axillary peduncles.  | 3. <i>C. prostratus</i> var. <i>deserti</i>    |

1. *Convolvulus auricomus* (A. Rich.) Bhandari var. *volubilis* (Clarke) Bhandari in Bull. Bot. Surv. India 6 (2-4) : 327. 1964 & Fl. Indian Desert 244, f. 83. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 529. 1991. *Convolvulus glomeratus* Choisy var. *volubilis* Clarke in Hook. f. Fl. Brit. India 4 : 219. 1883.

Local name : *Rotabel*.

Perennial, twining, white hairy herbs; stems numerous from woody root-stock. Leaves 3-5 x 0.8-2 cm, oblong, acute to subacute at apex, rounded or subcordate at base. Petioles up to 6 mm long. Flowers many, pinkish-white, in dense, axillary, pedunculate, silky white clusters ca 2 cm in diam.; peduncles 4-6 cm long, hairy. Outer bracts foliaceous, ovate-lanceolate, ca 2.5 cm long, densely clothed with white hairs, ciliate; inner ones smaller but little larger than the calyx. Calyx 2-3.5 cm long; lobes ovate-lanceolate, acuminate, two outer ones broader than the inner three, densely clothed with white hairs. Corolla tubular; lobes ca 1.5 cm long, hairy outside at apex. Capsules 5-6 mm in diam., globose, glabrous, pale yellow. Seeds blackish-brown, scabrid.

*Fl. & Fr.*: October – November.

*Ecology* : Common, found twining on field-fences and shrubs and undershrubs like *Capparis decidua* (Forssk.) Edgew., *Ziziphus nummularia* (Burm. f.) Wight & Arn., etc.

*Specimens examined* : Near Nimba, *Monika* 16631 (BSJO); Near Sundra, *Monika* 17166 (BSJO).

2. *Convolvulus prostratus* Forssk. Fl. Aegypt.-Arab. 203. 1775; Singh in Shetty & Singh, Fl. Rajasthan 2 : 530. 1991. *C. microphyllus* Sieb. ex Spreng. Syst. Veg. 1 : 611. 1825; Clarke in Hook. f. Fl. Brit. India 4 : 218. 1883, incl. var. *boissieri*; Bhandari, Fl. Indian Desert 247. 1978. *C. parviflorus* Spreng. Syst. Veg. 1 : 611. 1825. *C. pluricaulis* Choisy in Mem. Soc. Phys. Hist. Nat. Geneve 6 : 477. 1834; Clarke in Hook. f. Lc. 4 : 218. 1883, incl. var. *macra*; Duthie, Fl. Gangetic Plain 2 : 105. 1911. *C. scindicus* Boiss. Diagn. Pl. ser. 2 (3). 123. 1856, non Stocks 1852.

var. *prostratus*

Local name : *Santari*.

Procumbent or prostrate, perennial herbs, 20-50 cm long, hairy or ferruginously pilose; stem suffruticose at base, often floriferous from near the base. Leaves subsessile, 1.5-6.5 x 0.3-0.8 cm, linear-oblong or oblong-lanceolate, acute to obtuse, entire, hairy on both surfaces, lower leaves usually larger and spatulate. Flowers pinkish-white, 1 to 3-together, nearly sessile, in axillary clusters. Bracts linear-lanceolate, acuminate, outer longer than inner ones. Calyx-lobes 6-7 mm long, ovate, acuminate, subequal, 3 outer broader than 2 inner, densely silky hairy. Corolla funnel-shaped, more or less twice as long as the calyx, with a tuft of hairs at the apex of each lobe and 5 mid-petaline hairy bands. Ovary glabrous, on a cupular disc; stigma filiform. Capsules ca 3 mm in diam., globose, smooth. Seeds 2-4, brown, pubescent (Plate-20/1).

*Fl. & Fr.*: August-December.

*Ecology* : Common, found in sandy plains in association with *Euphorbia granulata* Forssk., *Dipterygium glaucum* Decne., etc.

*Specimens examined* : Near Ganga, *Monika* 16518 (BSJO); Near Girab, *Monika* 16655 (BSJO); Sam, *Monika* 16723 (BSJO).

3. *Convolvulus prostratus* Forssk. var. *deserti* (Hochst. & Steud. ex Baker & Rendle) Parmar in J. Econ. Taxon. Bot. 18 : 251. 1994. *Convolvulus deserti* Hochst. & Steud. ex Baker & Rendle in Dyer, Fl. Trop. Afr. 4 (2) : 164. 1905; Bhandari, Fl. Indian Desert 246. f. 84. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 530. 1991. *C. microphyllus sensu* Choisy in DC. Prodr. 9 : 402. 1845, non Sieb. ex Spreng. 1825.

Suffruticose herbs, up to 30 cm high; stem slender, terete, sparsely clothed with spreading hairs. Leaves subsessile, 3-4 x 0.5-0.8 cm, linear-oblong, obtuse or subacute at apex, tapering at base, adpressed hairy on both surfaces, gradually shorter upwards, lower ones up to 7 cm long and linear-spathulate. Flowers pink, 1-3 on axillary peduncles; peduncles 2-3 cm long, slender, terete, hairy. Bracts 0.8-1 cm long, linear, narrow, clothed with ferruginous hairs. Calyx-lobes 6-7 mm long, subequal, ovate, acuminate. Corolla 10-12 mm long, funnel-shaped; lobes pubescent along mid-petaline area. Ovary ovoid, glabrous. Capsules ca 3 mm long, pubescent. Seeds 2-4, dark brown, pubescent.

*Fl. & Fr.*: August – December.

*Ecology*: Common, found in sandy plains in association with *Euphorbia granulata* Forssk., *Dipterygium glaucum* Decne., etc.

*Specimen examined*: Near Sam Forest R. H., *Monika* 16605 (BSJO).

## 2. CRESSA L.

*Cressa cretica* L. Sp. Pl. 223. 1753; Clarke in Hook. f. Fl. Brit. India 4 : 225. 1883; Duthie, Fl. Gangetic Plain 2 : 103. 1911; Bhandari, Fl. Indian Desert 249. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 533. 1991. *C. indica* Retz. Obs. Bot. 4 : 242. 1786.

*Local name*: *Rudenti*.

Perennial, suberect, hairy, dwarf herbs, sometimes up to 25 cm high; stem with many, densely leafy, hairy branches. Leaves alternate, apparently crowded, 3-7 x 1.5-3.5 mm, ovate-rounded or narrowed towards base, subacute at apex, densely silky hairy, strigose at age. Flowers whitish-pink, subsessile, solitary or in small clusters in the axils of upper leaves. Bracts 2, linear, hairy, appressed to the calyx. Calyx-lobes 2-2.5 mm long, elliptic, obtuse, concave, densely silky. Corolla ca 4 mm long, campanulate, divided up to middle; lobes oblong, deflexed, hairy outside near the apex. Stamens 5, slightly exerted. Capsules 4-5 mm long, ovoid, crowned by style-base, pubescent at apex, usually 1-seeded. Seeds ca 2 mm long, chestnut-brown, glabrous.

*Fl. & Fr.*: November – March.

*Ecology*: Rare, found on the drying margins of water bodies in association with *Cleome scaposa* DC. It is an indicator of salinity.

*Specimen examined*: Near Jamara tank side, *Pandey* 7851 (BSJO).

## 3. IPOMOEA L. (nom. cons.)

- |  |                           |
|--|---------------------------|
| 1a. Leaves palmately 5 to 7-lobed. Corolla 3-4 cm long.                  | 1. <i>I. pes-tigridis</i> |
| 1b. Leaves entire. Corolla up to 1.5 cm long.                            | 2                         |
| 2a. Flowers sessile or subsessile, in axillary clusters.                 | 2. <i>I. indica</i>       |
| 2b. Flowers pedicelled, in 1 to 3-flowered, axillary, pedunculate cymes. | 3. <i>I. verticillata</i> |

1. *Ipomoea pes-tigridis* L. Sp. Pl. 162. 1753; Clarke in Hook. f. Fl. Brit. India 4 : 204. 1883; Duthie, Fl. Gangetic Plain 2 : 116. 1911; Bhandari, Fl. Indian Desert 258. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 545. 1991. *I. hepaticaefolia* L. Sp. Pl. 161. 1753. *I. capitellata* Choisy in Mem. Soc. Phys.

Geneve 6 : 446. 1834 & in DC. Prodr. 9 : 365. 1845. *I. pes-tigridis* L. var. *hepaticaeifolia* (L.) Clarke in Hook. f. *l.c.* 4 : 204. 1883. *I. pes-tigridis* L. var. *capitellata* (Choisy) Clarke in Hook. f. *l.c.* 4 : 204. 1883.

Annual, twining herbs; stem and branches slender, hirsute with long, spreading hairs. Leaves 4-9 x 4-10 cm, orbicular to somewhat reniform in outline, broadly cordate at base, palmately 5 to 9-lobed; lobes elliptic-oblong, narrowed at base, acute to acuminate at apex, adpressed hairy on both surfaces. Petioles 4-9 cm long, densely hairy. Flowers pale pink, in axillary, pedunculate, involucrate, in 3 to 5-flowered heads; peduncles 4-12 cm long, hairy with long spreading hairs. Outer bracts 1.5-2.5 cm long, linear-oblong, foliaceous, subacute at apex; inner ones ovate-cordate, smaller than outer. Calyx-lobes lanceolate, hirsute, unequal; inner sepals narrower than outer ones. Corolla 3-3.5 cm long, funnel-shaped, pilose on mid-petaline areas. Stamens and style included; filaments glabrous. Capsules ca 7 mm long, ovoid, glabrous. Seeds ca 3 mm long, triangular, silky villous, brown.

*Fl. & Fr.*: September – November.

*Ecology* : Common, found in sandy plains as a twinner on *Capparis decidua* (Forssk.) Edgew. and other shrubs, including fences of fields.

*Specimen examined* : Sudasari, Monika 17171 (BSJO).

2. *Ipomoea sindica* Stapf in Kew Bull. 93 : 346. 1894; Duthie, Fl. Gangetic Plain 2 : 113. 1911; Bhandari, Fl. Indian Desert 260. f. 93. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 547. 1991.

Local name : *Rotabel*.

Trailing or creeping, annual herbs, hirsute with spreading hairs; branches many from base, with long internodes. Leaves 3-7.5 x 2-5.5 cm, ovate-cordate, hastate at base, acute or acuminate at apex, appressed hairy on both surfaces, ciliate on the margins, entire. Petioles 1.5-3.5 cm long, hairy, terete. Flowers white, sessile, in axillary, 1 to 3-flowered, subsessile or shortly pedunculate clusters or cymes; pedicels 3-4 mm long, terete, hairy. Bracts 4-8 mm long, linear, hairy, acuminate. Calyx 6-8 mm long, dilated at base; lobes lanceolate, hispid, ciliate with bulbous-based hairs. Corolla 7-8 mm long, infundibuliform, with a tuft of hairs at the tip of each lobe. Capsules 3-7.8 mm in diam., globose to ovoid, glabrous. Seeds 4, ca 3 x 2 mm, triangular, minutely grey-velvety.

*Fl. & Fr.*: August-November.

*Ecology* : Common, found on the fences of cultivated fields and in grassy wastelands in association with *Dicoma tomentosa* Cass., *Indigofera cordifolia* Heyne ex Roth, etc.

*Specimens examined* : Sudasari R. F., Monika 16691 (BSJO); Sudasari, Monika 16755 (BSJO).

3. *Ipomoea verticillata* Forssk. Fl. Aegypt-Arab. 44. 1775; Bhandari, Fl. Indian Desert 261. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 550. 1991. *I. rumicifolia* Choisy in Mem. Soc. Phys. Geneve 6 : 447. 1834 & in DC. Prodr. 9 : 351. 1845; Clarke in Hook. f. Fl. Brit. India 4 : 207. 1883; Duthie, Fl. Gangetic Plain 2 : 114. 1911. *Convolvulus lasiospermus* Vis. Pl. Aegypt. Nub. 13. t. 1. f. 2. 1836.

Annual, prostrate herbs, 10-20 cm high, sparsely hairy. Leaves 3-4.5 x 2.5-3.5 cm, broadly ovate or subreniform, apiculate or obtuse at the tip, cordate or hastate at base with wide sinus, entire. Petioles up to 10 cm long, sparsely hirsute. Flowers yellowish-white, pedicellate, 1 to 3-together, on axillary peduncles 1-1.5 cm long. Bracts 3-3.5 mm long, linear, hairy. Calyx 6-7 mm long; lobes subequal, acute, dorsally



clothed with spreading hairs. Corolla 8-10 mm long, tubular-campanulate. Capsules ovoid, 0.9-1 cm long, glabrous, veined, crowned by style-base. Seeds 3-4, 2-2.2 mm long, velvety, brown.

*Fl. & Fr.*: July – August.

*Ecology* : Rare, found in sandy soils with rather high percentage of salts.

*Specimen examined* : Sudasari, Pandey 7846 (BSJO).

#### 4. *SEDDERA* Hochst.

*Seddera latifolia* Hochst. & Steud. in Flora 27. Beil. 8. t. 5B & C. 1844; Bhandari, Fl. Indian Desert 265. 1978; Singh in Shetty & Singh. Fl. Rajasthan 2 : 558. 1991. *Cressa latifolia* (Hochst. & Steud.) T. Anders. in J. Linn. Soc. Bot. 5 (suppliment 1) : 25. 1860. *Breweria latifolia* (Hochst. & Steud.) Benth. Gen. Pl. 2 : 877. 1873; Clarke in Hook. f. Fl. Brit. India 4 : 224. 1883. *Bonamia latifolia* (Hochst. & Steud.) Sant. in J. Bombay Nat. Hist. Soc. 47 (2) : 342. 1947.

Erect undershrubs; branches many from the woody base, clothed with grey-velvety pubescence. Leaves 8-13 x 3-8 mm, elliptic-oblong or ovate, obtuse at apex, rounded or narrowed at the base, silky hairy on both surfaces. Flowers white, 1 to 3-together, axillary, sessile, or aggregated into short terminal spikes. Bracteoles 2, ca 2 mm long, linear-lanceolate. Calyx silky hairy; lobes 3-5 mm long, ovate, acute, subequal. Corolla white, slightly exceeding the calyx; lobes 5, with hairy bands between the folds. Stamens equal; filaments dilated at base, with short rounded appendages. Ovary ovoid, glabrous below, hirsute in upper part. Capsules 4-6 mm in diam., ovoid, glabrous, splitting into 4 valves. Seeds 2, 2-3 mm long, glabrous, dark brown.

*Fl. & Fr.*: September-March.

*Ecology* : Rare, found in gravelly and rocky habitats in association with *Cleome scaposa* DC., *Fagonia schweinfurthii* (Hadidi) Hadidi ex Ghaffoor, etc. Sometimes forms dense patches of it's own.

*Specimens examined* : Near Khuci, Monika 16697 (BSJO), Near Sundra, Monika 17160 (BSJO).

### 36. SOLANACEAE

- |  |                   |
|--|-------------------|
| 1a. Fruits smooth, berry. Corolla less than 2 cm long.   | 2                 |
| 1b. Fruits spiny, capsule. Corolla 5-6 cm or more long.  | 1. <i>Datura</i>  |
| 2a. Twigs transformed into thorns. Corolla funnel-shaped. Anthers dehiscing longitudinally.  | 2. <i>Lycium</i>  |
| 2b. Twigs not transformed into thorns, may be prickly or spiny on surface. Corolla rotate, not funnel-shaped. Anthers dehiscing by apical pores. | 3. <i>Solanum</i> |

#### 1. *DATURA* L.

*Datura innoxia* Mill. Gard. Dict. ed. 8. no. 5. 1768; Raizada, Suppl. Duthie, Fl. Gangetic Plain 168. 1976; Bhandari, Fl. Indian Desert 268. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 564. 1991. *D. metel auct.* non L. 1753; Sim. in Curtis. Bot. Mag. t. 1440. 1812; Clarke in Hook. f. Fl. Brit. India 4 : 243. 1883; Duthie, Fl. Gangetic Plain. 2 : 131. 1911.

Local name : *Daturo*.

Annual, stout shrubs, up to 1 m high, pubescent with glandular hairs; stem cylindric, woody below. Leaves 10-15 x 6-8 cm or more, ovate, entire or slightly toothed, acute, rounded and oblique at the base. Petioles 3-10 cm long, pubescent. Flowers white, axillary, solitary; pedicels 1-2 cm long, terete, finely pubescent, recurved in fruit. Calyx 7-10 cm long, tubular, inflated at base, minutely pubescent, accrescent, reflexed in fruit; lobes triangular, acuminate. Corolla 13-15 cm long; tube 8-11 cm long; teeth 10, linear. Stamens 5; filaments slender, adnate to corolla-tube, glabrous. Ovary softly prickly; stigma bilobed. Capsules 3-5.5 cm in diam., globose, densely pubescent, armed with ca 1 cm long spines. Seeds compressed, light brown, ca 2 x 3 mm, surface finely reticulate (Plate-20/2).

*Fl. & Fr.*: September – January.

*Ecology* : Common, found in sandy to gravelly habitats near habitations in association with *Amaranthus viridis* L., *Cleome viscosa* L., etc.

*Specimen examined* : Near Miajlar village, Pandey 7922 (BSJO).

## 2. LYCIUM L.

*Lycium barbarum* L. Sp. Pl. 192. 1753; Clarke in Hook. f. Fl. Brit. India 4 : 241. 1883; Bhandari, Fl. Indian Desert 270. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 565. 1991.

Local name : *Morali*.

Woody shrubs, up to 2.5 m high, much-branched; branches transformed at apex into sharp, conical spines which often elongate and bear leaves and flowers. Leaves solitary or fascicled, 2-3 x 0.5-0.9 cm, oblong-lanceolate or oblong-spathulate, obtuse at apex, narrowed at base, glabrous. Petioles 3-4 mm long, terete. Flowers brownish-yellow, solitary or in fascicles of 2-5; pedicels filiform, ca 7 mm long. Calyx 3-4 mm long, cup-shaped, glabrous, irregularly lobed, persistent; lobes oblong, obtuse, margins membranous. Corolla 1.2-1.5 cm long, tunnel-shaped, glabrous; lobes more than half as long as tube, spreading, oblong. Stamens slightly exerted; filaments hairy at the base; anthers 1.5-1.6 mm long, orbicular. Ovary ovoid, glabrous; style 7-8 mm long, glabrous. Berries 4-5.5 mm in diam., globose, dark red. Seeds ca 2 mm in diam., subreniform, minutely pitted.

*Fl. & Fr.*: October – January.

*Ecology* : Common, found in sandy as well as gravelly areas, associated with *Capparis decidua* (Forssk.) Edgew., *Ziziphus nummularia* (Burm. f.) Wight & Arn., etc.

*Specimens examined* : Near Daw, Monika 16698 (BSJO); Bandera, Monika 17134 (BSJO); Satto, Pandey 7886 (BSJO).

## 3. SOLANUM L.

*Solanum virginianum* L. Sp. Pl. 187. 1753; Singh in Shetty & Singh, Fl. Rajasthan 2 : 575. 1991, *S. surattense* Burm. f. Fl. Ind. 57. 1768; Bhandari, Fl. Indian Desert 275. 1978, *S. xanthocarpum* Schrad. & Wendl. in Schrad. Sert. Hannov. 1 : 8. t. 2. 1795; Clarke in Hook. f. Fl. Brit. India 4 : 236. 1883; Duthie, Fl. Gangetic Plain 2 : 125. 1911.

Prostrate, perennial herbs, woody at the base, clothed with stellate hairs and yellowish prickles; prickles up to 1.5 cm long, straight. Leaves 8-15 x 3-8 cm, elliptic or ovate in outline, sinuate or subpinnatifid, stellate

hairy, armed with yellow prickles on the midrib and nerves. Petioles 3-6 cm long, stellate hairy, prickly. Flowers bright purple, in few-flowered, extra-axillary cymes; pedicels 3-8 mm long, elongated in fruit, stellate hairy. Calyx 6-7 mm long, densely hairy, prickly; tube 2-2.5 mm long; lobes linear, with broad sinuses between the lobes. Corolla-lobes 8-10 mm long, acute, stellate hairy outside. Stamens *ca* 2 mm long, glabrous; anthers longer than filaments, yellow, lanceolate, upcurved. Ovary ovoid, glabrous; style *ca* 1.2 cm long, glabrous. Berries 1-1.8 cm in diam., globose, white with green broad veins, yellow when ripe, glabrous, shining. Seeds *ca* 2 mm in diam., glabrous, ovoid-reniform, brown (Plate-16/4).

*Fl. & Fr.*: Almost throughout the year.

*Ecology*: Common, found in moist places near water reservoirs in association with *Glinus lotoides* L.

*Specimen examined*: Near Sam, Monika 16595 (BSJO).

### 37. SCROPHULARIACEAE

- |  |                          |
|--|--------------------------|
| 1a. Glandular pubescent herbs. Stamens 2.  | 1. <i>Anticharis</i>     |
| 1b. Subglabrous or scabridly hairy herbs, not glandular hairy. Stamens 4.  | 2                        |
| 2a. Leaves alternate, ovate-elliptic. Calyx deeply 5-lobed, no tube, not ribbed. Corolla subsaccate at the base. | 2. <i>Schweinfurthia</i> |
| 2b. Leaves opposite, linear-lanceolate. Calyx tubular, 15-ribbed. Corolla not subsaccate at the base.            | 3. <i>Striga</i>         |

#### 1. *ANTICHARIS* Endl.

- |   |  |
|---|--|
| 1a. Leaves oblong-lanceolate, ovate-oblong or elliptic, up to 2.5 cm long. Pedicels less than twice as long as the calyx. | 1. <i>A. glandulosa</i> var. <i>caerulea</i> |
| 1b. Leaves linear-lanceolate, more than 2.5 cm long. Pedicels more than twice as long as the calyx.                       | 2. <i>A. senegalensis</i>                    |

1. *Anticharis glandulosa* Aschers. var. *caerulea* Blatt. & Halib. ex Sant. in J. Bombay Nat. Hist. Soc. 56 (2) : 280. 1959; Bhandari, Fl. Indian Desert 279. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 582. 1991.

Erect, much-branched herbs, up to 30 cm high, clothed with viscid, glandular hairs. Leaves 1-2.5 x 0.4-1.2 cm, ovate-oblong to oblong-lanceolate or elliptic, attenuated at base, subobtusate at apex, glandular hairy on both surfaces. Petioles 3-4 mm long, glandular hairy. Flowers pinkish-purple, axillary, solitary; pedicels 3-4 mm long, terete. Bracts 2, almost at the middle of the pedicel, linear-lanceolate, glandular hairy. Calyx 4-5 mm long, almost divided to the base; lobes oblanceolate, glandular hairy. Corolla *ca* 11 mm long; lobes rounded at apex. Filaments short, glabrous; anthers versatile, curved. Ovary *ca* 2 mm long, ovoid, glabrous, situated on a cup-shaped disc; style glabrous. Capsules *ca* 8 mm long, ovoid, acuminate, pubescent. Seeds oblong, rounded at one end and attenuated at the other, brown, longitudinally ribbed, with transverse striations between the ribs.

*Fl. & Fr.*: September – November.

*Ecology*: Endemic, very rare plant in gravelly and rocky habitats.

*Specimen examined*: DNP, Shetty 3492 (BSJO).

2. *Anticharis senegalensis* (Walp.) Bhandari in Bull. Bot. Surv. India 6 (2-4) : 327. 1964 & Fl. Indian Desert 279. 1978; Raizada, Suppl. Duthie, Fl. Gangetic Plain 180. 1976; Singh in Shetty & Singh, Fl. Rajasthan 2 : 583. 1991. *Doratanthera senegalensis* Walp. Recept. Bot. Syst. 3 : 305. 1844-45. *D. linearis* Benth. in DC. Prodr. 10 : 347. 1846. *Anticharis linearis* (Benth.) Hochst. ex Aschers. in Monatsb. Akad. Wiss. Berl. 882. 1866; Hook. f. Fl. Brit. India 2 : 250. 1883.

Local name : *Dhuniya*.

Annual, erect, much-branched, glandular pubescent herbs, 30-40 cm high. Leaves 2-4.5 x 0.2-0.4 cm, linear-lanceolate, entire, acute, hairy on both surfaces. Flowers pale with purple tips, axillary, solitary; pedicels filiform, glabrous near the base, glandular towards apex. Bracts 2, 1-2.5 mm long, opposite or subopposite, linear, glandular hairy, inserted at the middle of pedicel or little above. Calyx up to 5 mm long, divided up to the base; lobes linear-lanceolate, acute, glandular hairy. Corolla 8-10 mm long; lobes 5, oblong, obtuse, subequal, longitudinally veined, glandular pubescent. Filaments glabrous; anther-lobes unequal, lower ones smaller, obtuse. Ovary ovoid, glabrous; style included; stigma shortly bifid. Capsules ovoid, acuminate or beaked, glandular-pubescent. Seeds oblong-truncate, longitudinally ribbed, with transverse striations between the ribs, brown (Plate-17/1).

Fl. & Fr.: August – October.

Ecology : Common, found in rather gravelly habitats. Main associates are *Cleome viscosa* L., *Tribulus terrestris* L., *Eragrostis ciliaris* (L.) R. Br., etc.

Specimens examined : Near Satto, Monika 16643, 17120 (BSJO); Sudasari, Pandey 7835 (BSJO).

Notes : Plants turn blue on drying. Purple-coloured plants were collected during present study.

## 2. SCHWEINFURTHIA A. Br.

*Schweinfurthia papilionacea* (L.) Boiss. Fl. Orient. 4 : 387. 1879; Merrill in Philipp. J. Sci. Bot. 19 : 380. 1921; Bhandari, Fl. Indian Desert 284. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 602. 1991. *Antirrhinum papilionaceum* L. Mant. Pl. 1 : 86. 1767; Burm. f. Fl. Ind. 131. 1768. *Linaria sphaerocarpa* Benth. in DC. Prodr. 10 : 287. 1846. *Antirrhinum glaucum* Stocks ex Wight, Ic. 4 (3) : 10. t. 1459. 1849. *Schweinfurthia sphaerocarpa* (Benth.) A. Braun, in Monatsb. Akad. Wiss. Berl. 875. 1866; Hook. f. Fl. Brit. India 4 : 252. 1883.

Local name : *Sunipat*.

Erect, much-branched, perennial herbs, 15-30 cm high; branches ascending, glabrous or puberulent. Leaves somewhat succulent, 1.2-2.5 x 0.6-1.9 cm, elliptic, ovate or ovate-elliptic or subspathulate to obovate, subacute to acute, entire, pubescent, tapering at base. Petioles 1-1.5 mm long. Flowers white, axillary, solitary; pedicels as long as petiole, deflexed in fruit. Calyx deeply 5-partite; upper segments broadly ovate, subcordate, acute; rest lanceolate. Corolla 10-12 mm long, with purple veins; upper lip bilobed, oblong, obtuse. Capsules obliquely globose, 2-celled, lower cell many-seeded, upper cell few-seeded. Seeds obconic, acutely winged, truncate at both ends, pale.

Fl. & Fr.: November-March.

Ecology : Rare, found in somewhat moist and shady habitats.

Specimen examined : DNP, Shetty 3489 (BSJO).

3. *STRIGA* Lour.

*Striga angustifolia* (D. Don) Saldanha in Bull. Bot. Surv. India 5 : 70. 1963; Bhandari, Fl. Indian Desert 286. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 604. 1991. *Buchnera angustifolia* D. Don, Prodr. Fl. Nep. 91. 1825. *B. euphrasioides* auct. non Vahl 1794; Benth. Scroph. Ind. 41. 1835. *Striga euphrasioides* sensu Benth. in Hook. Comp. Bot. Mag. 1 : 364. 1836, excl. basionym *Buchnera euphrasioides* Vahl 1794; Hook. f. Fl. Brit. India 4 : 299. 1884; Duthie, Fl. Gangetic Plain 2 : 157. 1911.

Erect, annual herbs, 10-25 cm high; stem filiform, scabrid on age. Leaves sessile, 2-4.5 x 0.2-0.3 cm, linear to linear-lanceolate, entire, subacute at apex, narrowed at base. Flowers white, subsessile, solitary, axillary, passing into long terminal spikes. Bracts represent upper leaves, longer than the calyx. Calyx tubular, 8-12 mm long, strongly 15-ribbed; lobes 5, ca 4 mm long, each 3-ribbed. Corolla 12-15 mm long; tube exerted, much incurved at middle, dorsally pubescent on neck; lower lobes much larger than the upper ones. Capsules 7.5-8 x 3-3.5 mm, elliptic-oblong, 2-valved, glabrous, grooved on the sides, apiculate, enclosed in the calyx.

*Fl. & Fr.*: August - October.

*Ecology* : Common, found in cultivated fields and in grassy gravelly and rocky situations with *Dicoma tomentosa* Cass., *Indigofera cordifolia* Heyne ex Roth, etc.

*Specimen examined* : Near Daw, Monika 16784 (BSJO).

## 38. OROBANCHACEAE

*CISTANCHE* Hoffm. & Link

*Cistanche tubulosa* (Schrenk) Wight, Ic. 4 (3) : 4. 1. 1420. 1850; Hook. f. Fl. Brit. India 4 : 324. 1884; Duthie, Fl. Gangetic Plain 2 : 163. 1911; Bhandari, Fl. Indian Desert 290. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 615. 1991. *Phelipaea tubulosa* Schrenk, Pl. Spec. Aegypt.-Arab. 23. 1840.

Leafless, purplish-brown, root-parasites, up to 60 cm high, having solitary or fascicled, fleshy scapes from the ground; scapes furrowed, puberulent, densely covered with triangular, 2-3.5 cm long spikes. Bracts 2-2.5 cm long, lanceolate, scarious-margined; bracteoles up to 1.7 cm long, linear-lanceolate. Calyx 1.2-1.8 cm long, tubular-campanulate; lobes 5-6 mm long, subequal, rounded. Corolla yellow, tubular, not 2-lipped, hairy inside in the lower half, the upper half bent outwards from the middle; lobes subequal, rounded and reflexed. Filaments pubescent at the base; anthers woolly, subserted. Style exerted, curved below the stigma. Capsules ca 2.5 x 0.8 cm, ovoid-oblong, laterally compressed, beaked. Seeds numerous, ca 1 mm in diam., reticulately pitted, black (Plate-17/2).

*Fl. & Fr.*: October - March.

*Ecology* : Common root-parasite on *Calligonum polygonoides* L., *Calotropis procera* (Ait.) R. Br. and *Salvadora persica* L.

*Specimens examined* : Near Sand-dune point, Sam, Monika 16606 (BSJO). Near Nimba, Monika 16776 (BSJO).

## 39. BIGNONIACEAE

*TECOMELLA* Seem.

*Tecomella undulata* (Sm.) Seem. in Ann. & Mag. Nat. Hist. ser. 3. 10 : 30. 1862 & in J. Bot. 1 : 18. 1863; Duthie, Fl. Gangetic Plain 2 : 171. 1911; Bhandari, Fl. Indian Desert 291. 1978; Singh in Shetty & Singh, Fl. Rajasthan 2 : 623. 1991. *Bignonia undulata* Sm. Exot. Bot. 1 : 35. t. 19. 1804-05. *Tecoma undulata* (Sm.) G. Don, Gen. Syst. 4 : 223. 1838; Clarke in Hook. f. Fl. Brit. India 4 : 378. 1884.

Local name : *Rohira*.

Medium-sized trees, 3-4 m high; branches drooping, glabrous or minutely stellate hairy when young. Leaves simple, subopposite, 6-12 x 1.5-2.5 cm, oblong, obtuse or emarginate at apex, more or less cuneate at base, margins slightly undulating and entire, glabrous. Petioles 1.5-2 cm long, terete, glabrous or minutely hairy. Cymes few-flowered, arranged in racemose manner, terminating short, lateral branches. Flowers orange to yellowish-orange; pedicels 1-1.8 cm long, terete, sparsely hairy with stellate hairs. Calyx 8-9 mm long, campanulate, greenish or yellow; lobes ovate, subobtuse. Corolla 4-6.5 cm long, campanulate; lobes 5, subequal, curved outside at tips. Stamens unequal-sized, exserted; filaments glabrous. Ovary on a yellow, annular disc; style glabrous, up to 3.5 cm long; stigma elliptic, bi-lamellate. Capsules 15-35 x 0.8-1 cm, linear-oblong, smooth. Seeds 2-2.5 x 0.9-1 cm, winged at the apex (**Plate-21/1**).

Fl. & Fr: February – April.

Ecology : Common, found in sandy plains and on small stabilized dunes.

Specimens examined : 2 km west from Miajlar, *Monika* 16523 (BSJO); Miajlar, *Monika* 16797 (BSJO).

Notes : The colour of flowers is highly variable, probably due to genetic constitution.

## 40. ACANTHACEAE

- |   |                       |
|---|-----------------------|
| 1a. Corolla 1-lipped, the upper lip absent.               | 1. <i>Blepharis</i>   |
| 1b. Corolla 2-lipped or subequally 5-lobed.               | 2                     |
| 2a. Flowers in trichotomously branched panicles or cymes. | 3. <i>Peristrophe</i> |
| 2b. Flowers in spikes.                                    | 2. <i>Justicia</i>    |

1. *BLEPHARIS* Juss.

*Blepharis linariaefolia* Pers. Syn. Pl. 2 : 180. 1806; Pandey & Singh in Shetty & Singh, Fl. Rajasthan 2 : 636. 1991. *Acanthodium grossum* Wight, Icon. 4 (4) : 5. t. 1535 & 1536. 1850, non Nees 1830. *Blepharis sindica* T. Anders. in J. Linn. Soc. 9 : 500. 1867; Clarke in Hook. f. Fl. Brit. India 4 : 479. 1884; Duthie, Fl. Gangetic Plain 2 : 183. 1911; Bhandari, Fl. Indian Desert 299. f. 113. 1978.

Local name : *Bhangari*.

Dichotomously branched perennials, with woody root-stock, 30-40 cm high; stem and branches ash-coloured, terete, finely pubescent. Leaves sessile, in whorls of 4, unequal, 4-6 x 0.2-0.4 cm, linear, acute, margins revolute and with few, spinous teeth near the base, minutely pubescent beneath. Flowers purple, subsessile, in 2-6 cm long, hairy spikes, latter 4 to 5-together on very short peduncles. Bracts 4-farious, ca

2.5 x 1.2 cm long, ovate, acuminate, spine-tipped, densely hairy, margins with 7-9 recurved spines; bracteoles 2, up to 1.5 cm long, linear-lanceolate, hairy, ciliate. Calyx divided up to base, 4-partite, pubescent; outer segments 9-10 mm long, ovate, shortly acuminate; lateral segments up to 7 mm long, ovate-lanceolate, acute. Corolla 1-1.5 cm long; tube constricted below the limb; lip 3-lobed, middle one larger than the laterals. Stamens 4, didynamous; filaments thick, rigid; anther-cells unequal, larger cell bearded. Capsules 7-8 mm long, ellipsoid, compressed, glabrous. Seeds ca 3.5 mm across, ovoid, densely covered with long, hygroscopic, brownish hairs.

*Fl. & Fr.*: August-November.

*Ecology* : Common, found in gravelly and rocky habitats in association with *Dicoma tomentosa* Cass.

*Specimens examined* : Near Meluo-ki-Basti, *Monika* 16589 (BSJO), Sudasari, *Monika* 16685, 16759 (BSJO); Miajlar road, *Shetty* 3397 (BSJO), *Pandey* 7837 (BSJO).

## 2. JUSTICIA L.

*Justicia procumbens* L. Sp. Pl. 15. 1753; Clarke in Hook. f. Fl. Brit. India 4 : 539. 1885; Bhandari, Fl. Indian Desert 304. 1978; Pandey & Singh in Shetty & Singh, Fl. Rajasthan 2 : 658. 1991. *Rostellaria procumbens* (L.) Nees in Wall. Pl. Asiat. Rar. 3 : 101. 1832. *Rostellularia procumbens* (L.) Nees in DC. Prodr. 11 : 371. 1847.

Local name : *Kagner*.

Annual, diffuse, glabrous herbs, with many, divaricate branches sometimes rooting on lower nodes. Leaves 2.5-3.8 x 1.2-1.5 cm, elliptic, ovate or lanceolate, subacute at both ends, softly pubescent. Petioles ca 1 cm long, sparsely hairy. Flowers pink to pinkish-purple, in axillary and terminal, 3-5.5 cm long spikes. Bracts and bracteoles ca 4 x 1.5 mm, linear-lanceolate, acute, pubescent, ciliate and scarious on margins. Calyx divided up to base; lobes 4, lanceolate or linear, subequal, with scarious and ciliate margins. Corolla ca 6 mm long, hairy outside; tube as long as the limb, funnel-shaped; upper lip broadly ovate, notched above; lower lip shortly 3-lobed. Stamens 2; filaments glabrous. Ovary ca 1 mm in diam., ovoid, glabrous. Capsules 5-8 mm long, oblong, beaked, pubescent. Seeds minute, finely tuberculate, brownish.

*Fl. & Fr.*: August-November.

*Ecology* : Occasional, found in wet and shady, sandy habitats.

*Specimen examined* : Miajlar, *Monika* 17111 (BSJO).

## 3. PERISTROPHE Nees

*Peristrophe paniculata* (Forssk.) Brummitt in Kew Bull. 38 : 451. 1983; Pandey & Singh in Shetty & Singh, Fl. Rajasthan 2 : 666. 1991. *Dianthera paniculata* Forssk. Fl. Aegypt.-Arab. 7. 1775. *D. bicalyculata* Retz. in Vet. Acad. Handl. 297. t. 9. 1775. *Justicia bicalyculata* (Retz.) Vahl, Symb. Bot. 2 : 13. 1791. *Peristrophe bicalyculata* (Retz.) Nees in Wall. Pl. Asiat. Rar. 3 : 113. 1832; Clarke in Hook. f. Fl. Brit. India 4 : 554. 1885; Duthie, Fl. Gangetic Plain 2 : 210. 1911; Bhandari, Fl. Indian Desert 307. 1978.

Erect, much-branched, puberulous undershrubs, up to 1.5 m high, with 6-angular stem and branches. Leaves 4-8 x 2-3.5 cm, ovate or ovate-lanceolate, acute to acuminate at apex, rounded at base, hairy

bothsides, margins ciliate. Petioles 7-10 mm long, puberulous. Flowers pinkish-purple, in terminal, lax, trichotomous panicles. Bracts 2, unequal, linear-spathulate, ciliate, acute; bracteoles like bracts but shorter. Calyx deeply divided; lobes linear or lanceolate, 3-4 mm long, acute, ciliate. Corolla 1-1.5 cm long, throat hairy; lower lip spotted with dark-coloured spots. Filaments bearded. Ovary pubescent. Capsules 5-8 mm long, elliptic, stalked, pubescent with glandular and simple mixed hairs. Seeds ca 2 mm across, orbicular, sparsely glandular hairy, dark brown.

*Fl. & Fr.*: September – December.

*Ecology*: Occasional, found in wastelands near habitations and along road-sides, usually forming thickets with *Amaranthus viridis* L., *Cleome viscosa* L. and long grasses.

*Specimen examined* : Near Kanoi, *Monika* 16751 (BSJO).

#### 41. VERBENACEAE

##### *CHASCANUM* E. Mey. (*nom. cons.*)

*Chascanum marrubifolium* Fenzl. ex Walp. Repert. 4 : 38. 1845; Raizada, Suppl. Duthic, Fl. Gangetic Plain 212. 1976; Pandey in Shetty & Singh, Fl. Rajasthan 2 : 676. 1991. *Pleurostigma subrotundum* Hochst. Fl. 24 (1) : 42. 1841, *nom. nud.* *Bouchea marrubifolia* (Fenzl. ex Walp.) Schauer in DC. Prodr. 11 : 558. 1847; Clarke in Hook. f. Fl. Brit. India 4 : 564. 1885; Bhandari, Fl. Indian Desert 308. 1978.

Much-branched, pubescent, perennial herbs, 20-40 cm high, with woody root-stock. Leaves 2-3.5 x 0.8-2.3 cm, broadly ovate to suborbicular or elliptic, coarsely dentate, obtuse, shortly cuneate at base, pubescent on both surfaces, distinctly nerved. Petioles 1-1.8 cm long, slender, pubescent. Flowers cream-coloured, in long, terminal, bracteate, up to 15 cm long spikes. Bracts 2-3 mm long, linear-lanceolate, pubescent, scarious-margined. Calyx tubular, 6-7 mm long, 5-ribbed, densely pubescent; teeth 5, very short. Corolla up to 1.2 cm long; lobes 5, rounded. Filaments glabrous. Ovary ovoid, glabrous; stigma capitate, glabrous. Fruits 2-3.5 mm long, 1-seeded, consisting two, oblong, black, glabrous pyrenes, enclosed in the calyx-tube.

*Fl. & Fr.*: September – December.

*Ecology* : Occasional, found near dried water reservoirs in association with *Glinus lotoides* L., *Bergia suffruticosa* (Del.) Fenzl., etc.

*Specimens examined* : Near Sundra, *Monika* 17162 (BSJO); Tejaraon, *Shetty* 3493 (BSJO). *Monika* 16678 (BSJO), *Pandey* 7891 (BSJO).

#### 42. NYCTAGINACEAE

1a. Flowers 1-3 mm long. Anthocarps 5-ribbed, without wart-like glands.

1. *Boerhavia*

1b. Flowers 6-8 mm long. Anthocarps 10-ribbed, with wart-like glands.

2. *Commicarpus*

##### 1. *BOERHAVIA* L.

1a. Plants erect. Anthocarps obpyramidal, glabrous.

2. *B. erecta*

1b. Plants prostrate, diffuse or straggling. Anthocarps fusiform, clavate or turbinata, glandular papillose.

2

2a. Leaves linear-lanceolate or elliptic-lanceolate. Flowers on 2-3 cm long, slender pedicels.

5. *B. rubicunda*



- 2b. Leaves ovate or ovate-lanceolate. Flowers sessile or subsessile. 3  
 3a. Flowers strictly in axillary cymes, not exceeding the leaves. 4. *B. repens*  
 3b. Flowers in diffuse, axillary or terminal panicles or corymbose cymes, much exceeding the leaves. 4  
 4a. Anthocarps turbinate to broadly clavate. 3. *B. procumbens*  
 4b. Anthocarps fusiform. 1. *B. diffusa*

1. *Boerhavia diffusa* L. Sp. Pl. 3. 1753; Duthie, Fl. Gangetic Plain 3 : 2. 1915, *pro parte*; Bhandari, Fl. Indian Desert 317. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 2 : 713. 1991. *B. repens* L. var. *diffusa* (L.) Hook. f. Fl. Brit. India 4 : 709. 1885.

Local name : *Chinawari, Sautha*.

Decumbent or prostrate, glandular-pubescent, perennial herbs; stem divaricately branched, thickened at nodes, sometimes pigmented with pink. Leaves opposite or subopposite, unequal at each node, 0.8-6 x 0.4-3.5 cm, broadly ovate or suborbicular, subacute at apex, rounded or subcordate at base, undulate on margins or entire, glabrous above, whitish scally beneath. Petioles 2-3.5 cm long, slender, more or less puberulous. Flowers dark pink, in axillary and terminal, bracteate, congested corymbose cymes or panicles exceeding leaves. Bracts 1-2 mm long, linear-lanceolate, glandular pubescent, acute. Perianth ca 3 mm long, viscid, glandular. Stamens 3; filaments pink; anther-lobes yellow. Stigma capitate. Anthocarps 3-4 x 0.8-2 mm, fusiform, 5-ribbed, clothed densely with stalked glandular hairs.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in sandy, gravelly as well as rocky habitats, usually in association with *Tribulus terrestris* L., etc.

*Specimen examined* : Sudasari, *Monika* 16770 (BSJO).

2. *Boerhavia erecta* L. Sp. Pl. 3. 1753; Nair in Bull. Bot. Surv. India 9 : 283. 1968; Raizada, Suppl. Duthie, Fl. Gangetic Plain 229. 1976; Pandey in Shetty & Singh, Fl. Rajasthan 2 : 714. 1991. *B. punarnava* Saha & Murthy in J. Sci. Ind. Research 21 C : 249-55. 1962.

Erect or suberect, perennial herbs; stem and branches red-pigmented, slightly pubescent when young, ribbed. Leaves 2-4 x 1.2-3.5 cm, ovate, ovate-oblong or ovate-lanceolate, acute to acuminate at apex, subrounded at base, whitish beneath, more or less entire. Flowers pale-pink, in lax, leafy, bracteate, cymose panicles. Anthocarps 4-5 mm long, obpyramidal, truncate at apex, tapering at base, grooved, clothed with raphids.

*Fl. & Fr.*: July - October.

*Ecology* : Rare, found in sandy as well as gravelly habitats in association with grasses like *Aristida adscensionis* L., *Cenchrus biflorus* Roxb., etc. Sometimes forms its own community. It is being reported first time from extreme deserts conditions.

*Specimen examined* : Miajlar, *Monika* 16798 (BSJO).

3. *Boerhavia procumbens* Banks ex Roxb. Fl. Ind. 1 : 148. 1820; Pandey in Shetty & Singh, Fl. Rajasthan 2 : 714. 1991. *B. repens* L. var. *procumbens* (Banks ex Roxb.) Hook. f. Fl. Brit. India 4 : 709. 1885. *B. coccinea sensu* Stewart, Ann. Cat. Vasc. Pl. W. Pakistan & Kashmir 233. 1972, non Mill. 1768.

Prostrate or decumbent, perennial herbs; stem and branches puberulous, pigmented with pink, terete. Leaves often unequal, 1.5-2.5 x 0.2-1.5 cm, ovate-oblong to subcordate, entire to repand, obtuse at apex, glabrous, green above, whitish beneath. Flowers pink or pale-pinkish, in diffuse, terminal panicles. Stamens 2-3, exerted. Anthocarps ca 3 mm long, turbinate or broadly clavate, strongly 5-ribbed, glandular-papillose.

*Fl. & Fr.*: January – December.

*Ecology*: Common, found in sandy plains, particularly near habitations and along the roads in association with *Corchorus depressus* (L.) Vicary, *Tribulus* spp., etc. It is being reported first time from extreme desertic conditions.

*Specimen examined*: Near Berisiyala, Monika 16700 (BSJO).

4. *Boerhavia repens* L. Sp. Pl. 3. 1753; Hook. f. Fl. Brit. India 4 : 709, 1885, excl. var. *diffusa* & *procumbens*; Pandey in Shetty & Singh, Fl. Rajasthan 2 : 714, 1991. *B. diffusa* Duthie, Fl. Gangetic Plain 3 : 2, 1915, *pro parte*, non L. 1753.

Perennial, prostrate, diffuse or straggling herbs, with woody root-stock; stem and branches puberulous, pigmented with pink. Leaves unequal at each node, 1-3.5 x 0.2-3 cm, ovate-oblong, white on lower surface, puberulous. Flowers pink or pinkish-mauve, in short, axillary, bracteate, pedunculate cymes not exceeding the leaves. Anthocarps 2.5-3.5 mm long, turbinate to broadly clavate, 5-ribbed, glandular-papillose.

*Fl. & Fr.*: Almost throughout the year.

*Ecology*: Rare, found in sandy and gravelly wastelands in association with *Amaranthus* spp. and *Heliotropium* spp.

*Specimens examined*: Bandera, Monika 16530, 17133 (BSJO); Sam, Monika 16556 (BSJO).

5. *Boerhavia rubicunda* Steud. Nom. Bot. ed. 2. 1 : 213, 1840; Nasir in Nasir & Ali, Fl. W. Pak. 115 : 7, f. 3 A-C, 1977; Pandey in Shetty & Singh, Fl. Rajasthan 2 : 715, 1991. *B. elegans* Choisy in DC. Prodr. 13 (2) : 453, 1849; Hook. f. Fl. Brit. India 4 : 710, 1885; Bhandari, Fl. Indian Desert 317, 1978.

Erect or diffuse, perennial, glabrous or puberulous herbs or undershrubs, 40-50 cm high, with woody root-stock. Leaves 2-4.8 x 0.5-1.3 cm, linear-lanceolate to elliptic-lanceolate, fleshy, mucronate at apex, narrowed at base, undulate or entire, whitish rugose beneath. Petioles 2-4 mm long, glabrous. Flowers pale pink to pinkish-purple, in lax, dichotomously branched, terminal panicles up to 25 cm long. Perianth 3-4 mm long, campanulate, ribbed. Stamens 2; anthers dumb-bell-shaped. Ovary ovoid, glabrous; stigma capitate, glabrous. Anthocarps 2-4 mm long, oblong-clavate, 5-ribbed, conspicuously puberulous in furrows.

*Fl. & Fr.*: August-February.

*Ecology*: Rare, found in sandy plains as well as sometimes on sand-dunes.

*Specimens examined*: Near Kanoi, Monika 16559 (BSJO); Along Miajlar road, Monika 17146 (BSJO).

## 2. COMMICARPUS Standl.

*Commicarpus verticillatus* (Poir.) Standl. in Contrib. U.S. Nat. Herb. 18 : 101, 1916; Bhandari, Fl. Indian Desert 318, 1978; Pandey in Shetty & Singh, Fl. Rajasthan 2 : 715, 1991. *Boerhavia verticillata* Poir. in Lam. Encycl. 5 : 56, 1804; Hook. f. Fl. Brit. India 4 : 710, 1885; Duthie, Fl. Gangetic Plain 3 : 3, 1915. *B. stellata* Wight, Icon. 3 (2) : 6, t. 875, 1844-45, non Boj. 1842.

Decumbent or straggling, perennial undershrubs; stem and branches glabrous, striated, more or less swollen at nodes, greyish. Leaves equal at each node, paired, 3-4.5 x 3-4 cm, oblong or broadly ovate to suborbicular, obtuse, acute or retuse at apex, rounded, cordate or narrowed at base, margins entire, sinuate or repand, glabrous or covered with white raphids beneath. Flowers bright pink, in 3 to 7-flowered, axillary, bracteate, pedunculate umbels; pedicels up to 1 cm long, slender, glabrous. Bracteoles 2-3 mm long, leaf-like, oblong, acute, deciduous. Perianth 6-7 mm long, campanulate, with white raphids, petaloid. Stamens 2-3, very slightly exserted; anthers dumb-bell-shaped. Anthocarp 6-7 mm long, clavate or turbinate, with 4-5, large, globose glands at the crown.

*Fl. & Fr.*: August – March.

*Ecology* : Rare, found in sandy habitats.

*Specimen examined* : Along Miajlar road, Shetty 3401 (BSIO).

### 43. AMARANTHACEAE

- |  |                         |
|--|-------------------------|
| 1a. Leaves alternate, fascicled or opposite and alternate mixed, never all opposite or clustered.  | 2                       |
| 1b. Leaves opposite or clustered only.   | 5                       |
| 2a. Fruits 2 to many-seeded.   | 5. <i>Celosia</i>       |
| 2b. Fruits 1-seeded.   | 3                       |
| 3a. Pseudo-staminodes present between the stamens or forming hypogynous cup.   | 2. <i>Aerva</i>         |
| 3b. Pseudo-staminodes absent.  | 4                       |
| 4a. Flowers unisexual.   | 4. <i>Amaranthus</i>    |
| 4b. Flowers bisexual.  | 6. <i>Digera</i>        |
| 5a. Flowers in axillary, head-like spikes. Anthers 1-celled.   | 3. <i>Alternanthera</i> |
| 5b. Flowers in elongated, axillary or terminal spikes. Anthers 2-celled.   | 6                       |
| 6a. Pseudo-staminodes present. Fertile flowers not subtended by sterile flowers; flowers deflexed.   | 1. <i>Achyranthes</i>   |
| 6b. Pseudo-staminodes absent. Fertile flowers subtended by sterile flowers, bearing accrescent hooked spines, forming burr in fruit; flowers not deflexed. | 7. <i>Pupalia</i>       |

#### 1. *ACHYRANTHES* L.

*Achyranthes aspera* L. Sp. Pl. 204. 1753; Hook. f. Fl. Brit. India 4 : 730. 1885; Duthie, Fl. Gangetic Plain 3 : 18. 1915; Bhandari, Fl. Indian Desert 319. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 718. 1991.

*Local name* : *Aandhi-jharo*.

Erect, annual herbs, up to 1 m high, usually branched from near the base; stem quadrangular, more or less densely hairy. Leaves opposite, 3-8 x 1.2-4.5 cm, elliptic to ovate or obovate, acute to acuminate or rounded at apex, obtuse at base, pubescent beneath. Petioles 1.8-2.5 cm long. Flowers greenish-white, deflexed, in terminal or axillary, pedunculate, 7-30 cm long spikes. Bracts and bracteoles subequal, 2-3.5 mm long, ovate, acuminate, spinescent, membranous. Perianth-lobes 4-5 mm long, subequal, obscurely 3-nerved, membranous-margined. Stamens 5, united at base forming a short tube; pseudo-staminodes lacerate. Ovary

obovoid; style 1, filiform; stigmas 2, capitate. Utricles 1.5-2.5 mm long, oblong-cylindric, truncate at apex, rounded at base. Seeds subcylindric, smooth. *ca* 1.2 mm long, truncate at apex, dark brown.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in wastelands near habitations and in fallow fields in association with *Cleome viscosa* L., *Heliotropium* spp., etc.

*Specimen examined* : Miajlar, Monika 17114 (BSJO).

*Notes* : Two varieties viz. var. *porphyristachya* (Wall. ex Moq.) Hook. f. and var. *arhentea* (Thw.) Hook. f. have been described besides synonym. Our specimen comes close to var. *porphyristachya* (Wall. ex Moq.) Hook. f. However, this complex needs detailed studies, as the morphological characters used to distinguish these taxa are not good enough for varietal rank.

## 2. *AERVA* Forssk. (*nom. cons.*)

*Aerva javanica* (Burm. f.) Juss. ex Schult. in Ann. Mus. Hist. Nat. Par. 11 : 13. 1808 & Syst. Veg. ed. 15. 5 : 565. 1819; Hook. f. Fl. Brit. India 4 : 727. 1885; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 721. 1991. *Iresine javanica* Burm. f. Fl. Ind. 212. t. 65. f. 2. 1768. *I. persica* Burm. f. *l.c.* 212. t. 65. f. 1. 1768. *Aerva tomentosa* Forssk. Fl. Aegypt.-Arab. 122, 170. 1775; Duthie, Fl. Gangetic Plain 3 : 15. 1915. *A. persica* (Burm. f.) Merrill in Philip. J. Sci. 19 : 348. 1921; Bhandari, Fl. Indian Desert 320. 1978.

Local name : *Bui*.

Erect, much-branched, hoary-tomentose, perennial undershrubs, up to 1 m high. Leaves alternate, 5-12 x 1-2.5 cm, linear-oblong to oblong-spathulate, subacute at apex, narrowed at base, hairy on both surfaces, sessile. Flowers dull white, sessile, unisexual, in linear-cylindric, densely woolly spikes arranged in terminal, leafless panicles. Bracteoles broadly ovate, acute, white, hyaline. Male perianth-lobes 5, elliptic-oblong, subobtusate, woolly on outer surface. Pistillode ovoid, shortly stipitate, with short style and minutely bifid stigma. Female perianth-lobes 2-2.5 mm long, oblong, subacute, apiculate. Stigmas 2, bifid, equalling the style. Utricles orbicular-ovoid or rounded. Seeds rounded, dark brown (Plate-17/3).

*Fl. & Fr.*: July – January.

*Ecology* : Very common and abundant in sandy habitats from plains to dunes. Sometimes forms its pure communities on the dunes and plays vital role in soil binding through underground root-system and stolons.

*Specimens examined* : Near Khuri, Monika 16501 (BSJO); Sakaro-ki-Basti, Monika 16583 (BSJO); Mathuo-ki-basti, Monika 16738 (BSJO); Sam. Shetty 3485 (BSJO).

## 3. *ALTERNANTHERA* Forssk.

*Alternanthera sessilis* (L.) R. Br. ex DC. Cat. Pl. Hort. Bot. Monsp. 4 : 77. 1813; Hook. f. Fl. Brit. India 4 : 731. 1885; Duthie, Fl. Gangetic Plain 3 : 20. 1915; Bhandari, Fl. Indian Desert 322. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 725. 1991. *Gomphrena sessilis* L. Sp. Pl. 225. 1753. *Illecebrum sessile* (L.) L. Sp. Pl. ed. 2. 300. 1762. *Alternanthera triandra* Lam. Encycl. 1 : 95. 1783.

Annual or perennial, prostrate or decumbent herbs; stem glabrous, terete, rooting at lower nodes. Leaves 2-3.5 x 0.3-1.5 cm or more, linear-lanceolate to linear-oblong or elliptic-obovate, obtuse, cuneate at base, entire or obscurely denticulate, somewhat fleshy, glabrous or thinly pilose on nerves. Petioles 2-8.5 mm long. Flowers white, in axillary, sessile, oblong or subglobose heads. Bracts and bracteoles deltoid-ovate, glabrous, mucronate, scarious. Tepals 2-2.5 mm long, ovate-elliptic, scarious, shortly acuminate, 1-nerved, sparsely hairy on the back. Filaments 5, only 3 with anthers, connate at base forming a tube; pseudo-staminodes subulate-filiform. Ovary obovoid, glabrous; style 1; stigma minute, capitate. Utricles 1.5-1.8 mm long, obcordate, dark brown, glabrous. Seeds shining, discoid, faintly reticulate, ca 1 mm in diam., reddish-brown.

*Fl. & Fr.*: Almost throughout the year.

*Ecology*: Common, found in cultivated fields as a weed and on the margins of water bodies.

*Specimen examined*: Near Sundra, Monika 17168 (BSJO).

#### 4. *AMARANTHUS* L.

- |   |                         |
|---|-------------------------|
| 1a. Plants monoecious.  | 2                       |
| 1b. Plants dioecious.   | 3. <i>A. palmeri</i>    |
| 2a. Bracteoles equalling or exceeding the tepals. Capsules circumscissile.              | 3                       |
| 2b. Bracteoles shorter than the tepals. Capsules indehiscent or irregularly rupturing.  | 4                       |
| 3a. Perianth-segments longer than the capsules.   | 4. <i>A. tricolor</i>   |
| 3b. Perianth-segments shorter than the capsules.  | 1. <i>A. graecizans</i> |
| 4a. Capsules rugulose or smooth, with a blunt apex, distinctly exceeding perianth.      | 2. <i>A. lividus</i>    |
| 4b. Capsules very strongly corrugated, with an acute apex, scarcely exceeding perianth. | 5. <i>A. viridis</i>    |

1. *Amaranthus graecizans* L. Sp. Pl. 990. 1753; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 726. 1991. *A. angustifolius* Lam. Encycl. 1 : 115. 1783, *nom. illegit.* *A. blitum* L. var. *graecizans* (L.) Moq. in DC. Prodr. 13 (2) : 263. 1849. *A. polygamus* L. var. *angustifolia* (Lam.) Hook. f. Fl. Brit. India 4 : 721. 1885.

Erect, annual herbs; stem striate, simple or branched, glabrous or with few multicellular hairs. Leaves 2-3.5 x 0.8-2.5 cm, broadly rhomboid-ovate, retuse at tip, narrowed at base. Petioles up to 3.5 cm long, terete, glabrous. Flowers in axillary, sessile, cymose clusters, male and female intermixed. Bracts and bracteoles narrowly lanceolate-oblong, awned, membranous. Perianth-segments 3, ca 2 mm long, ovate-oblong, shortly mucronate, membranous. Stigmas 3. Utricles ovoid to subglobose, rugose, narrowed at apex, exceeding the perianth. Seeds ca 1.5 mm in diam., compressed, faintly reticulate, shining black.

*Fl. & Fr.*: July - December.

*Ecology*: Occasional, found in sandy plains, particularly near habitations among thickets of *Amaranthus* spp., *Cleome viscosa* L., *Heliotropium* spp., etc.

*Specimens examined*: Near Mathuo-ki-Basti, Monika 16591 (BSJO); Sam, Monika 16719 (BSJO); Mangaliya-ki-dhani, Monika 17126 (BSJO).

2. *Amaranthus lividus* L. Sp. Pl. 990. 1753; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 728. 1991. *A. blitum* L. Sp. Pl. 990. 1753, *nom. confusum*; Hook. f. Fl. Brit. India 4 : 721. 1885, excl. var. *sylvestris*; Duthie. Fl. Gangetic Plain 3 : 13. 1915. *A. oleraceus* L. Sp. Pl. ed. 2. 1403. 1763.

Annual, erect, ascending or prostrate herbs; stem angular, yellowish-green, almost glabrous. Leaves 3-8 x 0.3-5.5 cm, elliptic-ovate or rhomboid-ovate, broad and always emarginate-mucronulate at apex, cuneate at base. Petioles 2-4 cm long, terete. Flowers greenish-white, in slender to stout, terminal spikes and axillary, cymose clusters or panicles up to 7 cm long. Utricles ca 2 mm long, subrotund to shortly pyriform, compressed, wrinkled on drying, exceeding the perianth. Seeds rounded, compressed, shining, brownish-black, glabrous.

*Fl. & Fr.*: July - May.

*Ecology*: Rare, found in sandy to gravelly wastelands in association with *Amaranthus graecizans* L., *Cleome scaposa* DC., etc.

*Specimen examined* : Near Sam, *Monika* 16521 (BSJO).

3. *Amaranthus palmeri* Wats. in Proc. Amer. Acad. 12 : 274. 1877; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 728. 1991.

Erect, annual herbs; stem pale green, sulcate, angular, nearly glabrous. Leaves 4-6.5 cm long, ovate or rhomboid to lanceolate, obtuse, prominently nerved. Flowers in terminal or often in small axillary spikes. Bracteoles ca 7 mm long, spino-tipped, 2 times as long as tepals, rigid in pistillate flowers, shorter and weaker in staminate ones. Staminate flowers with 5, oblong, acute-mucronate, ca 3 mm long tepals and 5 stamens. Pistillate flowers with tepals as long as or longer than capsules, oblong to obovate, whitish-green. Capsules dehiscent, subglobular, 2-beaked, rugose at top. Seeds ca 1 mm in diam., shining, dark brown.

*Fl. & Fr.*: September - November.

*Ecology* : Rare, found in gravelly habitats in association with *Cleome scaposa* DC., *Heliotropium* spp., etc.

*Specimens examined* : Near Bidna, *Monika* 16633 (BSJO); Near Sundra, *Monika* 17159 (BSJO).

4. *Amaranthus tricolor* L. Sp. Pl. 989. 1753; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 730. 1991. *A. tristis* L. Sp. Pl. 989. 1753. *A. mangostanus* L. Cent. Pl. 1 : 32. 1755; Hook. f. Fl. Brit. India 4 : 720. 1885. *A. polygamus* L. Cent. Pl. 1 : 32. 1755, non Hook. f. 1885; Duthie, Fl. Gangetic Plain 3 : 12. 1915. *A. gangeticus* L. Syst. Nat. ed. 10. 1268. 1759; Hook. f. *Lc.* 4 : 719. 1885; Duthie, *Lc.* 3 : 12. 1915, incl. var. *tristis*.

*Local name*: *Jangli-chauli*

Annual, erect or ascending herbs; stem much-branched, almost glabrous or sparsely hairy with crisped hairs. Leaves long-petioled, 2-6.5 x 0.8-2.9 cm, variable, rhomboid-ovate or broadly elliptic to lanceolate-oblong, subacute or emarginate at apex, slightly cuneate at base. Flowers green or crimson, in globose, axillary clusters and in terminal interrupted spikes. Bracts and bracteoles deltoid-ovate. Tepals elliptic-oblong, long awned. Utricles ovoid-urceolate, membranous. Seeds ca 1 mm in diam., lenticular, faintly reticulate, shining black, glabrous.

*Fl. & Fr.*: March - October.

*Ecology* : Occasional, found in wastelands, particularly near villages in humus rich soils.

*Specimen examined* : Near Bandera, *Monika* 16648 (BSJO).

5. *Amaranthus viridis* L. Sp. Pl. ed. 2. 1405. 1763; Hook. f. Fl. Brit. India 4 : 720. 1885; Duthie, Fl. Gangetic Plain 3 : 13. 1915; Bhandari, Fl. Indian Desert 324. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 731. 1991. *A. gracilis* Desf. Tabl. Ecole Bot. 43. 1804.

Local name: *Jangli-chauli*.

Annual, erect or ascending herbs, 20-60 cm high; stem terete, much-branched, thinly pubescent when young, glabrous at age. Leaves 3-8 x 1.3-4.5 cm, deltoid-ovate to rhomboid-ovate, obtuse and emarginate at apex, cuneate at base, glabrous or slightly pubescent on nerves. Petioles 1-7 cm long. Flowers green, in slender, axillary or terminal, simple or branched spikes. Bracts and bracteoles lanceolate-ovate, mucronate. Male perianth-segments 3, linear-oblong, with white membranous margins and green median region, convex dorsally, shortly mucronate, glabrous. Female perianth-segments narrowly oblong-spathulate. Ovary oblong; stigmas 3, on conical top of the ovary. Utricles subglobose, slightly exceeding the perianth, rugose, indehiscent, falling off with perianth, beaked. Seeds ca 1 mm in diam., rounded, more or less compressed, with blunt margins, dark brown, shining.

*Fl. & Fr.*: March - October.

*Ecology* : Common, found as a weed in cultivated fields and in wastelands near habitations, forming associations with *Cenchrus setigerus* Vahl, *Cleome gynandra* L., *C. viscosa* L., *Amaranthus* spp., *Heliotropium* spp., etc.

*Specimens examined* : Near Bidna, *Monika* 16632 (BSJO); Near Tejaraon tank, *Pandey* 7894 (BSJO).

##### 5. CELOSIA L.

*Celosia argentea* L. Sp. Pl. 205. 1753; Hook. f. Fl. Brit. India 4 : 714. 1885; Duthie, Fl. Gangetic Plain 3 : 7. 1915; Bhandari, Fl. Indian Desert 325. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 731. 1991.

Local name : *Kukari*.

Erect, annual herbs, up to 1 m high; stem simple or branched, glabrous, ribbed. Leaves alternate, 4-15 x 0.5-4.6 cm, ovate-elliptic to linear-lanceolate, acute or acuminate at apex, slightly narrowed at base. Petioles 1-2.8 cm long, slender. Flowers white with pink tip, in pedunculate, cylindrical, terminal, 4-15 cm long spikes. Bracts and bracteoles subequal, ovate-oblong or deltoid, upper ones lanceolate, mucronate, 1-nerved, persistent. Tepals 6-9 mm long, ovate, concave, mucronate. Stamens 5, 3-5 mm long, united at base forming a 1-1.5 mm long cup; pseudo-staminodes triangular, minute; anthers oblong. Ovary ellipsoid; style 1, 4-5 mm long, exceeding the perianth; stigmas 2. Utricles 3-3.5 mm long, obovoid, with rounded apex to globular, shorter than perianth. Seeds ca 1.2 mm in diam., reddish-brown, shining.

*Fl. & Fr.*: August - November.

*Ecology* : Common, found as a rainy season weed in cultivated fields with *Pulicaria* spp., *Alternanthera sessilis* (L.) R. Br., etc.

*Specimen examined* : Near Sundra, *Monika* 17170 (BSJO).

6. *DIGERA* Forssk.

*Digera muricata* (L.) Mart. Beitr. Amer. 77. no. 2. 1825 & Nov. Act. Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 13 (1) : 285. 1826; Bhandari, Fl. Indian Desert 326. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 732. 1991. *Achyranthes muricata* L. Sp. Pl. ed. 2. 295. 1762. *Digera arvensis* Forssk. Fl. Aegypt.-Arab. 65. 1775; Hook. f. Fl. Brit. India 4 : 717. 1885; Duthie, Fl. Gangetic Plain 3 : 8. 1915.

Local name : *Lolaru*.

Erect, annual herbs, 30-60 cm high; branches spreading, glabrous or pubescent when young. Leaves 2-7 x 0.8-6 cm, elliptic or ovate, subacute or rounded at apex, rounded at base, sometimes with reddish margins, glabrous. Petioles 1.5-4 cm long, terete, glabrous or slightly pubescent. Flowers pink, in axillary, lax racemes up to 30 cm long. Bracts deltoid-lanceolate or ovate, acuminate, scarious-margined, persistent, each subtending a very shortly pedunculate, partial inflorescence of 3 flowers, of which the central flower is fertile and laterals sterile and adpressed against the fertile flower. Perianth-lobes 5; outer 2 lobes 3-3.5 mm long, concave, 5 to 7-nerved, green with pink border; inner 3 lobes shorter and narrower than outer ones, 1 to 2-nerved, obtuse. Style ca 2 mm long; stigmas 2, recurved. Utricles 2-2.5 mm in diam., compressed, globose, muriculate, with a persistent style base. Seeds yellowish brown, minute, subglobose.

Fl. & Fr.: August - November.

Ecology : Common, found as a weed in cultivated fields or sometimes in wastelands.

Specimens examined : Near Sam, Monika 16546 (BSJO); Sam, Monika 16712 (BSJO).

7. *PUPALIA* Juss. (nom. cons.)

*Pupalia lappacea* (L.) Juss. var. *velutina* (Moq.) Hook. f. Fl. Brit. India 4 : 724. 1885; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 735. 1991. *Aerva velutina* Moq. in DC. Prodr. 13 (2) : 301. 1849. *Pupalia lappacea* auct. plur., non (L.) Juss. 1803; sensu Moq. l.c. 13 (2) : 331. 1849.

Erect, densely villous, woody herbs, up to 1 m high. Leaves 3-4 x 1-2.5 cm, shortly petioled, nearly orbicular, shortly acuminate, tomentose, slightly succulent. Petioles ca 2 cm long, hairy. Flowers in sessile clusters, borne in lax, pedunculate, terminal, cylindrical, 6-7 cm long spikes. Bracteoles of bisexual flowers cordate-ovate, mucronate; outer bracts of the clusters very broad, membranous, with yellow awns; sterile bracts with prominent, exserted, rigid, hooked tips. Filaments 5, united at base. Utricles ca 2 mm long, reddish-brown, ellipsoid, membranous. Seeds compressed, oblong-ellipsoid, with subtruncate ends, brown.

Fl. & Fr.: August - November.

Ecology : Very rare, found in gravelly habitats in association with *Eragrostis* spp., *Cleome scaposa* DC., etc.

Specimens examined : Along Miajlar road, Monika 16632 (BSJO); Along Miajlar-Sundra road, Monika 17156 (BSJO).

## 44. CHENOPODIACEAE

1a. Shrubs, with jointed stem. Leaves absent. Embryo spiral. Albumen absent.

2. *Haloxylon*

1b. Annual herbs, stem not jointed. Leaves well developed. Embryo annular. Albumen present.

1. *Chenopodium*



1. *CHENOPODIUM* L.

*Chenopodium album* L. Sp. Pl. 219. 1753; Hook. f. Fl. Brit. India 5 : 3. 1886; Duthie, Fl. Gangetic Plain 3 : 22. 1915; Bhandari, Fl. Indian Desert 328. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 737. 1991.

Local name : *Bathua*.

Annual, erect or decumbent, much-branched herbs; stem angular, ribbed, densely clothed with white powdery vesicles. Leaves variable in size and shape, 1.5-10 x 0.3-4.5 cm, ovate-rhomboid, oblong-lanceolate or elliptic-lanceolate, obtuse or acute, cuneate at base, lower slightly toothed or irregularly lobulate on margins, upper entire and smaller. Petioles 1-5 mm long, pubescent. Flowers pale green, bisexual, in clusters borne in lax, paniculate, ebracteate spikes. Perianth-lobes 1.5-2 mm long, distinctly connate at base, concave. Stamens slightly exerted. Ovary depressed-globose; stigmas 2, short. Utricles depressed-globose, thinly papillose, enclosed by perianth. Seeds lenticular or orbicular, shining, smooth, brownish-black.

Fl. & Fr.: October – February.

Ecology : Common, found as a weed in moist sandy places during winters and in cultivated fields.

Specimen examined : Sam, Monika 17172 (BSJO).

2. *HALOXYLON* Bunge

*Haloxylon salicornicum* (Moq.) Bunge in Boiss. Fl. Orient. 4 : 949. 1879; Hook. f. Fl. Brit. India 5 : 16. 1886; Bhandari, Fl. Indian Desert 330. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 739. 1991. *Caroxylon salicornicum* Moq. in DC. Prodr. 13 (2) : 174. 1849.

Local name : *Lana*.

Erect, much-branched, leafless, perennial shrubs, 0.8-1.2 m high, woody at base; stem and branches pale yellow, jointed; joints produced into 2, long triangular points which take the place of leaves and are woolly within. Flowers in erect spikes. Bracteoles ovate, with woolly axils. Perianth-segments in flower ca 2 mm long, transversely winged; wings 2.5 mm long, orbicular-obovate, veined, membranous. Seeds horizontal, flattened, orbicular.

Fl. & Fr.: August – October.

Ecology : Occasional, found in rather saline habitats forming its own patches.

Specimen examined : Near Sam, Monika 16752 (BSJO).

45. *POLYGONACEAE*

- |  |                      |
|--|----------------------|
| 1a. Annual, prostrate or erect herbs, with distinct, persistent leaves. Stamens 6-8. Styles 2-3.                       | 2. <i>Polygonum</i>  |
| 1b. Perennial, rigid, much-branched shrubs, leafless or with short-lived small leaves. Stamens more than 10. Styles 4. | 1. <i>Calligonum</i> |

1. *CALLIGONUM* L.

*Calligonum polygonoides* L. Sp. Pl. 530. 1753; Hook. f. Fl. Brit. India 5 : 22. 1886; Duthie, Fl. Gangetic Plain 3 : 42. 1915; Bhandari, Fl. Indian Desert 331. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 745. 1991.

Local name : *Phog*.

Perennial, rigid, much-branched shrubs; branches pale green, terete, glabrous; internodes 3-4 cm long. Leaves, when present, alternate, linear-oblong or subulate, obtuse at apex, soon caducous. Stipules short, membranous, cup-shaped, obliquely truncate, produce upwards at one side. Flowers pinkish, 5-7 fasciculate in the axils of ochreae; pedicels ca 2.5 mm long, terete. Bracteoles membranous, ovate, acute. Perianth ca 3 mm long; segments obovate, cuneate, obtuse. Stamens more than 10. Ovary tuberculate; styles 4; stigmas capitate. Fruits 6-8 mm long (excluding bristles), oblong, densely clothed with reddish-brown bristles, dilated at base. Seeds oblong, black, shining, smooth (Fig.-20; Plate-19/1).

Fl. & Fr.: April – May.

*Ecology* : Common, found in sandy plains as well as on stabilized and semi-stabilized sand-dunes, mostly forming pure communities.

*Specimen examined* : Near Bandera, Monika 16529 (BSJO).

2. *POLYGONUM* L. (*nom. cons.*)

*Polygonum plebeium* R. Br. var. *indica* (Heyne ex Roth) Hook. f. Fl. Brit. India 5 : 28. 1886; Duthie, Fl. Gangetic Plain 3 : 33. 1915; Bhandari, Fl. Indian Desert 333. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 752. 1991. *P. indicum* Heyne ex Roth, Nov. Pl. Sp. 208. 1821.

Diffusely branched, prostrate herbs, with a woody root-stock; branches angled, spreading all round from the base; internodes short. Leaves sessile, 6-15 x 2-3 mm, linear, oblong or obovate-oblong, flat, apiculate at apex. Stipules ca 2 mm long, hyaline, fimbriate to the middle. Flowers pink, in axillary fascicles of 3-6; pedicels up to 2 mm long, shorter than or equal to the perianth, jointed just below the perianth. Perianth-lobes 5, ca 2 x 0.8 mm, oblong, free nearly to the base, obtuse, two outer tepals acute. Stamens 6-8; filaments dilated near the base. Ovary 3-gonous, glabrous; styles 3, connate at base; stigmas capitate. Nutlets ca 1.5 mm long, trigonous, acute at both ends, black, shining.

Fl. & Fr.: September – January.

*Ecology* : Common, found in moist places, particularly on the margins of water reservoirs in association with *Gisekia pharnaceoides* L., etc.

*Specimen examined* : Near Bandera, Monika 16649 (BSJO).

## 46. ARISTOLOCHIACEAE

*ARISTOLOCHIA* L.

*Aristolochia bracteolata* Lam. Encycl. Meth. Bot. 1 : 258. 1783; Bhandari, Fl. Indian Desert 334. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 756. 1991. *A. sempervirens* Forssk. Fl. Aegypt.-Arab. 156. 1775.

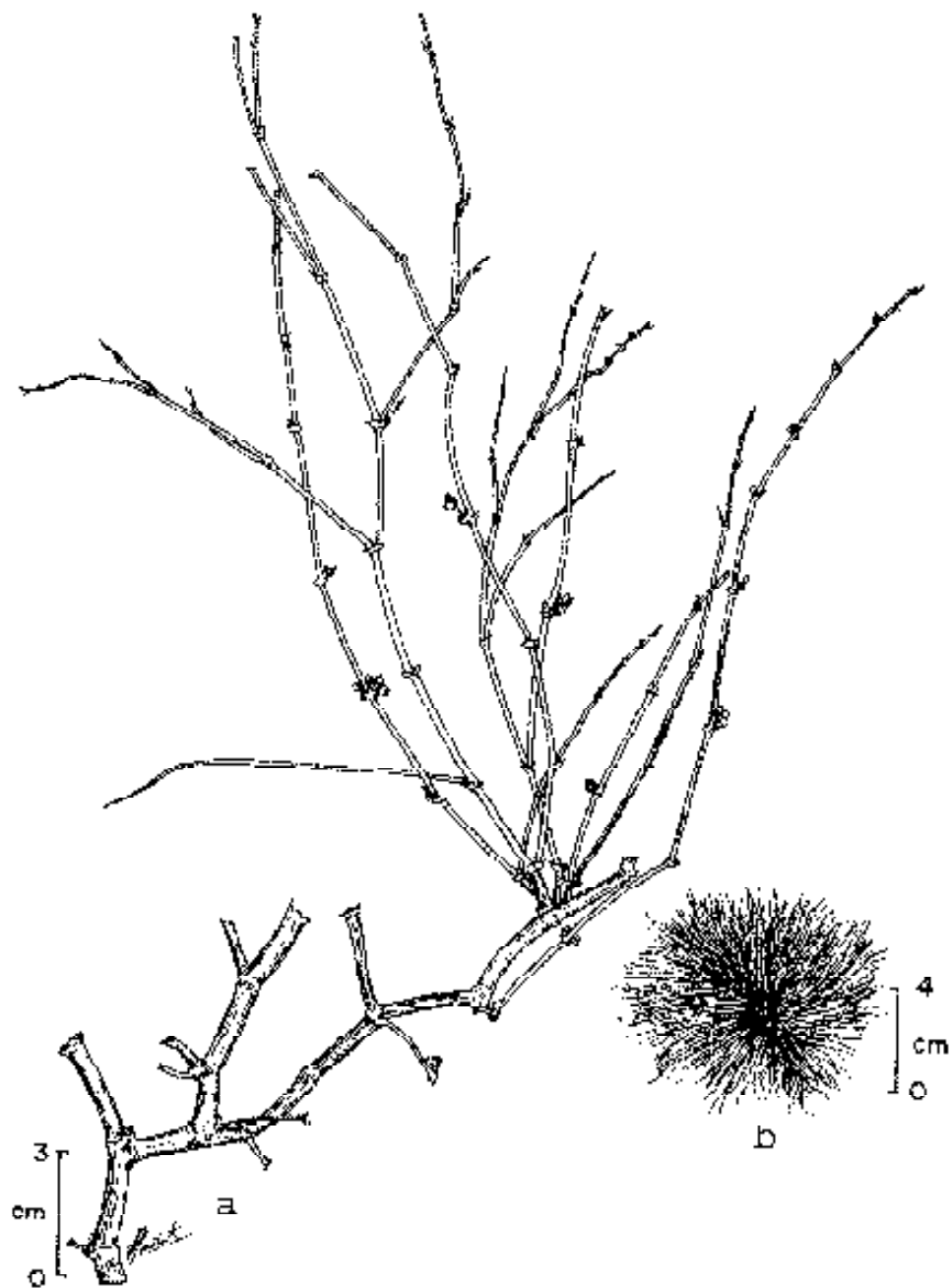


Fig. 20. *Calligonum polygonoides* L. : a. Habit. b. Fruit.

non L. 1753. *A. bracteata* Retz. Obs. Bot. 5 : 29. 1788; Hook. f. Fl. Brit. India 5 : 75. 1886; Duthie, Fl. Gangetic Plain 3 : 44. 1915.

Local name : *Hukkabel*.

Prostrate or suberect, perennial, glabrous herbs; stem and branches glabrous, angular, striate, sulcate when dry. Leaves 2.5-8.5 x 2.5-8 cm, broadly ovate or reniform, cordate at base with wide shallow sinus, obtuse at apex, crenulate, undulate or entire, reticulately veined, glabrous on both surfaces. Petioles 1.5-3.5 cm long, terete. Flowers dark purple, solitary, axillary; pedicels 6-25 mm long. Bracts sessile, leafy, subreniform at the base of pedicels. Perianth 2-5 cm long, with green, subglobose base, cylindrical tube and mouth trumpet-shaped; lip linear, as long as tube, reticulately veined, glandular hairy within, slightly shorter than tube, dark purple. Capsules ca 1.5 cm long, ellipsoid-oblong, glabrous, ribbed. Seeds 5-6 mm long, nearly as much broad, deltoid with a slightly cordate base, compressed, rugose black on one side, 2-lobed and whitish on the other side.

Fl. & Fr.: September – February.

Ecology : Occasional, found in the fences around the cultivated fields in association with some climbers like *Melothria maderaspatana* (L.) Cogn., etc.

Specimen examined : Near Daw, Monika 16785 (BSJO).

#### 47. EUPHORBIACEAE

- |  |                       |
|--|-----------------------|
| 1a. Flowers naked, arranged in cyathia. Sap milky.                 | 1. <i>Euphorbia</i>   |
| 1b. Flowers with perianth, not arranged in cyathia. Sap not milky. | 2. <i>Phyllanthus</i> |

#### 1. *EUPHORBIA* L.

- |   |  |
|---|--|
| 1a. Dendroid shrubs; stem fleshy, armed with spines.      | 1. <i>E. caducifolia</i>                     |
| 1b. Erect or prostrate herbs; stem not fleshy, unarmed.   | 2  |
| 2a. Erect or ascending herbs. Leaves more than 1 cm long. | 5. <i>E. hirta</i>                           |
| 2b. Prostrate herbs. Leaves less than 1 cm long.          | 3  |
| 3a. Plants glabrous. Capsules glabrous.                   | 2. <i>E. clarkeana</i>                       |
| 3b. Plants hairy. Capsules pubescent.                     | 4  |
| 4a. Leaves glabrous above, pubescent beneath.             | 4. <i>E. granulata</i> var. <i>glabrata</i>  |
| 4b. Leaves pubescent on both surfaces.                    | 3. <i>E. granulata</i> var. <i>granulata</i> |

1. *Euphorbia caducifolia* Haines in Indian For. 40 : 154. 1914 & Bot. Bihar & Orissa 2 : 143. 1921; Fischer in Kew Bull. 1925 : 341. 1925; Bhandari, Fl. Indian Desert 339. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 775. 1991. *E. nerifolia* auct. plur., non L. 1753, nec. Roxb. 1832.

Local name : *Danda-thor*.

Perennial, glabrous, fleshy, dendroid shrubs, up to 2 m high; branches many from the base, erect, 3-5 cm in diam., cylindrical, with distant, small, non-confluent tubercles, each tubercle with a black areole bearing a pair of divergent, glabrous, 5-8.5 mm long, pointed spines. Leaves fleshy, arising singly from the areoles, deciduous before anthesis, ovate, ovate-oblong or suborbicular, acute. Cyathia usually in triad,

bracteate, pedicellate, red; central one usually male; laterals hermaphrodite; pedicels stout, 2-5 mm long, in the axils of triangular-ovate bracts. Male involucre-lobes broadly oblong, obtusate, toothed or scarcely fimbriate, with 5 glands; anthers yellow. Female involucre-lobes 3, minute, rounded at apex; style 3, connate half way down. Capsules sharply 3-lobed, 10-12 mm in diam., glabrous. Seeds 3, globose, 2-3 mm in diam., one in each locule, smooth, greyish-brown (Plate 4/2).

*Fl. & Fr.*: January - April.

*Ecology* : Common, found in rocky habitats, forming thick patches of its own. It is a hardy species and may be planted by uprooting even large plants or through detached branches.

*Specimens examined* : Near Sipla, Monika 16539 (BSJO); Along Miajlar road, Shetty 6145 (BSJO).

2. *Euphorbia clarkeana* Hook. f. Fl. Brit. India 5 : 253. 1887; Duthie, Fl. Gangetic Plain 3 : 82. 1915; Bhandari, Fl. Indian Desert 339. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 776. 1991. *E. heyneana* Boiss. in DC. Prodr. 15 (2) : 35. 1862. *pro parte*, non Spreng. 1826.

Local name : *Dudheli*.

Annual, diffuse, prostrate or decumbent herbs; stems many, filiform, glabrous. Leaves 4-8 x 1-3 mm, distichously arranged, opposite, much longer than broad, obliquely linear-oblong, with base almost auricled on one side, entire or toothed at the rounded tip, glabrous. Petioles less than 1 mm long. Stipules rather large, setaceous from a broad toothed base. Cyathia usually solitary in each axil. Involucre stalked, campanulate, glabrous, with 5, lanceolate, toothed lobes; glands minute, without limb. Capsules ca 2 mm across, glabrous, trigonous; cocci keeled. Seeds ca 1.5 mm long, ovoid, acutely 4-angled, reddish, transversely rugose.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Rare, found in sandy wet plains and sometimes in the crevices of rocks in association with *Euphorbia granulata* Forssk., etc.

*Specimens examined* : Sudasari, Pandey 7847 (BSJO); Tejaraon, Pandey 7893 (BSJO); Bandera, Pandey 7916 (BSJO).

3. *Euphorbia granulata* Forssk. Fl. Aegypt.-Arab. 94. 1775; Hook. f. Fl. Brit. India 5 : 252. 1887; Duthie, Fl. Gangetic Plain 3 : 81. 1915; Bhandari, Fl. Indian Desert 341. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 778. 1991. *E. aegyptiaca* Boiss. var. *indica* Boiss. in DC. Prodr. 15 (2) : 35. 1862.

var. *granulata*

Local name : *Dhudheli*.

Annual, small, hispidly villous, prostrate herbs; branches many, brittle, spreading in all directions. Leaves opposite, 3-6 x 1-2.5 mm, obliquely obovate, obtuse or rounded at apex, very unequal at base, entire, coriaceous, puberulent on both surfaces. Petioles up to 1 mm long. Stipules subulate, ciliolate, minute. Cyathia subsessile, subsolitary, axillary, on short, leafy, raceme-like branchlets. Involucre turbinate, campanulate or funnel-shaped; lobes 5, deltoid, ciliate; glands 3-4, sessile, transverse, surrounded by 2 to 3-lobed, petal-like appendages. Capsules ca 1 mm in diam., puberulent with minute adpressed hairs. Seeds 4-angled, ca 0.7 mm long, slightly transversely rugose.

*Fl. & Fr.*: September- December.

*Ecology* : Common, found in sandy and gravelly plains forming large patches of it's own or with *Tribulus terrestris* L. and *Corchorus depressus* (L.) Vicary.

*Specimens examined* : Near Nimba, *Monika* 16514 (BSJO); Sam, *Monika* 16557 (BSJO).

4. *Euphorbia granulata* Forssk. var. *glabrata* Boiss. in DC. Prodr. 15 (2) : 34. 1862; Bhandari, Fl. Indian Desert 341. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 779. 1991. *E. granulata* Forssk. var. *glabra* Blatt. & Hallb. in J. Bombay Nat. Hist. Soc. 26 (4) : 97. 1920.

Annual, small, prostrate, hispid herbs, with spreading branches. Leaves 4-5 x 1-2 mm, ovate, oblique at base, obtuse at apex, entire, slightly pubescent on lower surface, glabrous above. Cyathia axillary, solitary, dirty white, thinly pubescent or nearly glabrous. Involucral glands with appendages rather more petaloid than the type but not much longer. Capsules puberulent all over with spreading hairs; cocci hirsute, not keeled. Seeds 4-angled, slightly transversely rugose, brownish-black.

*Fl. & Fr.*: August – October.

*Ecology* : Rare, found mixed with proper variety.

*Specimen examined* : Mathuo-ki-Basti, *Monika* 16739 (BSJO).

5. *Euphorbia hirta* L. Sp. Pl. 454. 1753; Duthie, Fl. Gangetic Plain 3 : 80. 1915; Bhandari, Fl. Indian Desert 342. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 780. 1991. *E. pilulifera* auct. plur. non L. 1753; Hook. f. Fl. Brit. India 5 : 250. 1887.

Local name : *Dhedli-dudheli*.

Annual, procumbent or erect herbs, 20-30 cm high; stem and branches hairy with yellow, spreading hairs. Leaves 2-4.5 x 0.6-1.8 cm, opposite, obliquely ovate-lanceolate or rhomboid-oblong, acute at apex, cuncate at base, serrate, puberulent on both surfaces. Petioles 2-3.5 mm long, pubescent. Stipules subulate, pubescent, soon falling. Cyathia many, crowded in axillary and terminal, shortly pedunculate cymes; peduncles 5-6 cm long, terete, pubescent. Involucre obconic or cup-like, stalked, with 4-glands and 5. acute, fringed lobes; glands stalked, globose, pink, slightly exceeding the lobes. Capsules globose-trigonus, minutely appressedly hairy, ca 1 mm in diam. Seeds ovoid, 4-angled, transversely rugose, reddish-brown.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found as a weed in wastelands, along road-sides, fallow and cultivated fields ,etc. Plants usually prefer wet and shady habitats.

*Specimen examined* : Near Phulia, *Monika* 16534 (BSJO).

## 2. *PHYLLANTHUS* L.

1a. Tepals 5. Disc-glands in male flowers 5.

1. *P. amarus*

1b. Tepals 6. Disc-glands in male flowers 6.

2

2a. Stipules peltate. Leaves obovate.

3. *P. maderaspatensis*

2b. Stipules simple, not peltate. Leaves oblong.

2. *P. fraternus*

1. *Phyllanthus amarus* Schum. & Thonn. in Kongl. Danske Vidensk. Selsk. Skr. 4 : 195. 1829; Brenan in Kew Bull. 1950 : 217. 1950; Bhandari, Fl. Indian Desert 345. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 787. 1991.

Local name : *Gugario*.

Annual, ascending herbs, 20-40 cm high; stem terete, glabrous, smooth. Leaves 0.8-1 x 0.4-0.5 cm, elliptic-oblong or somewhat obovate, obtuse or rounded at apex. Stipules (cataphylls) 3, at the base of branches, middle one subulate, larger; laterals ca 1 mm long, deltoid, acuminate, scarious, entire. Flowers minute, one male and one female in each axil, greenish. Male pedicels 0.6-1.2 mm long. Perianth-lobes 5, 0.5-0.6 mm long, subacute, scarious-margined. Disc-segments 5, orbicular, non-glandular. Stamens 3; filaments completely connate in to a column. Female pedicels 0.6-0.7 mm long, enlarging in fruit. Perianth-lobes 5, obovate-oblong, acute at apex, cuneate at base, scarious on margins. Disc 5-lobed, non-glandular. Style free, bifid. Capsules ca 2 mm in diam., obtusely trigonous, smooth. Seeds ca 1 mm long, sharply trigonous, longitudinally ribbed with transverse striations, dark brown.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Rare, found in sandy plains, preferably in wet and shady habitats.

*Specimen examined* : On the way to Sundra, Monika 16710 (BSJO).

2. *Phyllanthus fraternus* Webster, Contr. Gray Herb. 176 : 53. 1955; Raizada, Suppl. Duthie, Fl. Gangetic Plain 254. 1976; Bhandari, Fl. Indian Desert 346. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 788. 1991. *P. niruri* auct. plur. non L. 1753; Hook. f. Fl. Brit. India 5 : 298. 1887; Duthie, Fl. Gangetic Plain 3 : 98. 1915. *P. asperulatus* auct. plur. non Hutch. 1920; Sharma & Tiagi Fl. N. E. Rajasthan 379. 1979.

Local name : *Gugario*.

Annual, erect or suberect, glabrous herbs, 40-50 cm high; branches resembling a compound leaf. Leaves distichous, often overlapping, 0.8-1.5 x 0.4-0.8 cm, oblong, rounded at apex, cuneate at base, smooth, glabrous, dark green above, paler beneath. Petioles 0.5-0.8 mm long, terete. Stipules (cataphylls) 0.8-1 x 0.2-0.4 mm long, lanceolate, truncate at base. Flowers axillary, hidden under the leaves, yellowish-green. Male flowers 1 to 3-together; pedicels up to 0.5 mm long. Perianth 6-lobed; lobes elliptic to obovate, obtuse at tip, yellowish, with scarious margins. Disc-segments 6, obscurely glandular. Stamens 3; filaments connate at base forming a column. Female flowers solitary. Perianth-lobes 6, unequal, linear-spathulate. Disc an irregular cup, 6 to 9-lobed; lobes crenate. Style minutely bifid. Capsules ca 2 mm in diam., depressed-globose, smooth, brown. Seeds ca 1 mm long, trigonous, light brown, with 6-7 longitudinal ribs on the back and transverse striations.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in wastelands and along road-sides in shady and rather wet habitats.

*Specimen examined* : Bandera, Monika 17130 (BSJO).

3. *Phyllanthus maderaspatensis* L. Sp. Pl. 982. 1753; Hook. f. Fl. Brit. India 5 : 292. 1887; Duthie, Fl. Gangetic Plain 3 : 97. 1915; Bhandari, Fl. Indian Desert 346. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 789. 1991.

Annual, erect, glabrous herbs, 40-60 cm high; branches slender, angular. Leaves alternate, distantly borne, 2-3.5 x 1-1.5 cm, chartaceous, linear-oblong-lanceolate or obovate, rounded or truncate at apex, tapering at base. Petioles 2-3 mm long, slender, terete, glabrous. Stipules ca 2 mm long, lanceolate, acuminate, glabrous, purplish, auriculate at base. Male flowers fasciated, axillary, subsessile. Tepals 6, oblong-lanceolate, green with whitish membranous margins. Disc-glands 6. Stamens 3; filaments connate. Female flowers creamy-white, solitary, axillary, pedicelled, in independent axils or mixed with males sometimes. Tepals 6, elliptic or rounded, outer 3 slightly broader. Disc-glands 6. Styles 3, bifid. Capsules 3 mm in diam., globose, 3-lobed, glabrous. Seeds trigonous, convex at back, muricated on fine, longitudinal dotted lines.

*Fl. & Fr.*: August - October.

*Ecology* : Rare, found in sandy and gravelly habitats, usually mixed with grasses in forest areas.

*Specimen examined* : DNP, Tiwari 876 (BSJO).

#### 48. MORACEAE

##### *FICUS* L.

*Ficus religiosa* L. Sp. Pl. 1059. 1753; King in Hook. f. Fl. Brit. India 5 : 513. 1888; Duthie, Fl. Gangetic Plain 3 : 150. 1915; Bhandari, Fl. Indian Desert 348. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 804. 1991. *Urostigma religiosum* (L.) Gasp. Ric. Caprif. 82. t. 7. f. 1-5. 1845.

*Local name* : Pipal.

Tall, deciduous trees; bark greyish. Aerial roots lacking. Leaves 6-20 x 6-12 cm, ovate to ovate-suborbicular, entire, caudate-acuminate with 3-5 cm long acumen, subtruncate or cordate at base. Receptacles ca 1 cm in diam., in axillary pairs, spherical, reddish-purple when ripe; basal bracts 3. Male flowers very few, sessile, situated near the mouth; stamen 1. Fertile female flowers shortly pedicellate or sessile, with 5 perianth-lobes. Gall flowers sessile, with 3-lobed perianth. Achenes smooth.

*Fl. & Fr.*: Throughout the year.

*Ecology* : Commonly planted by inhabitants near villages, temples, etc.

*Specimens examined* : Near Phulja, Monika 16520 (BSJO).

#### 49. EPHEDRACEAE

##### *EPHEDRA* L.

*Ephedra ciliata* Fisch. & Meyer ex C. A. Meyer, Monogr. Gatt. Ephedra 100. 1846; Pandey in Shetty & Singh, Fl. Rajasthan 2 : 815. 1991. *E. foliata* Boiss. & Kotschy ex Boiss. Diagn. ser. 1. 7 : 101. 1846; Bhandari, Fl. Indian Desert 439. 1978. *E. peduncularis* Boiss. Fl. Orient. 5 : 717. 1884; Hook. f. Fl. Brit. India 5 : 640. 1888. *E. foliata* Boiss. & Kotschy ex Boiss. var. *ciliata* (Fisch. & Meyer ex Meyer) Stapf, Die Artend. Gatt. Ephedra 49. 1889.



Local name : *Andho-khimp*.

Dioecious, much-branched, climbing or scandent shrubs; branches often fasciated, smooth, slender, striated, knotted. Leaves 2-4 at each node, 2-2.5 x 1-1.5 cm, setaceous, connate at base. Male flowers in spikes, latter 1 to 3-together, on 1-2 cm long peduncles. Bracts 1.5-2 x 1.2-1.5 mm, round, obtuse, connate, ciliate. Perianth-lobes ca 2.5 mm long, obovate, ciliate. Staminal column slightly exerted. Female spikes 2 to 3-flowered, subsessile, in pedunculate cymes. Bracts connate; outer ca 1 mm long; inner ones 4-5 mm long. Fruits 6-7 x 5.5-6.5 mm, ovoid-globose, fleshy, white. Seeds 2, 5-6 x 2-2.5 mm, plano-convex, acute at apex, glabrous, brown (Plate-17/4).

*Fl. & Fr.*: September-December.

*Ecology* : Rare, found in sandy habitats, climbing on shrubs or sometimes on trees like *Acacia senegal* (L.) Willd., *A. nilotica* (L.) Del. subsp. *indica* (Benth.) Brenan, *Prosopis cineraria* (L.) Druce, etc.

*Specimen examined* : Miajlar, Monika 16660 (BSJO).

*Notes* : Only living gymnosperm found in DNP as well as in the whole desert.

## 50. LILIACEAE

### *DIPCADI* Medik.

*Dipcadi erythraeum* Webb. & Berth. Phyt. Canar. 3 : 341. 1848; Bhandari, Fl. Indian Desert 352. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 2 : 843. 1991. *Uropetalum unicolor* Stocks in J. Bot. 4 : 180. 1852. *Dipcadi unicolor* (Stocks) Baker in J. Linn. Soc. 11 : 397. 1871; Hook. f. Fl. Brit. India 6 : 346. 1892.

Local name : *Khilra*.

Bulbous, scapigerous herbs, up to 20 cm high; bulbs 1.5-2 cm in diam., tunicated, ovoid. Leaves 15-20 x 0.4-0.5 cm, narrowly linear, sheathing at base, acute at apex. Flowering scapes ca 20 cm long; flowers greenish, in lax racemes on the scapes; pedicels ca 5 mm long. Bracts ca 1.5 cm long, gradually smaller upwards, ovate, acuminate. Perianth campanulate, 1.5-1.6 cm long; outer lobes ca 9 x 3 mm, elliptic-oblong, obtuse, with tips recurved from the middle, 7-nerved; inner lobes 5-nerved, reflexed from the tip only. Ovary 5-6 mm long, elliptic-ovoid, sessile. Capsules ca 1.5 cm in diam., sessile, orbicular, slightly narrowed at the base, black, flat. Seeds rotund, compressed, narrowly winged, shining brownish-black.

*Fl. & Fr.*: August - November.

*Ecology* : Rare, found in moist places near water tanks in sandy plains. However, it usually prefers rocky substratum and produces flowers after first showers.

*Specimen examined* : Sudasari, Monika 16772 (BSJO).

## 51. CYPERACEAE

- |  |                    |
|--|--------------------|
| 1a. Flowering glumes distichous.   | 2                  |
| 1b. Flowering glumes spiral.   | 3                  |
| 2a. Rachilla of spikelets articulated, deciduous, spikelets falling entirely.              | <i>S. Mariscus</i> |
| 2b. Rachilla of spikelets not articulated, persistent, glumes falling apart from rachilla. | <i>Cyperus</i>     |

- |  |                          |
|--|--------------------------|
| 3a. Flowers with a perianth of hypogynous bristles or scales.  | 4                        |
| 3b. Flowers without a perianth of hypogynous bristles or scales.   | 5                        |
| 4a. Inflorescence reduced to a single terminal spike. Style articulated with the ovary. Nuts with a beak of persistent style-base. | 3. <i>Eleocharis</i>     |
| 4b. Inflorescence pseudolateral. Style continuous with ovary. Nuts not beaked.   | 6. <i>Schoenoplectus</i> |
| 5a. Nuts with a button-like thickening formed by the persistent style-base.  | 1. <i>Bulbostylis</i>    |
| 5b. Nuts without a button-like thickening of style-base.   | 4. <i>Fimbristylis</i>   |

### 1. *BULBOSTYLIS* Kunth (*nom. cons.*)

*Bulbostylis barbata* (Rottb.) Clarke in Hook. f. Fl. Brit. India 6 : 651. 1893; Duthie, Fl. Gangetic Plain 3 : 358. 1929; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 889. 1993. *Scirpus barbatus* Rottb. Descri. Pl. Rar. Prog. 27. 1772 & Ic. Rar. Nov. Pl. 52. t. 17. f. 4. 1773. *Fimbristylis barbata* (Rottb.) Benth. Fl. Austral. 7 : 321. 1878; Bhandari, Fl. Indian Desert 374. 1978. *Stenophyllus barbata* (Rottb.) T. Cooke, Fl. Bombay 2 : 887. 1908.

Annual, glabrous, densely tufted sedges. Culms up to 25 cm high, slender, trigonous at apex, striate. Leaves 10-12 x 0.2-0.35 cm, as long as or shorter than the stem, filiform, involute-margined, acute, glabrous or sparsely pilose beneath; sheaths 1-1.5 cm long, membranous, mouth bearded with long, white hairs. Spikelets 5-25 in one head, subtended by 3, setaceous bracts, sessile, 2-9 x 0.6-1.2 mm, oblong-lanceolate or linear, polygonal, acute; rachilla stout. Glumes 1.5-2.5 mm long, distant, ovate-lanceolate, boat-shaped, membranous, keeled. Stamens 1-3. Style ca 1 mm long, base persistent; stigmas 3. Achenes 0.7-0.8 mm long, obovate-orbicular, trigonous, rounded at apex, truncate at base, pale, obscurely tuberculate with transversely rectangular cells.

*Fl. & Fr.*: August – November.

*Ecology* : Rare, found in moist plains, usually on the margins of water bodies in association with *Cyperus* spp.

*Specimen examined* : Along Miajlar-Sundra Road, Monika 16709 (BSJO).

### 2. *CYPERUS* L.

- |   |                            |
|---|----------------------------|
| 1a. Spikelets digitately or stellately arranged on ultimate rays.     | 2                          |
| 1b. Spikelets spicately or racemosely arranged on ultimate rays.      | 4                          |
| 2a. Rootlets woolly.  | 3. <i>C. conglomeratus</i> |
| 2b. Rootlets not woolly.  | 3                          |
| 3a. Spikelets in contracted umbels.                                   | 2. <i>C. atkinsonii</i>    |
| 3b. Spikelets in one head.  | 1. <i>C. arenarius</i>     |
| 4a. Rhizomes stoloniferous; stolons bearing tubers. Glumes mucronate. | 5. <i>C. rotundus</i>      |
| 4b. Rhizomes not stoloniferous; no tubers. Glumes obtuse.             | 4. <i>C. iria</i>          |

1. *Cyperus arenarius* Retz. Obs. Bot. 4 : 9. 1786; Clarke in Hook. f. Fl. Brit. India 6 : 602. 1893; Raizada, Suppl. Duthie, Fl. Gangetic Plain 294. 1976; Bhandari, Fl. Indian Desert 364. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 897. 1993.

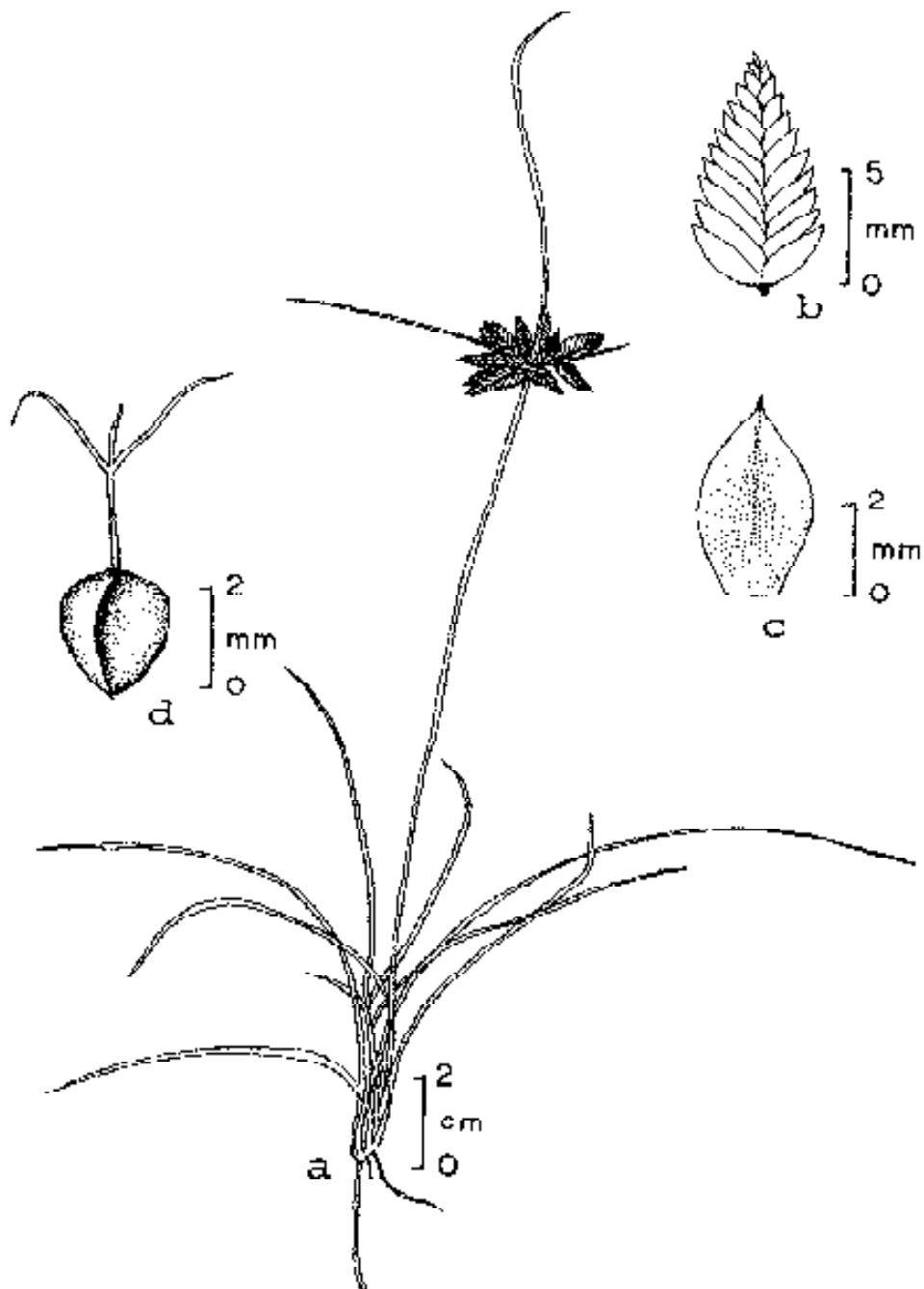


Fig. 21. *Cyperus arenarius* Retz. : a. Habit, b. Spikelet, c. Glume, d. Gynoecium.

Local name : *Motho*.

Perennial, 10-30 cm high sedges. Rhizomes creeping, branched, striate, rigid, clothed with brown, 2-5 cm long sheaths; rootlets thin, glabrous. Culms 1 or few arising from the apices of the branches of rhizomes, obtusely trigonous, glaucous, smooth. Leaves 5-20 x 0.2-0.3 cm, linear, convolute, nerveless, shorter or slightly longer than culms, lower few reduced to subphyllous sheaths. Inflorescence head-like, bearing 10-25 spikelets, more or less globose, 1.5-2 cm in diam., solitary, terminal. Bracts 2-3, leafy, 5-12 cm long, unequal. Spikelets 7-12 x 2-6 mm, elliptic-lanceolate, subacute, 7 to 25-flowered, dirty straw-coloured, dark brown on maturity; rachilla straight. Glumes imbricated, 3.5-4 x 2-2.5 mm, ovate-oblong, boat-shaped, obtuse or slightly emarginated, mucronate, 9 or 11-nerved. Stamens 3; filaments 3-4.5 mm long; anthers exerted. Style 1.5-2 mm long; stigmas 3, capillary, exerted. Nuts 2-3 mm long, broadly obovate, triquetrous, brownish-black, smooth (Fig.-21).

*Fl. & Fr.*: July – December.

*Ecology* : Common in sandy plains as well as on sand-dunes. It is a good soil binder and plays vital role in stabilizing the dunes.

*Specimens examined* : Near Miajlar, *Monika* 16662 (BSJO); Miajlar village, *Monika* 17110 (BSJO); Satto village, *Pandey* 7888 (BSJO).

2. *Cyperus atkinsonii* Clarke in J. Linn. Soc. 21 : 109, 1884 & in Hook. f. Fl. Brit. India 6 : 603, 1893; Raizada, Suppl. Duthie, Fl. Gangetic Plain 295, 1976; Bhandari, Fl. Indian Desert 365, 1978; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 898, 1993.

Perennial, tufted sedges, 30-60 cm high. Rhizomes woody, fibrous; roots fibrous, not woolly. Culms trigonous, with numerous, brown sheaths at the base. Leaves basal, 20-40 x 0.3-0.4 cm, shorter than culms, rigid, lanceolate, tapering at apex into a finely cuspidate point; sheaths persistent, brown, at length disintegrating into fibers. Inflorescence a simple umbel, often contracted into a head; rays 3-4, up to 4 cm long. Bracts 2-3, 10-12 cm long, leafy. Spikelets 10-15 in a head, 1-1.8 x 0.2-0.35 cm, 15 to 30-flowered, compressed, narrowly linear, subacute; rachilla persistent, not winged, slender. Glumes 3-3.5 mm long, ovate to oblong-lanceolate, with a strong sharp mucro beyond the obtuse tip. Stamens 3; filaments 2-2.5 mm long. Style 1.5-1.8 mm long; stigmas 3, smooth, glabrous. Nuts 1.2-1.5 mm long, obovate, trigonous, smooth, yellowish-brown.

*Fl. & Fr.*: March – September.

*Ecology* : Rare, grows in sandy soils in plains and on dunes in association with *Cyperus conglomeratus* Rottb. and *Cyperus arenarius* Retz.

*Specimen examined* : Sudasari, *Monika* 16696 (BSJO).

*Notes* : Very similar to *C. conglomeratus* Rottb., but can be easily identified by non-woolly rootlets.

3. *Cyperus conglomeratus* Rottb. Descr. & Ic. Rar. Nov. Pl. 21, t. 15, f. 7, 1773; Clarke in Hook. f. Fl. Brit. India 6 : 602, 1893; Bhandari, Fl. Indian Desert 367, 1978; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 900, 1993.

Tufted, perennial, glabrous sedges, up to 60 cm high. Rhizomes more or less woody; rootlets woolly, adhering with sand particles. Culms stout, terete below, trigonous above, clothed with ovate, acuminate,

brown scales. Leaves 15-50 x 0.4-0.5 cm, slightly shorter than culms, coriaceous, margins inrolled when dry, shortly cuspidate at apex; sheaths 5-8 cm long, pale green, with oblique mouth. Inflorescence a simple umbel of few densely crowded spikes. Bracts 3-5, 7-10 cm long, cuspidate at apex, dilated at base. Spikelets 1.5-2.5 x 0.2-0.3 cm, oblong-lanceolate, compressed, 10 to 25-flowered, light brown; rachilla stout, not winged. Glumes 6-7.5 x 1-1.5 mm, oblong-lanceolate or ovate, shortly mucronate, many-nerved. Stamens 3; filaments ca 2.5 mm long; anthers linear, ca 3 mm long. Style ca 2.5 mm long; stigmas 3. Nuts obovoid, unequally trigonous, 2-2.5 mm long, pale brown.

*Fl. & Fr.*: August – November.

*Ecology* : Common, found in sandy soils in plains and on dunes. It is a good soil binder, playing vital role in control of soil shifting.

*Specimen examined* : Along Miajlar-Sundra road, *Monika* 16705 (BSJO).

4. *Cyperus iria* L. Sp. Pl. 45. 1753; Clarke in Hook. f. Fl. Brit. India 6 : 606. 1893; Duthie, Fl. Gangetic Plain 3 : 329. 1929; Bhandari, Fl. Indian Desert 368. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 906. 1993.

Local name : *Motha*.

Tall, annual, glabrous sedges, with fibrous roots. Culms solitary or few together, 35-45 cm high, triquetrous, smooth. Leaves 2 or 3, slightly shorter than culms, 4-5.5 mm wide, smooth, weakly folded, scabrous on upper margins. Inflorescence a terminal, compound, diffuse umbel of spikes. Bracts 3-5, leafy. Spikelets 8-13 x 1.8-2 mm, linear-oblong, obtuse, compressed, 10 to 22-flowered, yellowish-brown; rachilla straight, flattened, hardly winged. Glumes ca 2 x 1.5 mm, obovate to elliptic-ovate or suborbicular, obtuse, 5 to 7-nerved, with broad hyaline margins, spreading, acutely ridged. Stamens 2-3; anthers oblong, yellow. Style very short; stigmas 3. Nuts 1.5-1.8 mm long, oblong-ovoid or obovate, triquetrous, equalling or longer than glumes, dark brown.

*Fl. & Fr.*: September – December.

*Ecology* : Common, found on marshy banks of water bodies in association with *Cyperus rotundus* L. and other hydrophyllous sedges.

*Specimens examined* : Near Singhdar, *Monika* 17123 (BSJO); Along Miajlar road, *Shetty* 3403 (BSJO).

5. *Cyperus rotundus* L. Sp. Pl. 45. 1753; Clarke in Hook. f. Fl. Brit. India 6 : 614. 1893; Duthie, Fl. Gangetic Plain 3 : 332. 1929; Bhandari, Fl. Indian Desert 371. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 911. 1993.

Local name : *Motho*.

Perennial, glabrous sedges, with slender stolons terminating into ellipsoid tubers; roots fibrous, clothed with flexuous hairs. Culms solitary or few together, 20-40 cm long, glabrous, triquetrous, bearing corn-like enlargement at base. Leaves equalling the culms, 2-5 mm wide, linear, usually clustered at the base of culms, flat, smooth, acuminate, 1-nerved; sheaths light brown, soon disintegrating into parallel fibres. Inflorescence a simple or compound, terminal corymb of spike bearing 3 to 10-spikelets. Bracts 2-5, leafy, as long as the inflorescence. Spikelets 2.5-3.5 x 1-2.5 mm, linear, compressed, acute, 10 to 28-flowered, light brown; rachilla winged. Glumes 2.5-3.5 x 1-2 mm, ovate-elliptic, obtuse, reddish-brown, keel green, hyaline on



Fig. 22. *Cyperus rotundus* L. : a. Habit.

margins, apiculate at tip. Stamens 3; filaments 4 mm long; anthers linear, ca 2 mm long. Style ca 1.5 mm long; stigmas 3, 0.5-2.8 mm long. Nuts 1-1.5 mm long, oblong to obovate, triquetrous, minutely punctulate, brown (Fig.-22).

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in marshy habitats on the banks of ponds etc and in other wet places including cultivated fields.

*Specimens examined* : Near Ganga, Monika 16619 (BSJO); Singhdar, Monika 16670 (BSJO); Along Miajlar road, Shetty 3405 (BSJO).

### 3. *ELEOCHARIS* R. Br.

*Eleocharis atropurpurea* (Retz.) Presl, Reliq. Haenk. 1 : 196. 1828; Clarke in Hook. f. Fl. Brit. India 6 : 627. 1893; Bhandari, Fl. Indian Desert 372. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 915. 1993. *Scirpus atropurpureus* Retz. Obs. Bot. 5 : 14. 1789. *Heleocharis atropurpurea* (Retz.) Kunth, Enum. Pl. 2 : 151. 1837; Duthie, Fl. Gangetic Plain 3 : 348. 1929.

Tufted, annual sedges, with fibrous roots. Culms capillary to filiform, finely channelled, 7-12 cm high. Leaves absent. Basal sheaths membranous, ca 1.5 cm long, pale, often reddish-brown at base, orifice obliquely truncate. Spikelets 3-5 x 1.5-2 mm, ovate-oblong, sub-acute at apex, many-flowered, reddish-brown; rachilla pitted. Glumes 1.2-1.5 mm long, ovate to elliptic, obtuse, concave, membranous, mid-vein green and broad. Stamens 2-3; anthers oblong-linear. Style bifid, 0.3-0.4 mm long. Nuts 0.5-0.6 mm long, obovoid or obdeltoid, flattened, biconvex, rounded-truncate at apex, shining, dark brown. Hypogynous bristles 4-6, slender, slightly shorter or as long as nuts, sparsely spinulose, white.

*Fl. & Fr.*: September – April.

*Ecology* : Common, found in marshy habitats near water reservoirs. Main associates are *Cyperus rotundus* L., *Fimbristylis quinquangularis* (Vahl) Kunth, etc. Sometimes forms it's own patches.

*Specimen examined* : Near Singhdar, Monika 16671 (BSJO).

### 4. *FIMBRISTYLIS* Vahl (*nom. cons.*)

*Fimbristylis quinquangularis* (Vahl) Kunth, Enum. Pl. 2 : 229. 1837; Clarke in Hook. f. Fl. Brit. India 6 : 644. 1893; Duthie, Fl. Gangetic Plain 3 : 356. 1929; Bhandari, Fl. Indian Desert 375. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 926. 1993. *Scirpus quinquangularis* Vahl, Enum. Pl. 2 : 279. 1805.

Annual or biennial, glabrous sedges, with short rhizomes densely tufted with fibrous roots, not stoloniferous. Culms 20-60 cm high, 4 to 5-gonous; culm-sheaths bladeless, subterete, straw-coloured. Leaves 10-25 x 0.2-0.3 cm, dorsi-ventrally flattened, linear, usually shorter than the culms, finely acuminate, margins scaberulous, some reduced to bladeless sheaths. Inflorescence a compound or decompound corymb bearing 10 to 30-spikelets. Bracts 3-5, setaceous, much shorter than the rays, filiform, acute. Spikelets 3-5 x 1-1.5 mm, ellipsoid, 8 to 15-flowered, pale brown; rachilla ragged with scale-like wings after the fall of glumes. Glumes 1.2-1.8 mm long, spirally imbricated, ovate, acute, margins hyaline, 3-nerved at back. Stamens 3; anthers obtuse. Style 0.6-0.7 mm long, slightly pubescent; stigmas 3. Nuts ca 0.7 mm, obovate-ovoid, obtusely trigonous, minutely tuberculate, yellowish-brown.

*Fl. & Fr.*: August – November.

*Ecology* : Occasional, found in marshy habitats in association with *Cyperus rotundus* L., *Eleocharis atropurpurea* (Retz.) Presl, *Mariscus squarrosus* (L.) Clarke, etc.

*Specimens examined* : Singhdar, Monika 16673, 16676, 17122 (BSJO).

*Notes* : Prasad & Singh (in J. Econ. Taxon. Bot. Ser. 21, 2002) have considered this species synonymous to *F. miliacea* (L.) Vahl, but we don't agree since latter bears culms 4-gonous, leaves laterally flattened and deeply pitted rachilla after the fall of glumes.

#### 5. *MARISCUS* Vahl (*nom. cons.*)

*Mariscus squarrosus* (L.) Clarke in Hook. f. Fl. Brit. India 6 : 623. 1893; Bhandari, Fl. Indian Desert 376. 1978; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 939. 1993. *Cyperus squarrosus* L. Cent. Pl. 2 : 6. 1756. *C. aristatus* Rottb. Descr. Pl. Rar. Progr. 22. 1772 & Descr. Ic. Rar. Nov. Pl. 23. t. 6. f. 1. 1773; Clarke in Hook. f. Lc. 6 : 606. 1893; Duthie, Fl. Gangetic Plain 3 : 328. 1929.

Densely tufted, annual sedges, with reddish-purple fibrous roots. Culms slender, wingedly triquetrous. Leaves 2-6, 10-15 x 0.1-0.3 cm, equalling or slightly shorter than culms, linear, flat, acuminate, 1-nerved; sheaths purplish-brown, membranous. Inflorescence simple, open or reduced to a single, hemispherical spike. Bracts 2-5, patent, unequal. Spikes 1-2 x 0.7-0.9 cm, broadly ellipsoid to subglobose, more or less echinate, yellowish-green. Spikelets 4-13 x 2-3.5 mm, spicately arranged, upper ascending, lower reflexed, 6 to 15-flowered, ovate or oblong-elliptic to elliptic-lanceolate, more or less flattened, straw-coloured; rachilla 0.2 mm wide, zigzag, brown. Glumes ca 2 mm long, oblong-spathulate, folded, reddish-brown, membranous, 7 to 9-nerved, keel produced into a recurved beak as long as the limb. Stamen 1; filament ca 2.5 mm long, flat, hyaline; anther 0.3-0.4 mm long. Style ca 0.8 mm long; stigmas 3, ca 1 mm long. Achenes ca 1 mm long, oblong, trigonous, purplish brown, punctulate, scarcely apiculate.

*Fl. & Fr.*: September – December.

*Ecology* : Occasional, found near water reservoirs in marshy habitats. Main associates are *Cyperus rotundus* L., *Eleocharis atropurpurea* (Retz.) Presl, etc.

*Specimens examined* : Singhdar, Monika 16672, 17122 (BSJO).

#### 6. *SCHOENOPLECTUS* (Reichb.) Palla (*nom. cons.*)

*Schoenoplectus roylei* (Nees) Ovczinn. & Czukav. Fl. Tadjikist. 2 : 40. 1963; Lye in Bot. Notiser 124 : 290. 1971; Parmar in Shetty & Singh, Fl. Rajasthan 3 : 950. 1993. *Isolepis roylei* Nees in Wight, Contrib. 107. 1834. *Scirpus quinquefarius* Buch.-Ham. ex Boeck. in Linnaea 36 : 701. 1870; Clarke in Hook. f. Fl. Brit. India 6 : 657. 1893. *S. roylei* (Nees) Parker in Duthie, Fl. Gangetic Plain 3 : 361. 1929; Bhandari, Fl. Indian Desert 378. 1978.

Local name : *Morto*.

Annual sedges, with fibrous roots. Culms 15-50 cm high, slender, terete or slightly compressed, often transversely septate when dry. Leaves absent; sheaths loose, membranous, with oblique mouth. Inflorescence a pseudolateral head near the top of culm. Spikelets 9-12 x 5-6 mm, ovoid-oblong, obtuse, slightly compressed,



golden-yellow. Glumes 3-4 mm long, usually 5-ranked, elliptic-lanceolate, inflated in fruit, membranous, acutely mucronate at apex, tapering at base, apex slightly curved, keeled. Bristles absent. Stamens ca 3 mm long; anthers linear, obtuse. Style ca 1.5 mm long; stigmas 3, slightly shorter than style. Nuts ca 1.5 mm long, obovoid, acutely trigonous, apiculate, rugose with transverse wavy lines, brownish-black.

*Fl. & Fr.*: September – November.

*Ecology* : Common, found in moist sandy places on the banks of water bodies in association with *Cyperus rotundus* L. and other sedges.

*Specimens examined* : Near Bandera, *Monika* 16647 (BSJO); Miajlar, *Monika* 16799 (BSJO).

## 52. POACEAE

- 1a. Spikelets 2-flowered, falling entire at maturity, usually with the upper floret hermaphrodite and the lower male or barren. 2
- 1b. Spikelets 1 to many-flowered, breaking up at maturity above the more or less persistent glumes, or if falling entire, than not 2-flowered with the lower floret male or barren and the upper hermaphrodite. 11
- 2a. Spikelets often paired with one sessile and the other pedicelled (rarely in threes with one sessile and the others pedicelled); glumes as long as the spikelets and enclosing the florets, more or less rigid and firmer than the lemmas which are both hyaline and membranous; upper lemma usually awned. 3
- 2b. Spikelets solitary or paired; lower glume usually smaller or sometimes suppressed; lower lemma mostly resembling the upper glume in texture; upper lemma papery to very tough and rigid, usually without awn. 7
- 3a. Joints of the rachis and pedicel of the pedicelled spikelets swollen, 3-angled, rounded or flattened. 4
- 3b. Joints of the rachis and pedicel narrow, seldom thickened upwards, occasionally with a translucent longitudinal groove. 5
- 4a. Lower glume covered on margins with beared warty projections. Sessile spikelets on one side of the rachis. 11. *Elyonurus*
- 4b. Lower glume without warty projections. Sessile spikelets alternating at each node of the rachis. 15. *Lasiurus*
- 5a. Margins of the lower glume of sessile spikelets inturned and rounded on the sides, at the most keeled upwards; callus mostly sharp and long; awns usually hairy. 14. *Heteropogon*
- 5b. Margins of the lower glume of sessile spikelets sharply infolded, 2-keeled; awns glabrous. 6
- 6a. Non aromatic grass. Upper lemma of the sessile spikelets not cleft, often stipitate and passing into the awn. 8. *Dichanthium*
- 6b. Aromatic grass. Upper lemma of the sessile spikelets 2-cleft, awned in the sinus. 5. *Cymbopogon*
- 7a. Spikelets with an involucre of bristles united at the base into a hard cup, falling with bristles. 3. *Cenchrus*
- 7b. Spikelets falling singly, not subtended by bristles. 8
- 8a. Spikelets arranged in more or less open panicles. 20. *Panicum*
- 8b. Spikelets arranged in one-sided spikes or spike-like racemes; spikes or racemes digitate or scattered, rarely solitary. 9
- 9a. Lemma of the upper florets thinly cartilaginous, usually with flat, hyaline margins. 9. *Digitaria*
- 9b. Lemma of the upper florets more or less crustaceous or coriaceous, usually with narrow in-rolled margins, exposing much of palea. 10

- 10a. Lower glume turned towards the rachis, the back of the upper lemma turned away from it, i.e. spikelets adaxial. **2. Brachiaria**
- 10b. Lower glume turned away from the rachis of the racemes or spikes, the back of the upper lemma facing it, i.e. spikelets abaxial. **10. Echinochloa**
- 11a. Spikelets born along one side of the rachis of solitary, digitate or scattered spikes or spike-like racemes (with one fertile floret and 1 to 3-nerved lemma), or on opposite side of the rachis of solitary spikes or racemes. 12
- 11b. Spikelets borne in open or contracted or spike-like panicles, less often in racemes or spikes. 17
- 12a. Inflorescence of digitate spikes or spikes racemose, very rarely solitary, if so, then the lemma obovate. 13
- 12b. Inflorescence terminal and spicate, not of digitate or racemose spikes; lemma not obovate. 15
- 13a. Spikelets with one or more fertile florets and one or more imperfect florets above them; lemma usually widened upwards. 14
- 13b. Spikelets with one fertile floret only, no imperfect florets. **22. Schoenefeldia**
- 14a. Spikes 1-3; fertile florets 2 or more. **25. Tetrapogon**
- 14b. Spikes 4 or more; fertile floret one only. **4. Chloris**
- 15a. Inflorescence of spaced cluster of awned spikelets on a simple rachis. **17. Melanocenchris**
- 15b. Inflorescence a simple spike or spikes of awned or awnless spikelets. 16
- 16a. Spikelets more or less sunken in thick, tough rachis. **19. Oropetium**
- 16b. Spikelets not sunken in thick rachis. **22. Schoenefeldia**
- 17a. Spikelets usually with two or more fertile florets, if with one fertile floret then with sterile, reduced florets above it. 18
- 17b. Spikelets with one fertile floret (male or female in unisexual, 1-flowered spikelets), with or without one or two male or barren florets below it, the latter often much reduced. 22
- 18a. Lemmas 1 to 3-nerved. 19
- 18b. Lemmas 9-nerved. **12. Enneapogon**
- 19a. Spikelets in open, contracted or spike-like panicles. **13. Eragrostis**
- 19b. Spikelets loosely imbricate in digitate or racemosely arranged spike-like racemes. 20
- 20a. Axis of spikes terminating into a sharp point. **6. Dactyloctenium**
- 20b. Axis and branches of inflorescence ending into a spikelet. 21
- 21a. Spikelets falling entire at maturity from the axis of straight spikes, the latter numerous and crowded into a long, narrow, dense panicle. **7. Desmostachya**
- 21b. Spikelets breaking up at maturity; spikes few to several. **18. Ochthochloa**
- 22a. Spikelets falling entire at maturity, either singly or in clusters from the axis of slender spike-like panicles or racemes; base of glume smooth. 23
- 22b. Spikelets rarely falling entire; base of glume bearded. 25
- 23a. Spikelets solitary; glumes awned. **21. Perotis**
- 23b. Spikelets in pair or solitary; glumes not awned. 24
- 24a. Spikelets solitary, distant, on flattened, wedge-shaped pedicels; lower glume pectinately spinous, dorsally smooth; upper glume thickened, tuberculate. **16. Leptochloa**
- 24b. Spikelets in pairs, crowded on short pedicels face-to-face; lower glume armed with hooked spines; upper glume smooth. **26. Tragus**

- 25a. Spikelets 3-awned; lemma indurated rigid at maturity, terete or dorsally compressed. 26  
 25b. Spikelets not awned; lemma hyaline or membranous. 23. *Sporobolus*  
 26a. Central awn branch glabrous. 1. *Aristida*  
 26b. Central awn branch plumose. 24. *Stipagrostis*

### 1. *ARISTIDA* L.

- 1a. Articulation between the lemma and awns present. 2  
 1b. Articulation between the lemma and awns absent. 1. *A. adscensionis*  
 2a. Articulation between lemma and awns situated at the top of column. 4. *A. notabilis*  
 2b. Articulation between lemma and awns situated between the tip of lemma and base of column. 3  
 3a. Upper glume longer than lower; base of callus forked. 3. *A. hystricula*  
 3b. Upper glume shorter than the lower; base of callus pointed. 2. *A. funiculata*

*1. Aristida adscensionis* L. Sp. Pl. 82. 1753; Hook. f. Fl. Brit. India 7 : 224. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 407. 1960; Bhandari, Fl. Indian Desert 386. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 973. 1993, *A. depressa* Retz. Obs. Bot. 4 : 22. 1786; Bor, *l.c.* 409. 1960.

Local name : *Lampro.*

Erect or ascending, annual or perennial grass, 30-60 cm high. Culms erect from a shortly decumbent base, slender, tufted. Leaves 10-25 x 0.1-0.3 cm, convolute, filiform, smooth; sheaths smooth, with rounded auricles; ligule a ridge of short, fine hairs. Panicles 10-25 or more cm long, contracted, unequally branched; rachis filiform, smooth; pedicels capillary. Spikelets erect, 5-8 mm long, 1-flowered, greenish-purple. Lower glume 6-8 mm long, linear-lanceolate, scabrous on the keel, emarginate, acute; upper glume about as long as lower, lanceolate, 2-toothed, apiculate, smooth on the keel. Lemma slightly exceeding the glumes, 7-9 mm long, convolute, 3-nerved, laterally compressed, passing into the awn. Awn trifid; central branch up to 2.5 cm long; lateral ones slightly shorter. Callus linear-oblong, up to 5 mm long, pointed, hairy at base. Caryopsis linear-oblong.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in sandy and gravelly plains sometimes forming thick populations of its own. Other associates are *Cenchrus biflorus* Roxb., *Indigofera cordifolia* Heyne ex Roth, *Lasiurus scindicus* Henr., etc.

*Specimens examined* : Near Sehmeri, *Monika* 16558 (BSJO); Mathuo-ki-Basti, *Monika* 16741 (BSJO).

2. *Aristida funiculata* Trin. & Rupr. Sp. Gram. Stip. 159. 1842 & in Mem. Acad. Sci. Petersb. ser. 6. 7 : 159. 1843; Hook. f. Fl. Brit. India 7 : 226. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 410. 1960; Bhandari, Fl. Indian Desert 386. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 974. 1993.

Local name : *Lamp.*

Geniculately ascending, tufted annuals, 30-50 cm high. Leaves 10-15 x 0.1-0.2 cm, flat or convolute, ciliate at base; sheaths glabrous; ligule a small, ciliate membrane. Panicles 10-15 cm long, lax; rachis angular. Spikelets green, 1.5-2.5 cm long, with purplish tinge. Lower glume up to 2.5 cm long, linear-lanceolate,

acute, tapering into an awn, 1-nerved; upper glume shorter than the lower glume, up to 2.3 cm long. Lemma 2-4.5 mm long, articulated at the top; column up to 4.5 cm long, twisted. Awn 3-fid; central branch up to 5.5 cm long; lateral ones slightly shorter. Callus conical, pungent.

*Fl. & Fr.*: September – November.

*Ecology* : Common, found mostly in gravelly habitats in association with *Aristida* spp., *Cenchrus ciliaris* L., *Fagonia* spp., etc. Sometimes forms pure formations.

*Specimens examined* : Near Sakro-ki-Basti, *Monika* 16582 (BSJO); Sudasari, *Monika* 16760 (BSJO); Sam, *Shetty* 3449 (BSJO).

3. *Aristida hystricula* Edgew. in J. Linn. Soc. Bot. 6 : 208. 1862; Hook. f. Fl. Brit. India 7 : 227. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 410. 1960; Bhandari, Fl. Indian Desert 388. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 975. 1993.

Local name : *Lamp*.

Tufted, small, erect, annual grass, up to 15 cm high. Leaves 3-4.5 x 0.1-0.25 cm, convolute, curved, glabrous; sheaths 1-2 cm long, glabrous; ligule a small line of hairs. Panicles with slender, erect, capillary branches, 2-4 cm long. Spikelets 1-2 cm long, linear-lanceolate, green with purplish tinge. Lower glume 4-5 mm long, linear-oblong, scarious, with a short awn; upper glume 8-10 mm long, narrowly lanceolate, bifid at the apex, with a small awn. Lemma 2-4 mm long, terete, pubescent, convolute, articulated at the tip; column 1.5-1.8 cm long, twisted. Awn 3-fid; central branch up to 5.5 cm long; lateral ones much shorter, up to 2 cm long. Callus oblong, hairy, 0.5 mm long, bifid.

*Fl. & Fr.*: August – November.

*Ecology* : Common, found in gravelly and rocky habitats in association with *Cenchrus biflorus* Roxb., *Tribulus terrestris* L., etc. Not so abundant as earlier two species.

*Specimens examined* : Near Sam, *Monika* 16593 (BSJO); Near Satto, *Monika* 16642 (BSJO).

4. *Aristida mutabilis* Trin. & Rupr. Sp. Gram. Stip. 150. 1842 & in Mem. Acad. Sci. Petersb. ser. 6, 7 : 150. 1843; Hook. f. Fl. Brit. India 7 : 226. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 411. 1960; Bhandari, Fl. Indian Desert 388. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 977. 1993.

Erect or ascending, tufted, annual grass, 15-50 cm high. Leaves 3-10 x 0.25 cm long, convolute, smooth, rigid, curved; sheaths glabrous, hairy at the mouth, margins membranous. Panicles 8-15 cm long, subcylindrical; rachis smooth. Spikelets 5-6.5 mm long, short-pedicelled, pale green. Lower glume 4-5 mm long, scabrous on keel, shortly awned; upper glume up to 6 mm long, 2-toothed at tip, awned. Lemma 3-5 mm long, 3-nerved, terete, scabrid at the top; column up to 5 mm long. Awn 3-fid, up to 3 cm long; central branch slightly longer than lateral ones. Callus shortly bearded.

*Fl. & Fr.*: September – December.

*Ecology* : Rare, found in sandy plains, mixed with other grasses.

*Specimen examined* : DNP, *Pandey* 7858 (BSJO).

2. *BRACHIARIA* Griseb.

- |   |   |
|---|---|
| 1a. Spikelets approximate; the distance up to 1.5 mm. | 2   |
| 1b. Spikelets distant; the distance 1-2 cm.           | 1. <i>B. kurzii</i>                       |
| 2a. Spikelets glabrous.                               | 2. <i>B. ramosa</i> var. <i>ramosa</i>    |
| 2b. Spikelets pubescent.                              | 3. <i>B. ramosa</i> var. <i>pubescens</i> |

1. *Brachiaria kurzii* (Hook. f.) A. Camus in Lecomte, Fl. Gen. de l'Indo Chine 7 : 438. 1922; Bor. Grass. Burm. Ceyl. Ind. Pak. 283. 1960; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 989. 1993. *Panicum kurzii* Hook. f. Fl. Brit. India 7 : 38. 1896.

Erect or decumbent, annual grass, up to 40 cm high, often rooting at lower nodes. Leaves 4-8 x 0.7-1.5 cm, lanceolate, acuminate at apex, amplexicaul at base, margins crisped in upper half; ligule shortly bearded. Spikes 3-7.5 cm long; pedicels shorter than the spikelets. Spikelets distant, the distance 1-2 cm, *ca* 2.5 mm long, ovate, acute, glabrous, shiny. Lower glume clasping, distinctly 3 to 5-nerved, reaching up to the half of the length of spikelets. Upper lemma 2-2.5 mm long, elliptic-oblong, rugose, apiculate.

*Fl. & Fr.*: August-November.

*Ecology*: Very rare, found in moist sandy plains in shady places.

*Specimen examined*: Near Meluo-ki-Basti, *Monika* 16744 (BSJO).

*Notes*: This species was reported by Sarup (1951), Vyas (1967) and Wadhwa during sixties from Rajasthan. After a long period of about 40 years, it is being reported from Desert National Park.

2. *Brachiaria ramosa* (L.) Stapf in Prain, Fl. Trop. Africa 9 : 542. 1919; Bor. Grass. Burm. Ceyl. Ind. Pak. 284. 1960; Bhandari, Fl. Indian Desert 391. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 990. 1993. *Panicum ramosum* L. Mant. Pl. 1 : 29. 1767; Hook. f. Fl. Brit. India 7 : 36. 1896, *pro parte*.

var. *ramosa*

Local name : *Murat, Makra*.

Tufted, ascending, annual grass, 40-60 cm high, often rooting at lower nodes. Leaves 5-15 x 0.5-1.5 cm, linear-lanceolate, flat, acuminate at apex, rounded at base, glabrescent, scabrous on margins; sheaths finely striated, glabrous except with few marginal cilia towards the mouth; ligule a hairy line. Racemes 3-5, arranged in 5-15 cm long panicles, each raceme up to 5 cm long; rachis triquetrous or slightly flattened, glabrous; pedicels filiform, angular. Spikelets proximate, the distance up to 1.5 mm. *ca* 3 mm long, ovoid, apiculate, alternate or paired. Lower glume *ca* 1.5 mm long, 3 to 7-nerved, ovate, obtuse; upper one membranous, 7-nerved. Upper lemma crustaceous, transversely rugose, subacute. Palea brown. Caryopsis 1.5-2 mm long, elliptic, slightly flattened.

*Fl. & Fr.*: August - October.

*Ecology*: Occasional, found in wet sandy plains, prefers rather shady habitats.

*Specimen examined*: Berisiyala, *Pandey* 7868 (BSJO).

3. *Brachiaria ramosa* (L.) Stapf var. *pubescens* Basappa & Muniyamma in Proc. Indian Nat. Sci. Acad. Part B 49 (5) : 380. 1983; Pandey & Singh in Journ. Econ. Taxon. Bot. 7 : 234. 1985; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 990. 1993.

Tufted, ascending, annual grass, often rooting at lower nodes, up to 40 cm high. Leaves 7-15 x 0.4-1.6 cm, linear-lanceolate, acuminate at apex, puberulous on both surfaces; ligule bearded. Spikelets pubescent, otherwise as in type variety.

*Fl. & Fr.*: August- November.

*Ecology* : Rare, found in moist sandy plains growing with proper variety.

*Specimen examined* : Near Miajlar, *Monika* 16800 (BSJO).

*Notes*: This variety is considered to be endemic to Karnataka. Pandey & Singh (*l.c.*) reported it from desertic zones of W. Rajasthan; it's extended distribution is further confirmed by it's collection from DNP.

### 3. *CENCHRUS* L.

- |  |                        |
|--|------------------------|
| 1a. Bristles of involucre retrorsely scabrid, tenaciously prickly.   | 1. <i>C. biflorus</i>  |
| 1b. Bristles of involucre antorsely scabrid, not prickly.  | 2                      |
| 2a. Bristles connate above the base into a 2-3 mm long cup.  | 4. <i>C. setigerus</i> |
| 2b. Bristles united only at the base to form a shallow disc.   | 3                      |
| 3a. Annual grass. Involucre with a wide connate base; inner bristles stout at base; outer ones ca 2 cm long, creamish.   | 3. <i>C. prieurii</i>  |
| 3b. Perennial grass. Involucre with small, elliptic base; inner bristles not very stouter at base; outer ones up to 1.5 cm long, greenish with purplish tinge. | 2. <i>C. ciliaris</i>  |

1. *Cenchrus biflorus* Roxb. Fl. Ind. 1 : 238. 1820; Hook. f. Fl. Brit. India 7 : 89. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 287. 1960; Bhandari, Fl. Indian Desert 392. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 993. 1993. *C. catharticus* Delile, Cat. Hort. Monsp. 1838 : 4. 1839; Hook. f. *l.c.* 7 : 90. 1896.

Local name : *Bhurat*.

Erect or geniculately ascending, annual grass. 20-70 cm high. Leaves 6-30 x 0.2-0.6 cm, linear-lanceolate, scabrid, acuminate; sheaths glabrous; ligule a densely ciliate rim. Inflorescence a cylindric, spiciform, dense panicle up to 15 cm long, tinged with purple; rachis angular. Involucre subsessile; bristles numerous, united at base into a shallow disc; outer row of shorter, retrorsely scabrid, hook-like bristles; inner subequal, subulate, inside margins ciliolate, retrorsely scabrid above. Spikelets usually 2 in each involucre, each 3-5 mm long, sessile. Lower glume 2-2.5 mm long, lanceolate, hyaline; upper one 4-4.5 mm long, ovate, hyaline, 1 to 5-nerved. Lower lemma ovate, acuminate; upper one equalling the lower, cuspidately acuminate, membranous. Caryopsis ca 2.5 mm long, elliptic-oblong, rugulose (Fig.-23).

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in sandy plains forming pure formations or associated with *Aristida* spp., *Indigofera cordifolia* Heyne ex Roth, etc.

*Specimens examined* : Sam, *Monika* 16554 (BSJO); Tejaraon, *Monika* 16679 (BSJO); Ganga, Pandey 7811 (BSJO).

2. *Cenchrus ciliaris* L. Mant. Alt. 302. 1771; Bor, Grass. Burm. Ceyl. Ind. Pak. 287. f. 33. 1960; Bhandari, Fl. Indian Desert 393. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 994. 1993. *Pennisetum*

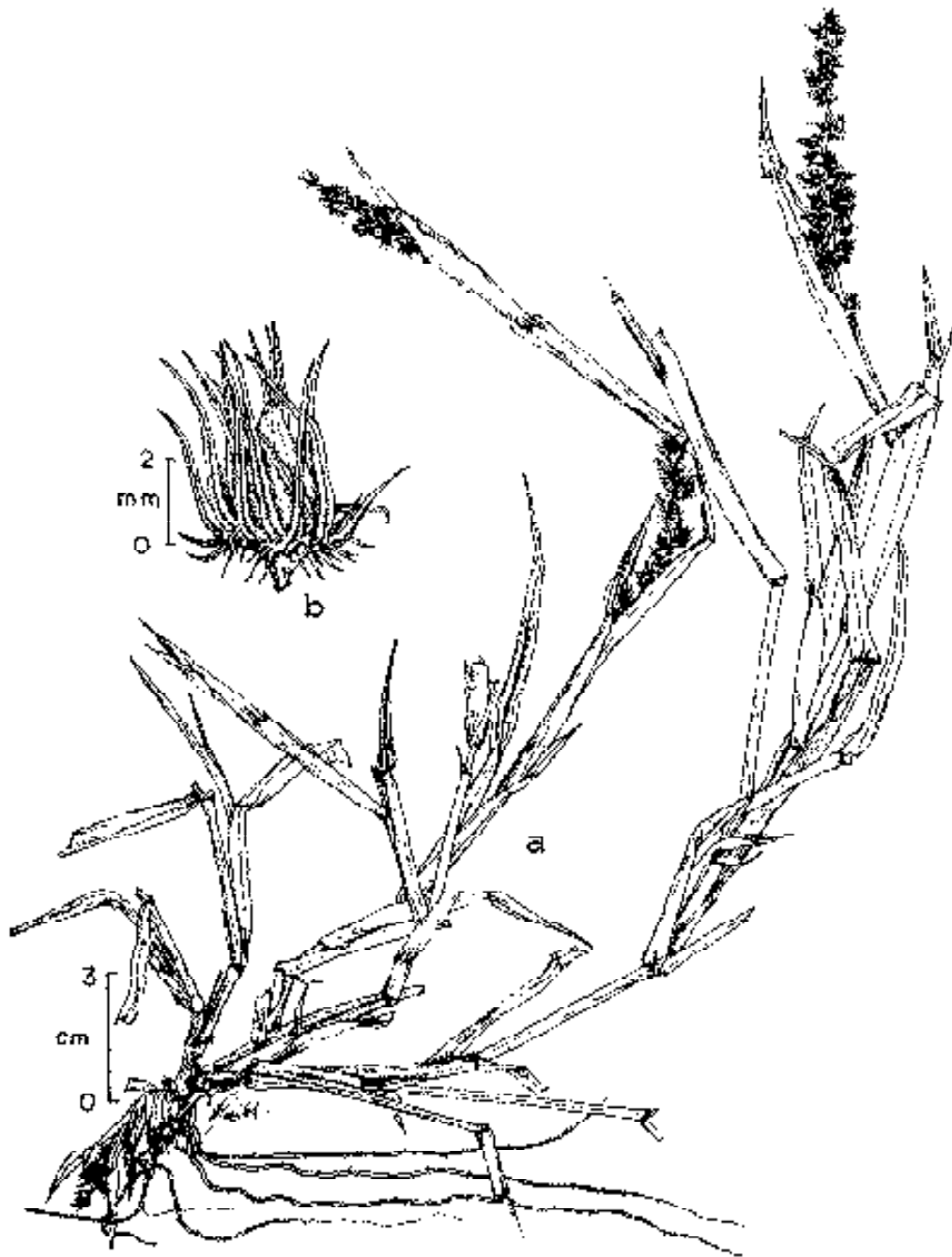


Fig. 23. *Cenchrus biflorus* Roxb. : a. Habit, b. Involucre with spikelets.

*cenchroides* Rich. in Pers. Syn. Pl. 1 : 72. 1805; Hook. f. Fl. Brit. India 7 : 88. 1896. *P. ciliare* (L.) Link, Hort. Berol. 1 : 213. 1827.

Local name : *Dhaman*.

Tufted, rigid, erect or ascending perennial grass, with rather woody, nodose root-stock, up to 1 m or more high. Leaves 10-25 x 0.2-0.5 cm, linear, flat, glabrous or sparsely hairy with tubercle-based stiff hairs, convolute when dry; sheaths scabridulous; ligule a ciliate rim. Panicles up to 8 cm long, purple, subcylindrical; rachis puberulous, angular. Involucre subsessile; bristles numerous, up to 10 mm long; the outer row slender, scabridulous; inner ones thickened, flattened, connate towards base into a disc, ciliate with spreading, tubercle-based hairs. Spikelets 1-4 in each involucre, 4-5 mm long, oblong-lanceolate. Lower glume 2.2-2.5 mm long, ovate-lanceolate, faintly 1-nerved; upper one ca 3 mm long, ovate, acuminate. Lower lemma male or rarely hermaphrodite, 4-4.5 mm long, ovate-lanceolate, 3 to 5-nerved; upper same as the lower, membranous. Caryopsis 1.5-2 mm long, oblong, truncate.

*Fl. & Fr.*: August – December.

*Ecology* : Most common grass of the area, found in sandy plains and on small stabilized dunes. The main associates are *Indigofera cordifolia* Heyne ex Roth among legumes and *Lasiurus scindicus* Henr. among grasses.

*Specimens examined* : Near Daw, Monika 16536 (BSJO); Sam, Monika 16604 (BSJO); Kanoi, Pandey 7880 (BSJO).

3. *Cenchrus prieurii* (Kunth) Maire in Bull. Mus. Hist. Nat. Paris ser. 2. 3 : 523. 1931; Bor, Grass. Burm. Ceyl. Ind. Pak. 290. 1960; Bhandari, Fl. Indian Desert 394. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 995. 1993. *Pennisetum prieurii* Kunth, Rev. Gram. 2 : 411. t. 119. 1831; Hook. f. Fl. Brit. India 7 : 89. 1896.

Local name : *Lambio-bhurat*.

Glabrous, geniculately ascending, annual grass, 30-50 cm high. Leaves 8-25 x 0.3-0.8 cm, linear, acute, flat, scabridulous on lower surface, scabrid on nerves; sheaths scabridulous; ligule a ciliate rim. Panicles 6-15 cm long, cylindric, purplish; rachis angular, scabridulous on angles. Involucre elongate, shortly pedunculate; bristles numerous, connate at base into an elliptic disc; outer bristles 9-10 mm long, erect, slender, scabridulous; inner stouter, ciliate inside towards base, subequal. Spikelets 1-2 in each involucre, 3.5-4 mm long, sessile, ovate, acuminate, glabrous. Lower glume 2.5-3 mm long, lanceolate, obtuse, 1-nerved, hyaline; upper one ca 3.5 mm long, ovate, obtuse, 3 to 5-nerved. Lower lemma barren; upper one 3.5-4 mm long, ovate, acuminate, hermaphrodite, 5-nerved. Caryopsis 2-3 mm long, elliptic-oblong.

*Fl. & Fr.*: August – November.

*Ecology* : Common, found in sandy plains in association with *Cenchrus biflorus* Roxb., *Eragrostis ciliaris* (L.) R. Br., *Indigofera cordifolia* Heyne ex Roth, etc.

*Specimens examined* : Sam, Monika 16604 (BSJO); Miajlar, Pandey 7904 (BSJO).

4. *Cenchrus setigerus* Vahl, Enum. Pl. 2 : 395. 1805; Bor, Grass. Burm. Ceyl. Ind. Pak. 290. 1960; Bhandari, Fl. Indian Desert 395. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 996. 1993. *C. biflorus* auct. non Roxb. 1820; Hook. f. Fl. Brit. India 7 : 89. 1896.



Local name : *Dhaman*.

Erect or geniculately ascending, perennial grass, 20-65 cm high, with stout root-stock; stem glabrous or slightly scabrid at the base of inflorescence. Leaves 8-22 x 0.3-0.8 cm, linear-lanceolate, acuminate, scabridulous; sheaths compressed, keeled, mouth bearded; ligule a short hairy rim. Panicles up to 10 cm long, greenish with purple tinge, cylindric, solitary; rachis angular. Involucre cup-shaped, subsessile, 2 to 3-flowered; bristles connate into a cup; outer 2-2.5 mm long, glabrous; inner ca 3 mm long, puberulent, antrorsely scabrid. Spikelets 3-4 mm long, sessile, ovate, subacute. Lower glume 2.3-2.5 mm long, ovate, subacute, 1-nerved, hyaline; upper one ca 3.5 mm long, 5-nerved. Lower lemma barren or male, 5 to 7-nerved, ovate, paleate; upper one hermaphrodite, ovate, obtuse. Palea 2.5 mm long, oblong, obtuse. Caryopsis 2-3 mm long, oblong, truncate, smooth, shining, pale brown.

*Fl. & Fr.*: August – November.

*Ecology* : Occasional, found usually in sandy plains and sometimes in gravelly soils in association with *Cenchrus biflorus* Roxb., *Indigofera cordifolia* Heyne ex Roth, etc.

*Specimen examined* : DNP, Tiwari 893 (BSJO).

#### 4. *CHLORIS* Sw.

*Chloris barbata* Sw. Fl. Ind. Occ. 1 : 200. 1797; Hook. f. Fl. Brit. India 7 : 292. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 465. 1960; Bhandari, Fl. Indian Desert 396. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 998. 1993. *Andropogon barbatus* L. Mant. Pl. Alt. 302. 1771, non L. 1759.

Local name : *Choto-armio*.

Tufted, geniculately ascending perennial grass, up to 1 m high; internodes 6-10 cm long, terete, glabrous. Leaves 20-35 x 0.2-0.3.5 cm, flat, linear, acuminate; sheaths glabrous; ligule membranous. Spikes 4-20, digitate, with blackish-purple tinge. Spikelets 2-2.5 x 1-1.5 mm, plump, 3-flowered, 3-awned. Lower glume 1.2-1.5 mm long, lanceolate; upper one slightly longer than the lower. Lower lemma up to 2.5 mm long, ovate-elliptic, ciliate, awned; upper lemma reduced to clavate scale, awned; awn 3-4 mm long. Empty lemma above the fertile floret 2-4. Palea oblong, equalling the glume. Caryopsis 1.5-2 mm long, oblong, compressed, smooth.

*Fl. & Fr.*: July – September.

*Ecology* : Occasional, found in sandy plains among the thickets of bushes, often in association with *Cenchrus biflorus* Roxb., *Tribulus terrestris* L., etc.

*Specimen examined* : Near Daw, Monika 16790 (BSJO).

#### 5. *CYMBOPOGON* Spreng.

*Cymbopogon jwarancusa* (Jones) Schult. Syst. Veg. Mant. 2 : 458. 1824; Bor, Grass. Burm. Ceyl. Ind. Pak. 128. 1960; Bhandari, Fl. Indian Desert 399. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1009. 1993. *Andropogon jwarancusa* Jones in Asiat. Res. 4 : 109. 1795; Hook. f. Fl. Brit. India 7 : 203. 1896.

Erect or geniculately ascending, densely tufted, perennial grass, up to 1.5 m high; roots aromatic. Leaves 10-25 x 0.2-0.5 cm, flat, linear, tip filiform, base narrowed; basal sheaths coiled; ligule membranous,

up to 1 mm long. Panicles 15-40 cm or more long, spatulate. Racemes 1.5-2.8 cm long. Spikelets 3-4 pairs, half hidden by 5 mm long villi on joints and pedicels. Sessile spikelets 4-5 mm long, linear-lanceolate, hermaphrodite, awned; lower glume flat, scabrid, 2 to 4-nerved. Pedicelled spikelets ca 5.5 mm long, male, oblong-elliptic, acuminate; lower glume 7 to 9-nerved.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in sandy plains in grasslands of *Cenchrus* spp. and *Lasiurus scindicus* Hent. forming scattered patches.

*Specimens examined* : Near Sudasari, *Monika* 16576 (BSJO); Near Khuri, *Monika* 16785 (BSJO).

#### 6. *DACTYLOCTENIUM* Willd.

- 1a. Annual grass. Spikes 2-5 cm long. Anthers less than 1 mm long. Caryopsis coarsely transversely rugose.  
1. *D. aegyptium*
- 1b. Perennial grass. Spikes 0.5-2 cm long. Anthers more than 1 mm long. Caryopsis finely granulate.  
2. *D. scindicum*

1. *Dactyloctenium aegyptium* (L.) Willd. Enum. Hort. Berol. 1029. 1809; Bor, Grass. Burm. Ceyl. Ind. Pak. 489. f. 54. 1960; Bhandari, Fl. Indian Desert 401. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1012. 1993. *Cynosurus aegyptius* L. Sp. Pl. 72. 1753. *Eleusine aegyptia* (L.) Desf. Fl. Atlant. 1 : 85. 1798; Hook. f. Fl. Brit. India 7 : 295. 1896.

Geniculately ascending, annual grass, 20-60 cm high; stem stoloniferous, often rooting at lower nodes, glabrous. Leaves 7-20 x 0.2-0.6 cm, linear, acute, flat, hairy, ciliate with bulbous-based hairs, tapering into a fine point; ligule a ring of white hairs. Spikes 2-6, digitate, 3-6 cm long; rachis trigonous, rigid, excurrent into a pungent, ca 2 mm long mucro. Spikelets many, spreading at right angle to rachis, 3 to 5-flowered, 3-4 mm long. Glumes divaricate; lower glume ca 2.5 mm long, ovate, acute; upper equal to the lower, suborbicular, midrib terminating into a recurved awn. Lemma ca 3 mm long, gibbously ovate, mucronate or awned. Caryopsis subglobose, ca 1 mm in diam., rugose, reddish-brown (Fig.-24).

*Fl. & Fr.*: July – October.

*Ecology* : Common, found in sandy soils along the roads and in wastelands. It usually creeps on the ground and forms a carpet with *Tribulus terrestris* L.

*Specimen examined* : Near Ganga, *Monika* 16567 (BSJO).

2. *Dactyloctenium scindicum* Boiss. Diagn. Pl. Orient. ser. 2. 4 : 131. 1859; Bor, Grass. Burm. Ceyl. Ind. Pak. 489. 1960; Bhandari, Fl. Indian Desert 402. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1013. 1993. *Eleusine aristata* Ehrenb. ex Boiss. Fl. Orient. 5 : 557. 1884; Hook. f. Fl. Brit. India 7 : 296. 1896. *E. scindica* (Boiss.) Duthie, Illus. Indig. Fodd. Grass. pl. 36. 1886 & Fodd. Grass. N. India 58. 1888.

Local name : *Tantia-ghas*.

Profusely branched, creeping, stoloniferous perennial grass, 20-40 cm high, rooting at distant, thickened, villous, woody nodes; culms tomentose with long hairs. Leaves 4-10.5 x 0.1-0.5 cm, linear, acute, loosely

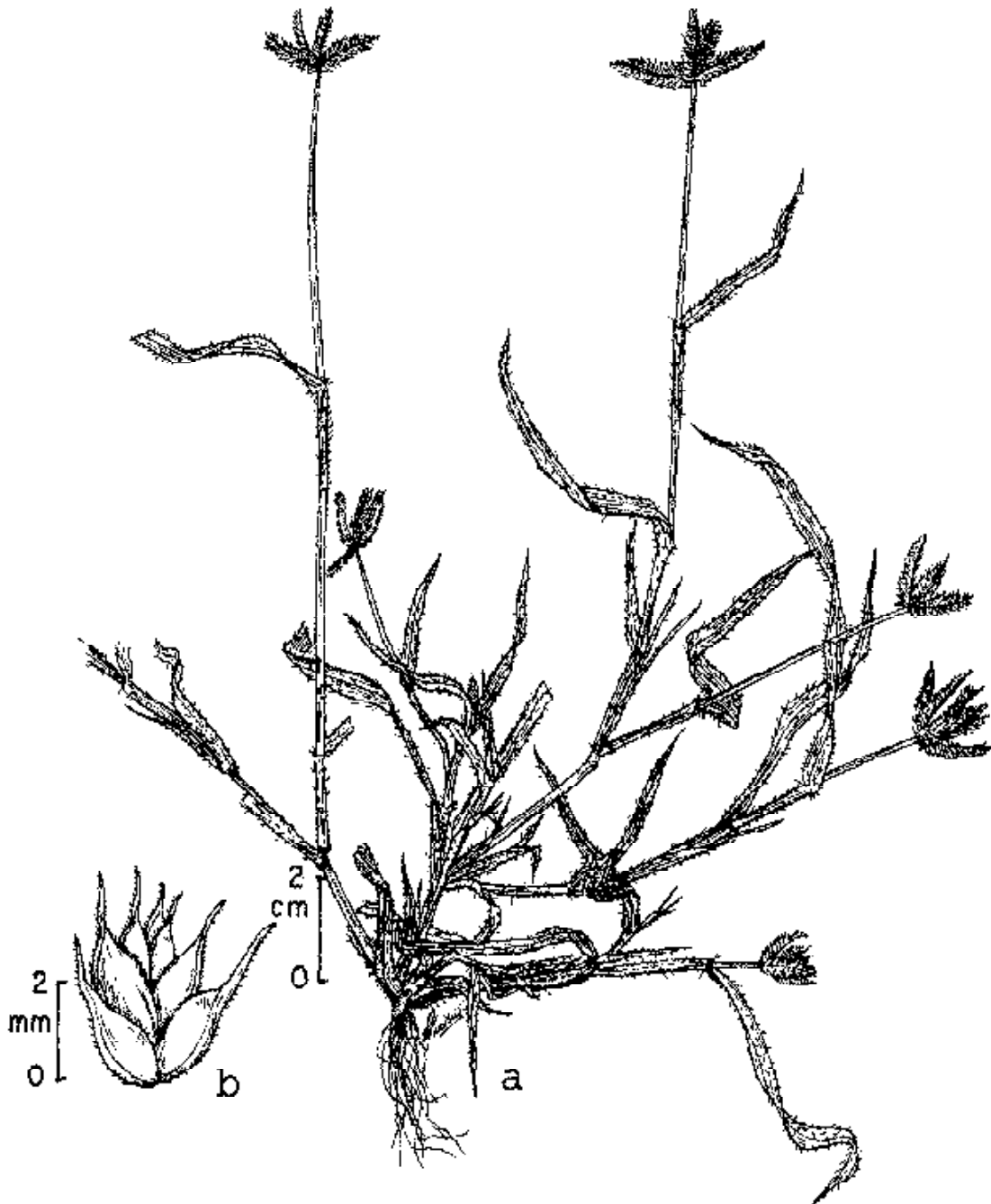


Fig. 24. *Dactyloctenium aegyptium* (L.) Willd. : a. Habit, b. Spikelets.

folded, glaucous, sparsely hairy, margins ciliate with bulbous-based hairs; sheaths sparsely hairy; ligule a fringe of hairs. Spikes 3-4, digitate, often recurved after drying, bearded at the base, each up to 2 cm long; rachis tip excurrent into a pungent, ca 2 mm long mucro. Spikelets 3-3.5 mm long, 3 to 9-flowered. Lower glume ca 2 mm long, ovoid, tipped with an arista, keel narrowly winged; upper one ovate, ca 2.5 mm long, with 0.5 mm long, 1-nerved arista and ciliate keel. Lemma ca 3 mm long, ovate, membranous with a strong mid-nerve and weak lateral nerves, acute, cuspidate, glabrous, keeled. Palea with scabrous keel. Caryopsis 0.7-1 mm long, ovoid, rugose, brown, granulate.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in extremely dry sandy plains forming mats on the ground with *Tribulus terrestris* L. and *Indigofera cordifolia* Heyne ex Roth.

*Specimens examined* : Meluo-ki-Basti, Monika 16588 (BSJO); Sudasari, Pandey 7840 (BSJO).

#### 7. *DESMOSTACHYA* Stapf

*Desmostachya bipinnata* (L.) Stapf in Dyer, Fl. Cap. 7 : 632. 1900; Bor, Grass. Burm. Ceyl. Ind. Pak. 491. 1960; Bhandari, Fl. Indian Desert 402. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1015. 1993. *Briza bipinnata* L. Syst. Nat. ed. 10. 2 : 875. 1759. *Poa cynosuroides* Retz. Obs. Bot. 4 : 20. 1786. *Eragrostis cynosuroides* (Retz.) P. Beauv. Ess. Agrost. 162. 1812; Hook. f. Fl. Brit. India 7 : 324. 1896.

Local name : *Dab*.

Erect, tufted, rhizomatous perennial grass, ca 1 m high, with stout root-stock. Leaves 20-50 x 0.3-0.9 cm; basal leaves fascicled, acuminate, rigid, hispid on margins; sheaths glabrous, densely flabellate; ligule a hairy line. Panicles 15-45 cm long, narrowly pyramidal, often interrupted; rachis puberulent. Spikes 1.5-3.5 cm long, clustered. Spikelets sessile, biseriate, linear-oblong, pale brown, ca 1.5 cm long, shining, 20 to 30-flowered, deflexed. Glumes very unequal; lower glume 0.4-0.5 mm long; upper one 1.5-1.6 mm long, obtuse. Lemma 1.5-2 mm long, ovate, acute, coriaceous, straw-coloured. Palea shorter than its glume, with minutely scabrid keel. Caryopsis 0.5-0.6 mm long, obliquely ovoid, laterally compressed, obscurely trigonous, brown.

*Fl. & Fr.*: August – November.

*Ecology* : Rare, found in sandy plains. The rhizomes which develop in all directions from the scaly root-stock play vital role in soil binding.

*Specimen examined* : DNP, Tiwari 905 (BSJO).

#### 8. *DICHANTHIUM* Willemet

- |   |                         |
|---|-------------------------|
| 1a. Inflorescence a solitary raceme, spatheate. Lower glume with a pit in the lower half. | 2. <i>D. joveolatum</i> |
| 1b. Inflorescence of digitate or subdigitate racemes, not spatheate. Glumes not pitted.   | 1. <i>D. annulatum</i>  |

1. *Dichanthium annulatum* (Forssk.) Stapf in Prain, Fl. Trop. Africa 9 : 178. 1917; Bor, Grass. Burm. Ceyl. Ind. Pak. 133. 1960; Bhandari, Fl. Indian Desert 403. 1978; Deshpande, Fl. India Fasc. 15 : 5. f. 1-2. 1984; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1017. 1993. *Andropogon annulatus* Forssk. Fl. Aegypt.-Arab. 173. 1775; Hook. f. Fl. Brit. India 7 : 196. 1896.

Densely tufted, erect or ascending perennial grass, up to 1.5 m high; nodes densely bearded. Leaves 15-25 x 0.2-0.7 cm, linear-lanceolate, acuminate, glabrous or more or less sparsely hairy with bulbous-based hairs, scabrid on margins; sheaths terete, striate, bearded at tip; ligule membranous, ca 2.5 mm long, oblong, obtuse, glabrous. Racemes 2-10, 3-7.5 cm long, digitate or subdigitate; rachis filiform. Sessile spikelets 3-4.5 mm long, elliptic-oblong, imbricating; callus shortly hairy at base; lower glume oblong, with bulbous-based hairs on the keel, chartaceous, hairy from middle upwards to the truncate apex, margins narrowly incurved; upper glume as long as lower glume, lanceolate, subacute, 3-nerved; lower lemma linear-oblong, nerveless, glabrous; upper one represented by flattened, scabrid, slender awn. Pedicelled spikelets 3-5 mm long, awned; pedicel as long as or more than half as long as sessile spikelet; lower glume elliptic, oblong, 7 or more-nerved, keel bristly; upper glume ciliate; lemma small.

*Fl. & Fr.*: August – December.

*Ecology* : Common, found in sandy and gravelly plains among thickets of bushes and scattered in grasslands.

*Specimen examined* : Near Ganga, Monika 16620 (BSJO).

2. *Dichanthium foveolatum* (Del.) Roberty in Boissiera 9 : 170. 1960; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1019. 1993. *Andropogon foveolatus* Del. Fl. d' Egypt. 16. t. 8. f. 2. 1812; Hook. f. Fl. Brit. India 7 : 168. 1896. *A. strictus* Roxb. Fl. Ind. 1 : 260. 1832. *Eremopogon foveolatus* (Del.) Stapf in Prain, Fl. Trop. Africa 9 : 183. 1917; Bor, Grass. Burm. Ceyl. Ind. Pak. 148. 1960; Bhandari, Fl. Indian Desert 417. 1978. *E. strictus* (Roxb.) A. Camus in Ann. Soc. Linn. Lyon. (n.s.) 68 : 208. 1921.

Local name : *Rohis*.

Erect or ascending, tufted perennial grass, 30-70 cm high; stem geniculately ascending, bearded and with purplish tinge on nodes. Leaves 7-15 x 0.1-0.2 cm, linear, acute, sparsely ciliate near base, minutely puberulent; basal sheaths silky-villous, whitish; ligule truncate, ciliate, hyaline. Racemes 3-4 cm long, solitary; peduncles capillary; joints and pedicels slender, ciliate on two opposite sides with silky hairs. Sessile spikelets ca 4 mm long, lanceolate; callus short, bearded; lower glume 3.5-4 mm long, lanceolate-oblong, flat, 4-nerved, with deep circular pit in the upper half; upper glume 3.5-4 mm long, oblong, ciliate, obtuse, 3-nerved; lower lemma nerveless; upper lemma reduced to a awn, scabridulous. Pedicelled spikelets with 2-5 mm long pedicels; lower glume ca 3 mm long, lanceolate, acute, pitted, 5-nerved, margins slightly incurved; upper one linear-lanceolate, 3-nerved, as long as lower.

*Fl. & Fr.*: August – December.

*Ecology* : Rare, found in rocky and gravelly habitats among the thickets of *Euphorbia caducifolia* Haines.

*Specimen examined* : DNP, Shetty 3443 (BSJO).

### 9. *DIGITARIA* Haller (*nom. cons.*)

*Digitaria ciliaris* (Retz.) Koel. Descr. Gram. 27. 1802; Bhandari, Fl. Indian Desert 404. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1025. 1993. *Panicum ciliare* Retz. Obs. Bot. 4 : 16. 1786. *P. adscendens* H. B. & K. Nov. Gen. Sp. Pl. 1 : 97. 1816. *Digitaria fimbriata* Link, Hort. Berol. 1 : 226. 1827. *D. adscendens* (H. B. & K.) Henr. in Blumea 1 : 92. 1934; Bor, Grass. Burm. Ceyl. Ind. Pak. 298. 1960.

*D. adscendens* (H. B. & K.) Henr. var. *fimbriata* (Link) Cuf. in Bull. Jard. Bot. Etat. Brux. 39 (Suppl.) : 1327. 1969.

Local name : *Jharanio*.

Erect or geniculately ascending annual grass, up to 1 m high, often rooting at lower nodes. Leaves 7-22 x 0.2-0.9 cm, linear-lanceolate, acuminate, rounded at base, flat, margins scabridulous, surface sparsely hairy; sheaths glabrous; ligule membranous, ca 2.5 mm long, more or less lacerate. Racemes 3-9, 4-20 cm long, subdigitate; rachis triquetrous, narrowly winged. Spikelets 2-nate, 3-3.5 mm long, elliptic-lanceolate or oblong-lanceolate, acute, bearded; two pedicels at a node connate at base, one longer up to 1.5 cm long, other 0.5-0.7 cm long. Lower glume 2-3.5 mm long, scaly, triangular; upper glume 2-2.5 mm long, membranous, 3-nerved. Lower lemma as long as the spikelet, ovate-oblong, acute, membranous, 5 to 7-nerved, appressed puberulous, silky pubescent; upper lemma subchartaceous. Stamens 3. Caryopsis 2.5-3 mm long, ellipsoid, brown, glabrous.

*Fl. & Fr.*: August - October.

*Ecology* : Common, found in sandy plains and gravelly to rocky habitats among the thickets of bushes.

*Specimen examined* : Near Sudasari, *Monika* 16693 (BSJO).

#### 10. *ECHINOCHLOA* P. Beauv. (*nom. cons.*)

*Echinochloa colona* (L.) Link, Hort. Berol. 2 : 209. 1833; Bor, Grass. Burm. Ceyl. Ind. Pak. 308. f. 34. 1960; Bhandari, Fl. Indian Desert 406. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1033. 1993. *Panicum colonum* L. Syst. Nat. ed. 10. 2 : 870. 1759; Hook. f. Fl. Brit. India 7 : 32. 1896.

Local name : *Jiria*.

Erect or geniculately ascending, slender, annual grass, 30-80 cm high; stem hairy at nodes, often rooted at lower nodes. Leaves 10-20 x 0.2-0.7 cm, linear, flat, acuminate, glabrescent or margins scabridulous, marked by a purplish-brown band at the junction of the blade and sheath; sheaths up to 5 cm long, striate, keeled; ligule absent. Spikes 9-20, suberect or appressed to the axis, 2-2.5 cm long, arranged racemosely; rachis angular, scabridulous on angles. Spikelets 2-2.5 mm long, ovoid-ovate or obovate-elliptic, acute, more or less pubescent, secund. Lower glume ca 1 mm long, ovate or suborbicular, membranous, 5-nerved; upper glume 1.5-2 mm long, broadly ovate, concave, 5-nerved, hairy. Lower lemma similar, empty, with hyaline palea; upper lemma broadly ovate, turgid, coriaceous. Caryopsis 1-1.5 mm long, plano-convex, elliptic, reddish brown.

*Fl. & Fr.*: September - November.

*Ecology* : Rare, found in moist and marshy habitats on the margins of tanks in association with sedges.

*Specimen examined* : Near Singhdar, *Monika* 16674 (BSJO).

#### 11. *ELYONURUS* Humb. & Bonpl. ex Willd.

*Elyonurus royleanus* Nees ex A. Rich. Tent. Fl. Abyss. 2 : 471. 1851; Hook. f. Fl. Brit. India 7 : 161. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 145. 1960; Bhandari, Fl. Indian Desert 408. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1036. 1993.

Geniculate ascending, annual grass, 15-25 cm high, slightly pubescent just below the nodes, otherwise internodes glabrous. Leaves 4-10 x 0.4-1.2 cm, linear-lanceolate, rigid, acute to acuminate, green, brick-red on maturity, glabrescent; ligule a short membrane, ciliolate. Racemes 2-5 cm long, erect, enclosed by sheath, pale green tinged with purple; joints densely bearded with whitish, long, silky hairs. Sessile spikelets 9-12 mm long; callus 0.5-0.8 mm long, densely bearded. Lower glume ca 12 mm long, with 3-5 mm long reddish-purple-coloured, bifid beak, linear, ciliate-margined with purple tubercles; upper glume membranous, linear-lanceolate, acuminate, 1-nerved. Lower lemma glabrous, oblong, acute, nerveless; upper lemma oblong, obtuse. Pedicelled spikelets with ca 2.5 mm long pedicels. Lower glume 8-9 mm long, linear, with a narrow beak; upper glume ca 5 mm long, lanceolate, membranous, awned.

*Fl. & Fr.*: August - November.

*Ecology* : Rare, found in rocky and gravelly habitats in association with *Enneapogon desvauxii* P. Beauv., *Fagonia schweinfurthii* (Hadidi) Hadidi ex Ghafoor, etc.

*Specimen examined* : Sudasari, Monika 16575 (BSJO).

## 12. ENNEAPOGON Desv. ex P. Beauv.

*Enneapogon desvauxii* P. Beauv. Ess. Agrost. 82. t. 16/11. 1812; Pandey in Shetty & Singh. Fl. Rajasthan 3 : 1037. 1993. *Pappophorum brachystachyum* Jaub. & Spach in Ann. Sci. Nat. Bot. ser. 3. 14 : 365. 1850 & in Illus. Pl. Or. 4 : 34. t. 324. 1851; Hook. f. Fl. Brit. India 7 : 302. 1896. *Enneapogon brachystachyus* (Jaub. & Spach) Stapf in Dyer, Fl. Cap. 7 : 654. 1900; Bor, Grass. Burm. Ceyl. Ind. Pak. 608. f. 70/2. 1960; Bhandari, Fl. Indian Desert 409. 1978.

Erect, tufted perennial grass, 20-40 cm high; stem filiform, caespitose, villous at nodes. Leaves 5-10 x 0.2-0.35 cm, linear-filiform, convolute, acute; sheaths 2-2.5 cm long, pubescent; ligule a short rim of hairs. Panicles 2.5-5 cm long, steel-grey, compact, ovate-oblong in outline. Spikelets 2 to 3-flowered, 3-4.5 mm long, awned, pedicelled. Lower glume 2-4.5 mm long, ovate-lanceolate, ciliate on margins and keel, 3 to 5-nerved; upper glume as long as lower, ovate-lanceolate, 3 to 5-nerved, margins hyaline, softly pubescent outside. Lemma ca 1.5 mm long, villous at base, awned; all awns more or less equal in length, shortly ciliate. Palea slightly shorter than lemma, shortly ciliate on the keel. Caryopsis ca 1.5 mm long, ovoid, smooth, shining brown.

*Fl. & Fr.*: August - December.

*Ecology* : Common, found in gravelly and rocky habitats. Main associates are *Fagonia schweinfurthii* (Hadidi) Hadidi ex Ghafoor, *Tragus roxburghii* Panigrahi, etc.

*Specimen examined* : Near Berisiyala, Monika 16702 (BSJO).

## 13. ERAGROSTIS M. N. Wolf

- |   |                       |
|---|-----------------------|
| 1a. Spikelets breaking up from above downwards at maturity; rachis fragile. | 2                     |
| 1b. Spikelets breaking up from below upwards; rachis tough.                 | 4                     |
| 2a. Keels of palea ciliate.   | 3                     |
| 2b. Keels of palea not ciliate, but scabrid or smooth.                      | 3. <i>E. japonica</i> |
| 3a. Panicles spiciform, more or less interrupted.                           | 2. <i>E. ciliaris</i> |

- 3b. Panicles effuse. **1. *E. amabilis***
- 4a. Lower branches of panicles fascicled or sub-whorled, with pitted glands just above and below the lowest node, and also with glandular bands below the culm-nodes. Palea deciduous. **5. *E. pilosa***
- 4b. Lower branches of panicles not whorled; glandular bands below the culm-nodes absent. Palea persistent. **4. *E. minor***

1. *Eragrostis amabilis* (L.) Wight & Arn. in Hook. & Arn. Bot. Buchey Voy. 251. 1833; Uma & Daniel J. Econ. Taxon. Bot. 22 (1): 211. 1998. *Poa amabilis* L. Sp. Pl. 68. 1753. *Poa tenella* L. Sp. Pl. 69. 1753. *P. plumosa* Retz. Obs. Bot. 4 : 20. 1786. *Eragrostis tenella* (L.) P. Beauv. ex Roem. & Schult. Syst. Veg. 2 : 576. 1817; Stapf in Hook. f. Fl. Brit. India 7 : 315. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 513. 1960; Bhandari, Fl. Indian Desert 415. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1051. 1993. *E. tenella* (L.) P. Beauv. ex Roem. & Schult. var. *plumosa* (Retz.) Stapf in Hook. f. *l.c.* 7 : 315. 1896.

Local name : *Chirio-ro-khet*.

Annual, erect or ascending, glabrous, weak grass, up to 40 cm high. Leaves 6-14.5 x 0.2-0.7 cm, linear-lanceolate, glabrous, acuminate; sheaths bearded at mouth; ligule a narrow rim of hairs. Panicles 9-15 cm long, oblong in outline, open; rachis bearded at nodes. Spikelets 3 to 9-flowered, 2.5-3 mm long, breaking up from the apex; rachilla capillary, fragile, scabrous. Glumes subequal, ovate, subacute; lower 0.3-0.4 mm long; upper ones *ca* 0.5 mm long. Lemmas *ca* 0.7 mm long, broadly ovate-oblong, 3-nerved. Keels of palea ciliate with spreading, setose hairs. Stamens 3. Caryopsis 0.4-0.5 mm long, ovoid-ellipsoid, shiny, brown.

*Fl. & Fr.*: August – November.

*Ecology* : Common, found in moist places in sandy habitats and as a weed of cultivation.

*Specimen examined* : Kapurdi, Shetty 2353 (BSJO).

2. *Eragrostis ciliaris* (L.) R. Br. in Tuckey, Narr. Exp. Congo, App. 478. 1818; Stapf in Hook. f. Fl. Brit. India 7 : 314. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 506. 1960; Bhandari, Fl. Indian Desert 413. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1045. 1993. *Poa ciliaris* L. Syst. Nat. ed. 10. 2 : 875. 1759. *Eragrostis ciliaris* (L.) R. Br. var. *brachystachya* Boiss. Fl. Orient. 5 : 582. 1884; Stapf in Hook. f. *l.c.* 7 : 315. 1896; Bor, *l.c.* 506. 1966.

Erect or procumbent, tufted, annual grass, 20-40 cm high. Leaves 5-10 x 0.1-0.5 cm, linear-lanceolate, flat, acute; sheaths bearded with long hairs at mouth; ligule ciliate. Panicles 4-15 cm long, interruptedly lobed or dense and cylindrical, spiciform, densely woolly. Spikelets 2-5 x 0.2-0.3 mm, 6 to 12-flowered, densely clustered, greenish with yellowish-pink tinge, breaking up from above downwards; rachilla fragile. Glumes subequal, *ca* 1.2 mm long, ovate-lanceolate, acute. Lemmas *ca* 1.5 mm long, oblong, mucronulate; keel hairy or smooth, obtuse. Palea equal to lemma, deciduous; keel tuberculate, ciliate; cilia 0.6-0.7 mm long. Caryopsis 0.3-0.5 mm long, ellipsoid, light brown.

*Fl. & Fr.*: August – November.

*Ecology* : Common, found in sandy plains, particularly on drying banks of water bodies.

*Specimens examined* : Near Mathuo-ki-Basti, Monika 16592 (BSJO); Along Miajlar road, Shetty 3390 (BSJO).

3. *Eragrostis japonica* (Thunb.) Trin. in Mem. Acad. Sci. Petersb. ser. 6. 1 : 405. 1830; Bor, Grass. Burm. Ceyl. Ind. Pak. 509. 1960; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1047. 1993. *Poa japonica*



Thunb. Fl. Jap. 51. 1784. *P. diarrhena* Schult. Syst. Veg. Mant. 2 : 616. 1827. *Eragrostis diarrhena* (Schult.) Steud. Syn. Fl. Glum. 1 : 266. 1854; Bor, *Lc.* 507. 1960; Bhandari, Fl. Indian Desert 413. 1978. *Eragrostis interrupta auct. plur. non* (R. Br.) P. Beauv. 1812; Stapf in Hook. f. Fl. Brit. India 7 : 316. 1896, incl. vars. *diarrhena* (Schult.) Stapf and *koenigii* Stapf. *Diandrochloa japonica* (Thunb.) Henry in Bull. Bot. Surv. India 9 : 290. 1968. *D. diarrhena* (Schult.) Henry, *Lc.* 9 : 290. 1968.

Tufted, perennial grass, up to 65 cm high; culms slender, smooth, geniculately ascending. Leaves 15-25 x 0.3-1.5 cm, flat, linear, glabrous, acute; sheaths glabrous, close; ligule a fimbriate membrane. Panicles 20-50 cm long, either contracted with appressed branches or interrupted with short spreading and subwhorled branches. Spikelets 3-6 mm long, 7 to 14-flowered, breaking away from above downwards; rachilla jointed between the lemmas. Glumes subequal, hyaline, obtuse, 1-nerved. Lemmas pale green, ca 1 mm long, obtuse. Stamens 2. Caryopsis ca 0.5 mm long, obovoid, smooth, brown.

*Fl. & Fr.*: October – February.

*Ecology* : Common, found in sandy plains, particularly on drying banks of reservoirs.

*Specimen examined* : Near Schmar, *Monika* 16617 (BSJO).

4. *Eragrostis minor* Host, Icon. Descr. Gram. Austr. 4 : 15. 1809; Stapf in Hook. f. Fl. Brit. India 7 : 321. 1896; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1048. 1993. *Poa eragrostis* L. Sp. Pl. 68. 1753. *Eragrostis poaeoides* P. Beauv. Ess. Agrost. 162. 1812; Bor, Grass. Burm. Ceyl. Ind. Pak. 512. 1960; Bhandari, Fl. Indian Desert 414. 1978.

Erect or ascending, tufted, annual grass, 20-60 cm high. Leaves 4-15 x 0.2-0.8 cm, linear, acute, flat, usually with a row of warty glands along the margins; sheaths glandular and bearded at mouth; ligule a ridge of short hairs. Panicles up to 15 cm long, dense to open, oblong in outline; mature branches spreading, stiff, with short pedicels. Pedicels and branchlets usually with crateriform glands. Spikelets ca 6 mm long, 7 to 12-flowered, green pigmented with purple, breaking up from the base; rachilla tough. Glumes 1-1.2 mm long, subequal, ovate, acute, 1-nerved. Lemmas ca 1.6 mm long, obtuse, glandular on the keels. Palea persistent, scabrid on the keel. Stamens 3. Caryopsis ca 0.5 mm long, oblong, dorsally flattened, brownish.

*Fl. & Fr.*: September – March.

*Ecology* : Common, found in sandy plains as a weed of cultivation and in other moist habitats.

*Specimens examined* : Near Sakaro-ki-Basti, *Monika* 16581 (BSJO); Ganga, *Pandey* 7815 (BSJO).

5. *Eragrostis pilosa* (L.) P. Beauv. Ess. Agrost. 71, 162, 175. 1812; Stapf in Hook. f. Fl. Brit. India 7 : 323. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 512. 1960; Bhandari, Fl. Indian Desert 414. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1050. 1993. *Poa pilosa* L. Sp. Pl. 68. 1753.

Tufted, erect or geniculately ascending, annual grass, 40-75 cm high, glandular. Leaves 8-12 x 0.1-0.4 cm or more, linear, flat or convolute, smooth, acuminate; sheaths close, glabrous, mouth bearded; ligule a short hairy ridge. Panicles 8-20 cm long, oblong in outline, open, lowest branches pilose in the axils, often with glands above and below the nodes; branches fasciated above, whorled below; rachis almost glabrous, filiform. Spikelets 6 to 15-flowered, 4-7.5 mm long, linear-oblong, purplish-green; florets breaking up from the base with tough, persistent rachilla. Lower glume ca 1.5 mm long, ovate-oblong, acute, 1-nerved; upper slightly larger, ovate-lanceolate, acuminate. Lemmas ovate, subacute, ca 1.6 mm long, strongly nerved. Palea

2-nerved, slightly shorter than glumes, deciduous, keel smooth or scaberulous. Stamens 3. Caryopsis up to 0.8 mm long, ellipsoid, laterally compressed and apiculate at base, brown.

*Fl. & Fr.*: September – November.

*Ecology* : Rare, found in wet sandy banks of water bodies and as a weed in cultivated fields in association with *Eragrostis minor* Host, *Tribulus terrestris* L., etc.

*Specimens examined* : Near Ganga, *Monika* 16622 (BSJO); Singhdar, *Monika* 16675 (BSJO); Bandera, *Monika* 17129 (BSJO).

#### 14. *HETEROPOGON* Pers.

*Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult. Syst. Veg. 2 : 836. 1817; Bor, Grass. Burm. Ceyl. Ind. Pak. 163. f. 6. 1960; Bhandari, Fl. Indian Desert 418. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1059. 1993. *Andropogon contortus* L. Sp. Pl. 1045. 1753; Hook. f. Fl. Brit. India 7 : 199. 1896.

Local name : *Lapio*.

Tufted, perennial grass, up to 1 m high. Leaves 18-30 x 0.2-0.6 cm, linear, acuminate, flat; sheaths glabrous, compressed, keeled, with auricled mouth; ligule a short, ciliate rim. Racemes 3-12 cm long, solitary. Spikelets closely imbricate; lower 2-6 sessile spikelets awnless, male or neuter; upper sessile spikelets with long, twisted awns, female or hermaphrodite. Callus acute, bearded. Lower glume of sessile spikelets oblong-linear, hispidulous, many-nerved; awns up to 7.5 cm long; upper one linear, obtuse, brown, more or less hispid. Lower lemma oblong, truncate; upper one subulate. Pedicellate spikelets 8-13 mm long; pedicels 1-2 mm long. Lower glume lanceolate, eglandular, hirsute with bulbous-based hairs, slightly winged and wings serrulate; upper glume oblong-lanceolate, 5-nerved. Lower lemma empty, oblong, ciliate, incurved; upper lemma obovate-oblong, ciliate. Caryopsis ca 2 mm long, oblong, terete, brown.

*Fl. & Fr.*: August – November.

*Ecology* : Rare, found in sandy and gravelly plains among the thickets of bushes.

*Specimen examined* : Bandera, Pandey 7915 (BSJO).

#### 15. *LASIURUS* Boiss.

*Lasiurus scindicus* Henr. in Blumea 4 : 514. 1941; Bor, Grass. Burm. Ceyl. Ind. Pak. 189. 1960; Bhandari, Fl. Indian Desert 381. 1990; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1071. 1993. *Saccharum hirsutum* Forssk. Fl. Aegypt.-Arab. 16. 1775, non *Rottboellia hirsuta* Vahl 1790, nec. *Lasiurus hirsutus* (Vahl) Boiss. 1859; *sensu* Bhandari, l.c. 420. 1978. *Elyonurus hirsutus* (Forssk.) Munro ex Benth. in J. Linn. Soc. 19 : 68. 1881; Stapf in Hook. f. Fl. Brit. India 7 : 162. 1896. *Lasiurus ecaudatus* Satyan. & Shankar. in J. Bombay Nat. Hist. Soc. 60 (3) : 763. pl. 1. 1963; Bhandari, l.c. 380. 1990.

Local name : *Sevan*.

Densely tufted, perennial grass, with rhizomatous root-stock covered with silky cataphylls, up to 1 m high; culms terete, more or less hairy on lower internodes, glabrous above. Leaves 9-15 x 0.4-0.5 cm, linear, convolute, finely acuminate, glabrous; sheaths rigid, terete; ligule a fringe of hairs. Racemes 6-10 x 0.5-0.8 cm, solitary, densely villous; rachis fragile, jointed; joints ca 4 x 2 mm, subclavate, densely villous on the

back, ciliolate along angles. Sessile spikelets 8-12 mm long, one on either side of central pedicellate spikelet. Lower glume 7 to 9-nerved, 8-9 mm long, coriaceous, 2-toothed at apex, acuminate, densely silky villous; upper glume ca 6 mm long, ovate, 3 to 5-nerved, aristate-acuminate. Lemmas short, ovate, acute, hyaline, 3-nerved. Pedicellate spikelets similar to sessile ones, slightly shorter, male or neuter.

*Fl. & Fr.*: Almost throughout the year.

*Ecology* : Common, found in sandy plains forming extensive Sevan grasslands.

*Specimens examined* : Near Khuri, *Monika* 16506 (BSJO); Sudasari, *Monika* 16539 (BSJO).

#### 16. *LEPTOTHRIUM* Kunth

*Leptothrium senegalense* (Kunth) W. D. Clayton in Kew Bull. 27 : 151. 1972; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1072. 1993. *Latipes senegalensis* Kunth. Rev. Gram. 1 : 261. t. 42. 1830; Hook. f. Fl. Brit. India 7 : 97. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 682. 1960; Bhandari, Fl. Indian Desert 421. 1978.

Short-lived annual grass, with few, leafy, ascending branches, 15-30 cm high. Leaves 5-8 x 0.1-0.4 cm, subulate, convolute; sheaths glabrous, with hairy mouth and ciliolate margins; ligule absent. Racemes 7-15 cm long, bright green; peduncles flattened or slightly winged, ciliate with hooked hairs on the margins. Spikelets in pairs, one perfect and the other sterile or perfect, former little above the latter, upper spikelet 6-7 mm long and lower ca 4.5 mm long. Lower glume 6-7 mm long, recurved, lanceolate, 3 nerved, pectinate-margined; upper glume 4-4.5 mm long, ovate-lanceolate, 3 to 4-nerved, purplish-brown, tuberculate on back. Lemmas ca 2 mm long, ovate-oblong, acute, hyaline, keeled. Lower glume of lower spikelet 3-4 mm long, lanceolate, ciliate; upper glume up to 2 mm long, tubercled throughout its length, ciliate. Caryopsis 1.2-1.5 mm long, ovoid-lanceolate, free.

*Fl. & Fr.*: October- February.

*Ecology* : Occasional, found in sandy and saline plains forming cushions. Sometimes found as a weed in cultivated fields.

*Specimens examined* : Near Miajlar, *Monika* 16658 (BSJO); Near Kanoi, *Monika* 16748 (BSJO).

#### 17. *MELANOCENCHRIS* Nees

1a. Cluster of spikelets including awns up to 8 mm long.

2. *M. jacquemontii*

1b. Cluster of spikelets including awns more than 10 mm long.

1. *M. abyssinica*

1. *Melanocenchris abyssinica* (R. Br. ex Fresen.) Hochst. in Flora 38 : 274. 1855; Bor, Grass. Burm. Ceyl. Ind. Pak. 473. 1960; Bhandari, Fl. Indian Desert 422. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1073. 1993. *Eutriana abyssinica* R. Br. ex Fresen. in Mus. Sencken. 2 : 142. 1837. *Gracilea royleana* (Nees ex Steud.) Hook. f. var. *plumosa* Hook. f. Fl. Brit. India 7 : 284. 1896.

Tufted, erect, annual grass, up to 25 cm high; culms angular, minutely pubescent. Leaves 3-5.5 x 0.1-0.2 cm, linear-lanceolate, acute, filiform, scabridulous, convolute-margined, ciliate; sheaths 1.5-2.5 cm long, covered with scattered, whitish tubercle-based hairs; ligule a hairy ridge. Spikes 3-5 cm long; rachis trigonous, minutely scabridulous, flexuous. Spikelets in fascicles on rachis, including the awns ca 1.4 cm

long, tinged with purple. Lower glume rigidly coriaceous, 1.2-1.4 cm long including the awn, 1-nerved, villous at base; upper glume with broad, hyaline margin near the base, narrowed into an awn at apex. Lower lemma ovate-lanceolate, 3-nerved, scabrid on back, aristate; upper one 3-toothed at apex, stalked. Palea 2-toothed. Caryopsis 1.5-1.6 mm long, oblong, smooth, brown; hilum punctiform.

*Fl. & Fr.*: August – October.

*Ecology* : Common grass of the gravelly and rocky habitats.

*Specimen examined* : Along Ganga-Bidna Road, Monika 16636 (BSJO).

2. *Melanocenchris jacquemontii* Jaub. & Spach, Ill. Pl. Or. 4 : 36. t. 325. 1851; Bor, Grass. Burm. Ceyl. Ind. Pak. 473. 1960; Bhandari, Fl. Indian Desert 422. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1074. 1993. *M. royleana* Nees ex Steud. Syn. Pl. Glum. 1 : 218. 1854. *Gracilea royleana* (Nees ex Steud.) Hook. f. Fl. Brit. India 7 : 284. 1896.

Suberect, tufted, annual grass, 15-20 cm high; culms scabridulous at angles. Leaves 3-6 x 0.1-0.25 cm, filiform, linear-lanceolate, acute, convolute-margined, covered with scattered, long, tubercle-based hairs; sheaths 1-2 cm long, covered with scattered, long, tubercle-based hairs, ciliate; ligule a thick row of short, white hairs. Spikes 4-6 cm long, filiform; rachis trigonous, flexuous, smooth. Spikelets in clusters, 7-8 mm long including awns, green with purplish tinge, 2-flowered. Lower glume subulate-elongate, ca 2.5 mm long excluding the awn; awns antrorsely barbellate; upper one ca 2 mm long excluding awn, both glumes villous at base. Lemmas 4-5 mm long, ovate-lanceolate, 2 to 3-lobed at apex, awned. Stamens 3. Stigmas plumose. Caryopsis 1.5-2.5 mm long, elliptic, brown.

*Fl. & Fr.*: August – November.

*Ecology* : Common, found in sandy to gravelly as well as rocky habitats.

*Specimen examined* : Sudasari, Monika 16765 (BSJO).

#### 18. *OCHTHOCHLOA* Edgew.

*Ochthochloa compressa* (Forssk.) Hilu in Kew Bull. 36 : 560. 1981; Bhandari, Fl. Indian Desert 383. 1990; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1075. 1993. *Panicum compressum* Forssk. Fl. Aegypt.-Arab. 18. 1775. *Eleusine flagellifera* Nees in Linnaea 16 : 220. 1842; Hook. f. Fl. Brit. India 7 : 294. 1896. *E. compressa* (Forssk.) Asch. & Schweinf. ex C. Christ. in Dansk. Bot. Arch. 4 (3) : 12. 1922; Bor, Grass. Burm. Ceyl. Ind. Pak. 492. 1960; Bhandari, Fl. Indian Desert 407. 1978.

Local name : *Ghora-dhob, Ganthia-ghas.*

Prostrate or geniculately ascending, stoloniferous, perennial grass, 20-25 cm high; nodes leafy, thickened, rooting at lower nodes. Leaves 2.5-5 x 0.1-0.3 cm, linear-lanceolate, glaucous, rigid, acuminate, recurved, upper very short; sheaths glabrous; ligule a line of hairs. Spikes 3-6, digitate, 2-4 cm long; rachis slender, pubescent. Spikelets 4 to 6-flowered, 5-8 mm long, imbricate, sessile. Lower glume 3-3.5 mm long, ovate, acute, membranous; upper glume 3.5-4 mm long, coriaceous, lanceolate, aristate, with broad membranous margins. Lemmas ca 5 mm long, ovate-lanceolate, apiculate, chartaceous, 3-nerved, with membranous margins. Palea oblong, with ciliate keel.

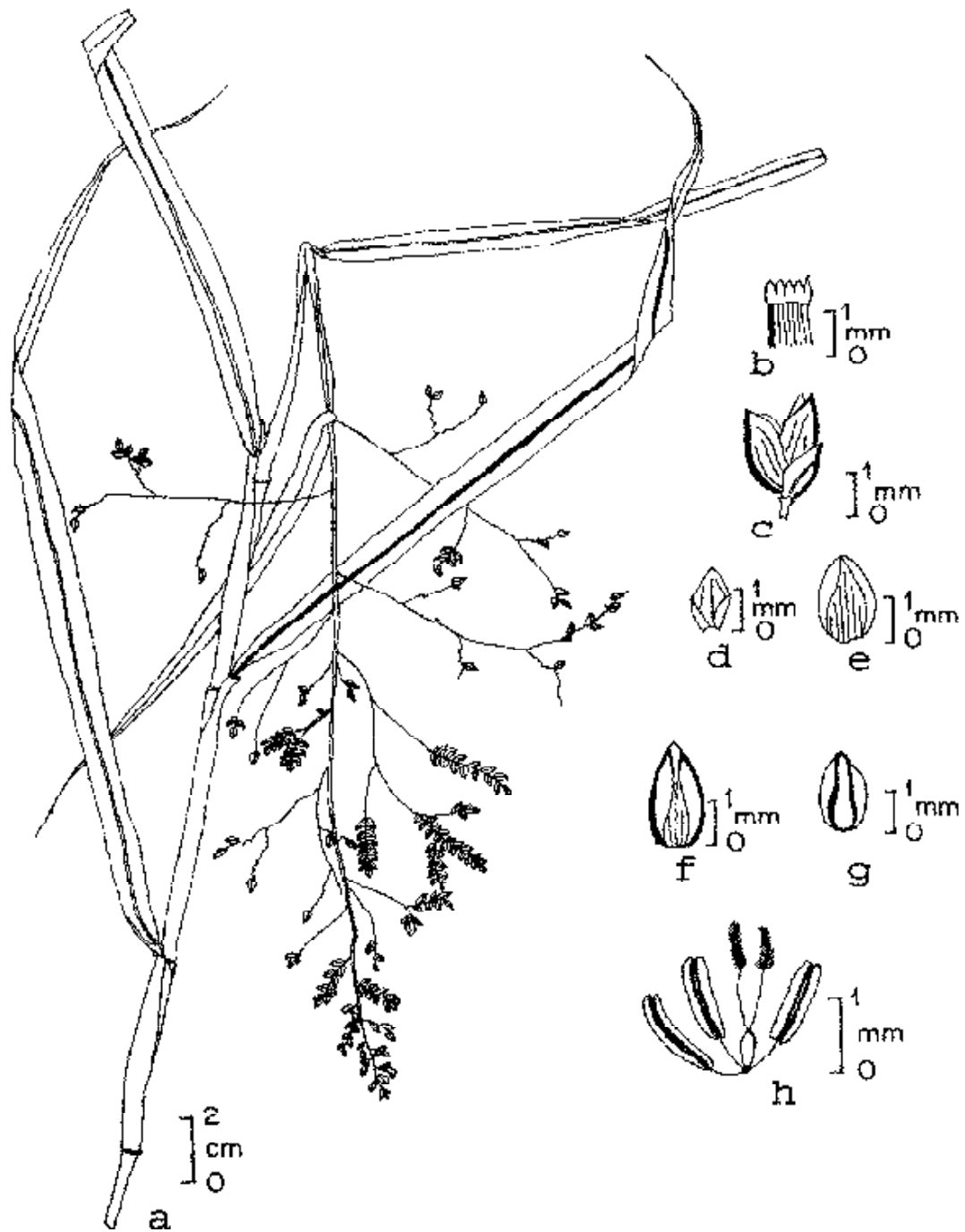


Fig. 25. *Panicum antidotale* Retz. : a. Habit. b. Ligule. c. Spikelet. d. Lower glume, e. Upper glume. f. Lower lemma, g. Upper lemma, h. Pistil & stamens.

*Fl. & Fr.*: August- February.

*Ecology* : Common, found in sandy and gravelly plains. Main associates are *Euphorbia granulata* Forssk., *Indigofera tinifolia* (L. f.) Retz., etc. Sometimes forms it's pure communities.

*Specimens examined* : Near Berisiyala, *Monika* 16538 (BSJO); Near Kanoi, *Monika* 16570 (BSJO).

#### 19. *OROPETHUM* Trin.

*Oropetium thomaeum* (L. f.) Trin. Fund. Agrost. 98. t. 3. 1820; Hook. f. Fl. Brit. India 7 : 366. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 474. 1960; Bhandari, Fl. Indian Desert 423. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1078. 1993. *Nardus thomaea* L. f. Suppl. Pl. 105. 1781.

Small, tufted, short-lived, perennial grass. 6-10 cm high, with fibrous, capillary roots. Leaves 3-7.5 x 0.1-0.2 cm, erect or curved, acute, filiform, rolled, coriaceous, sparsely ciliate on the margins; sheaths compressed, membranous; ligule lacerate-membranous, erect. Spikes 1-3, 2.5-4.5 cm long, erect, slightly curved at apex; rachis 4-gonous. Spikelets 1-flowered, ca 2 mm long, acute, deeply embedded in the distichous cavities of the rachis. Lower glume minute, hyaline; upper one linear-lanceolate, ca 2 mm long, acute, rigid, recurved in fruit, 3-nerved. Lemmas 1.5-1.6 mm long, semicircular, hyaline; callus bearded. Caryopsis ca 0.7 mm long, obovate, shining brown.

*Fl. & Fr.*: August-October.

*Ecology* : Rare, found in rocky habitats, chiefly in the crevices of rocks.

*Specimen examined* : DNP, Shetty 344f (BSJO).

#### 20. *PANICUM* L.

1a. Spikelets up to 3 mm long, narrow, elliptic-lanceolate or ovoid.

1. *P. antidotale*

1b. Spikelets 4 mm or more long, sharply acute, ovate to elliptic.

2. *P. turgidum*

1. *Panicum antidotale* Retz. Obs. Bot. 4 : 17. 1786; Hook. f. Fl. Brit. India 7 : 52. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 322. 1960; Bhandari, Fl. Indian Desert 424. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1081. 1993.

Local name : *Ghirdano, Garmano.*

Tall, stout, perennial grass, up to 1.5 m high, with thick, stout, creeping root-stock; culms solid, terete, woody at base, rooting at lower nodes, smooth. Leaves 20-50 x 0.5-1.5 cm, linear, acute, glabrous; sheaths glabrous, 4-8 cm long, smooth, striate with naked margins; ligule membranous, small, fimbriate. Panicles 15-30 cm long, effuse; branches fasciated, 4-10 cm long, filiform; rachis angular, slender, glabrous. Spikelets up to 3 mm long, ovoid, glabrous, acute. Lower glume 1.5-2 mm long, about one half to two third the length of spikelet, broadly ovate, obtuse, 2 to 3-nerved; upper glume ca 2 mm long, broadly ovate, acuminate. Lower lemma equalling to upper glume; upper lemma ca 1.8 mm long, elliptic, obtuse, coriaceous, yellowish. Caryopsis 2-2.5 mm long, elliptic-ovate, light brown (Fig.-25).

*Fl. & Fr.*: October - January.

*Ecology* : Common, found in sandy plains forming isolated patches in the grasslands and in the fences of cultivated fields.

*Specimens examined* : Near Nimba, *Monika* 16627 (BSJO); Tank near Tejaraon, *Pandey* 7898 (BSJO).

2. *Panicum turgidum* Forssk. Fl. Aegypt.-Arab. 18. 1775; Hook. f. Fl. Brit. India 7 : 44. 1896; Bor. Grass. Burm. Ceyl. Ind. Pak. 331. 1960; Bhandari, Fl. Indian Desert 425. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1086. 1993.

Local name : *Muratio*.

Tufted, erect, perennial grass, up to 1 m high, woody at base with fibrous, felty, thick roots; internodes 3-4 cm or more long; branches fascicled, swollen at base. Leaves few, basal, 5-15 x 0.6-0.7 cm, linear-lanceolate, glabrous, convolute, stiff and pungent; sheaths coriaceous, 2-7 cm long; ligule a dense ciliate rim. Panicles terminal, 7-15 cm long, subpyramidal, loose; rachis angular, grooved, glabrous. Spikelets 3-4.5 mm long, solitary or 2-nate, ovoid or ovate-suborbicular, turgid, glabrous. Lower glume up to 2.5 mm long, lanceolate, 5 to 7-nerved; upper one equalling the lower lemma, 7 to 9-nerved. Upper lemma coriaceous, yellowish. Caryopsis ca 3 mm long, elliptic, apiculate, convex, brown.

*Fl. & Fr.*: July-November.

*Ecology* : Common, found in sandy plains as well as on dunes. It plays vital role in stabilizing the sand-dunes.

*Specimens examined* : Near Sam. Sand-dune point, *Monika* 16611 (BSJO); Miajlar, *Pandey* 7903 (BSJO).

## 21. *PEROTIS* Ait.

*Perotis hordeiformis* Nees in Hook. & Arn. Bot. Beech. Voy. 247, 248. 1838; Bor. Grass. Burm. Ceyl. Ind. Pak. 611. 1960; Bhandari, Fl. Indian Desert 426. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1096. 1993. *P. latifolia* Hook. f. Fl. Brit. India 7 : 98. 1896, *pro parte*, non Ait. 1789.

Tufted, geniculately ascending, annual grass, 20-50 cm high, with woody root-stock. Leaves 2-5 x 0.3-0.8 cm, ovate or ovate-lanceolate, acute or acuminate, subamplexicaul at the base; margins ciliate, undulate, with cartilaginous teeth; sheaths up to 1.5 cm long, glabrous; ligule thin, membranous. Spikes cylindrical, bottle-brush-like, purplish-green, up to 20 cm long; rachis minutely pubescent. Spikelets linear, up to 2.5 mm long, scabridulous. Glumes equal and smaller, linear-lanceolate, 1-nerved, with definite lines of shining white hairs on the dorsal surface, awned; callus absent. Lemma solitary, narrowly linear, 1-1.5 mm long. Caryopsis 1-2 mm long, subcylindrical, pale brown.

*Fl. & Fr.*: August - November.

*Ecology* : Common, found on the sand-dunes and in gravelly plains.

*Specimen examined* : Miajlar village, *Monika* 17116 (BSJO).

## 22. *SCHOENEFELDIA* Kunth

*Schoenefeldia gracilis* Kunth, Rev. Gram. 1 : 283. t. 53. 1830; Bor. Grass. Burm. Ceyl. Ind. Pak. 474. 1960; Bhandari, Fl. Indian Desert 429. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1105. 1993.

*S. pallida* Edgew. in J. Asiat. Soc. Bengal 21 : 183. 1852. *Chloris pallida* (Edgew.) Hook. f. Fl. Brit. India 7 : 289. 1896.

Tufted, erect or geniculately ascending, annual grass, 30-50 cm high. Leaves 10-20 x 0.5 cm, linear, very narrow, flaccid, hairy, acuminate, with capillary tips; ligule of a few hairs. Spikes 2-4, digitate, golden-yellow, 6-15 cm long, closely pectinate, with 2 rows of erecto-patent, long-awned spikelets. Spikelets 2-3.5 mm long, narrow, tapering, subsessile, 1-flowered. Lower glume 2-3 mm long, ovate-lanceolate, aristately acuminate, hairy, 1-nerved; upper one 2-2.5 mm long, ovate-lanceolate, ciliate at the keel, 1-nerved. Lower lemma 2-2.5 mm long, ovate, 1-nerved, base bearded, tip notched, awned. Palea narrow, tip bidentate. Caryopsis 1.5-1.8 mm long, linear, slender.

*Fl. & Fr.*: August – October.

*Ecology* : Common, found in sandy plains forming thick patches. The main associates are *Indigofera tinifolia* (L. f.) Retz. and *Lasiurus scindicus* Henr.

*Specimen examined* : Near Ganga, Monika 16625 (BSJO).

### 23. *SPOROBOLUS* R. Br.

*Sporobolus coromandelianus* (Retz.) Kunth, Rev. Gram. 1 : 68. 1829; Hook. f. Fl. Brit. India 7 : 252. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 627. 1960; Bhandari, Fl. Indian Desert 432. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1119. 1993. *Agrostis coromandeliana* Retz. Obs. Bot. 4 : 19. 1786. *Vilfa coromandeliana* (Retz.) P. Beauv. Ess. Agrost. 16, 147. 1812.

Densely tufted, diffusely ascending, annual grass, 20-35 cm high, sometimes rooting at lower nodes. Leaves 7-8 x 0.4-0.5 cm, lanceolate to linear-lanceolate, flat, acuminate, sub-coriaceous, subcordate at base, many-nerved, midrib prominent and scabridulous with few, long, scattered hairs towards base; margins cartilaginous, scabrid, serrulate; sheaths glabrous, compressed, striate; ligule a thin, short, membranous ridge with a fringe of dense fine hairs. Panicles 6-10 cm long, pyramidal, branches in distant, 4-6 whorls. Spikelets 1.2-1.5 mm long, subsessile, adpressed to the rachis, 2-5 on the branchlets in the lower portion, solitary in the upper part, green. Lower glume minute, scale-like, hyaline, ovate to suborbicular, obtuse; upper one ca 1.3 mm long, 1-nerved, ovate to oblong, membranous. Lemmas ca 1.2 mm long, oblong, obtuse, 1-nerved. Palea ca 1.2 mm long. Caryopsis ca 0.7 x 0.5 mm, ellipsoid, slightly compressed, reddish-brown.

*Fl. & Fr.*: August- December.

*Ecology* : Rare, found in moist places near water reservoirs in association with *Echinochloa colona* (L.) Link and some sedges.

*Specimen examined* : Along Sam-Sudasari road, Monika 16618 (BSJO).

### 24. *STIPAGROSTIS* Nees

- |  |                         |
|--|-------------------------|
| 1a. Lower leaf-sheaths and internodes woolly.  | 2. <i>S. plumosa</i>    |
| 1b. Lower leaf-sheaths and internodes glabrous, but with few hairs at mouth, not woolly. | 1. <i>S. hirtigluma</i> |

1. *Stipagrostis hirtigluma* (Steud. ex Trin. & Rupr.) De Winter in Kirkia 3 : 136. 1963 & in Bothalia 8 : 361. 1965; Bhandari, Fl. Indian Desert 398. 1990; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1125. 1993.



*Aristida hirtigluma* Steud. ex Trin. & Rupr. Sp. Gram. Stirp. 171. 1842 & in Mem. Acad. Sci. Petersb. ser. 6. 7 (2) : 171. 1843; Hook. f. Fl. Brit. India 7 : 227. 1896, *pro parte*; Bor, Grass. Burm. Ceyl. Ind. Pak. 410. 1960; Bhandari, Fl. Indian Desert 387. 1978.

Local name : *Dholo-lamp*.

Erect, tufted, perennial grass, 40-60 cm high. Leaves 7-15 x 0.1-0.2 cm, convolute, filiform, with capillary tips; sheaths glabrous, with few long hairs at the mouth; ligule narrow, densely ciliate, membranous. Panicles 8-15 cm long, capillary, loose or contracted. Spikelets pale-green tinged with purple, linear-lanceolate. Lower glume 8-10 mm long, linear-oblong, acute, scarious; upper glume 9-12 mm long, rest like lower one. Lemma up to 4 mm long, slightly mucronate, long-awned; callus ca 0.5 mm long, shortly villous, pointed; column 4-5 mm long, plumose with long, slender hairs, articulated on the glume; central awn ca 3.5 cm long, silvery-plumose in the upper half, with an excurrent naked tip; lateral awns 1-1.5 cm long, very slender, hair-like, glabrous.

Fl. & Fr.: August - November.

Ecology : Rare, found in sandy and gravelly plains in association with *Stipagrostis plumosa* (L.) Munro ex T. Anders., *Sporobolus coromandelianus* (Retz.) Kunth and *Aristida* species.

Specimen examined : Along Bidna-Ganga road, *Monika* 16635 (BSJO).

2. *Stipagrostis plumosa* (L.) Munro ex T. Anders. in J. Linn. Soc. Bot. 1 (Suppl. 5) : 40. 1860; Bhandari, Fl. Indian Desert 398. 1990; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1126. 1993. *Aristida plumosa* L. Sp. Pl. ed. 2. 2 : 1666. 1763; Hook. f. Fl. Brit. India 7 : 228. 1896; Bor, Grass. Burm. Ceyl. Ind. Pak. 411. 1960.

Erect, densely tufted, perennial grass, up to 30 cm high; culms slender; internodes 4-5 cm long, lower nodes and internodes woolly. Leaves 7-9 x 0.1-0.2 cm, filiform, convolute, curved, acuminate, smooth; lower sheaths woolly. Panicles 6-11 cm long, contracted. Spikelets 1-flowered, awned, straw-coloured. Lower glumes 7-14 mm long, 3-nerved; upper one 9-15 mm long, 3-nerved, glabrous. Lemma 4-5 mm long, awned; callus 1-1.2 mm long, bearded, pungent; central awn 3-5 cm long, plumose, without an excurrent naked tip; lateral awns naked, up to 2.5 cm long, glabrous.

Fl. & Fr.: August-November.

Ecology : Rare, found in moist, sandy as well as gravelly habitats in association with *Aristida* spp.

Specimens examined : Miajlar village, *Monika* 17103 (BSJO); Phalari, *Pandey* 7826 (BSJO).

## 25. TETRAPOGON Desf.

*Tetrapogon tenellus* (Koen. ex Roxb.) Chiov. in Ann. R. Ist. Bot. Roma 8 : 352. 1908; Bor, Grass. Burm. Ceyl. Ind. Pak. 475. 1960; Bhandari, Fl. Indian Desert 435. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1127. 1993. *Chloris tenella* Roxb. Fl. Ind. 1 : 329. 1820; Hook. f. Fl. Brit. India 7 : 290. 1896.

Erect or geniculately ascending, tufted, annual grass, up to 50 cm high; stem weak, branched from nodes, glabrous. Leaves up to 15 x 0.5 cm, flaccid, linear-lanceolate, acuminate, undersurface with long hairs, margins ciliate; sheaths glabrous, keeled, compressed; ligule membranous, truncate. Spikes solitary or paired, up to 6.5 cm long; peduncles hirsute. Spikelets 3 to 6-flowered, 5-6 mm long, cuneate, bifarious, 3-awned.

Glumes 5-6, unequal, hyaline, 1-nerved; lower glume 4-5 mm long, acute; upper glume slightly longer than lower. Lower lemma 5-6 mm long, obovate or cuneiform, ciliolate, awned, coriaceous; upper lemma *ca* 5 mm long. Palea elliptic, with ciliate margins; callus densely villous. Caryopsis oblong, brownish.

*Fl. & Fr.*: August – November.

*Ecology* : Rare, found in the sandy and gravelly plains scattered in grasslands of short grasses.

*Specimen examined* : Miajlar village, *Monika* 17116 (BSJO).

## 26. *TRAGUS* A. Haller (*nom. cons.*)

*Tragus roxburghii* Panigrahi in Kew Bull. 29 : 495. 1974; Bhandari, Fl. Indian Desert 436. 1978; Pandey in Shetty & Singh, Fl. Rajasthan 3 : 1131. 1993. *Lappago biflora sensu* Roxb. Fl. Ind. 1 : 284. 1820, *quoad* *descript.*, *excl. type*. *Tragus biflorus sensu* Schult. Syst. Veg. Mant. 2 : 205. 1824, *quoad* *descript.*; Bor, Grass. Burm. Ceyl. Ind. Pak. 682. 1960. *T. racemosus sensu* Hook. f. Fl. Brit. India 7 : 97. 1896, non Scop. 1777.

Local name : *Makhni*.

Prostrate or geniculate ascending, annual grass, up to 20 cm high, branched from the base and often rooting at lower nodes. Leaves 2-4.5 x 0.2-0.4 cm, ovate-lanceolate or linear-lanceolate, acuminate, amplexicaul at base, undulate with pectinately setose margins; sheaths 1-2 cm long, setose at mouth; ligule a slender, ciliate rim. Spikes pale yellow, 3-6 cm long, cylindrical, loose, borne at the end of branches forming spike-like panicle; peduncle enclosed by leaf-sheaths; rachis pubescent. Spikelets *ca* 3 mm long, in pairs, at the end of *ca* 1 mm long pedicels facing each other, acute. Lower glume very minute, hyaline; upper one *ca* 2.5 mm long, slightly curved, involute, enveloping the lemma, strongly 3 to 5-nerved, with rows of stout, hooked spines, pubescent between the ribs of spines. Lemma solitary, *ca* 2 mm long, oblong-lanceolate, glabrescent, apiculate, 3-nerved. Palea hyaline, 2-nerved, subacute, about as long as glume. Caryopsis 1.2-1.3 mm long, linear-oblong, slightly compressed, light brown.

*Fl. & Fr.*: August – November.

*Ecology* : Common, found in sandy as well as gravelly, degraded habitats.

*Specimens examined* : Near Sam, *Monika* 16553 (BSJO); Near Kanoi, 16746 (BSJO).



1. *Cleome viscosa* L.



2. *Polygala erioptera* DC.



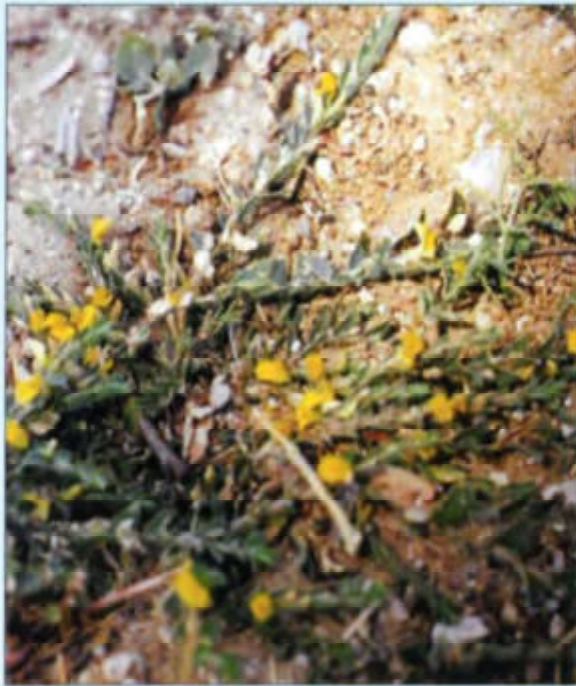
3. *Grewia tenax* (Forssk.) Fiori



4. *Fagonia bruguieri* DC.

**Plate-12**





1. *Crotalaria hebecarpa* (DC.) Rudd.



2. *Rhynchosia minima* (L.) DC.



3. *Tephrosia falciformis* Ramas.



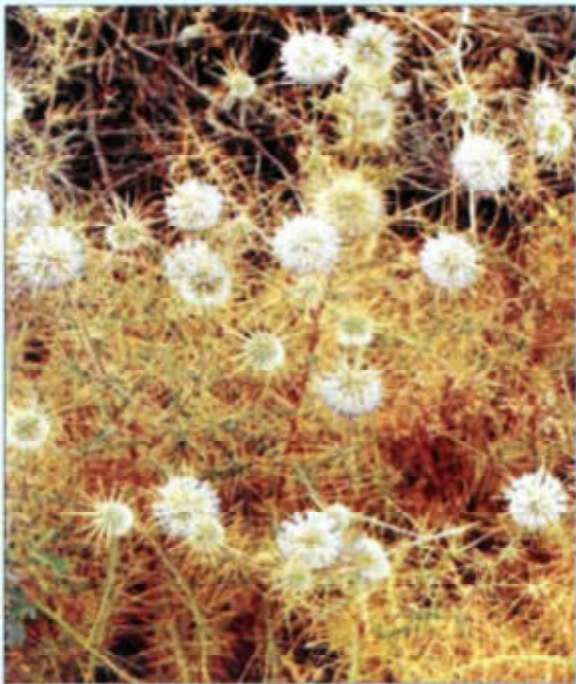
4. *Tephrosia strigosa* (Dalz.) Sant. & Mahesh.

**Plate-13**

1. *Senna italica* Mill.2. *Mimosa hamata* Willd.3. *Cucumis prophetarum* L.4. *Borreria articularis* (L. f.) F. N. Will.

## Plate-14





1. *Echinops echinatus* Roxb.



2. *Pulicaria angustifolia* DC.



3. *Tridax procumbens* L.



4. *Odontanthera varians* (Stocks) Mabberley

**Plate-15**





1. *Pergularia daemia* (Forsk.) Chiov.



2. *Heliotropium europaeum* L.  
var. *lasiocarpum* (Fisch. & Mey.) Kazmi



3. *Heliotropium subulatum* (Hochst. ex DC.) Vatke



4. *Solanum virginianum* L.

**Plate-16**





1. *Anticharis senegalensis* (Walp.) Bhandari



2. *Cistanche tubulosa* (Schrenk) Wight



3. *Aerva javanica* (Burm. f.) Juss. ex Schult.



4. *Ephedra ciliata* Fisch. & Meyer ex  
C. A. Meyer ♀

**Plate-17**



### FLORAL COMPOSITION A STATISTICAL ANALYSIS

The total Angiospermic flora of Desert National Park, including both indigenous and naturalised plants, comprises about 244 species and varieties belonging to 51 families and 147 genera. *Ephedra ciliata* is the only living Gymnosperm found in the Park as well as whole desert.

Table-7 : Number and percentage of families, genera and species in DNP and comparison with whole desert (Bhandari, 1978, 1990).

Groups	Family				Genera				Species			
	DNP		Desert		DNP		Desert		DNP		Desert	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
<b>Angiosperm</b>												
Dicotyledons	48	92.31	74	85.06	114	77.03	274	76.97	190	77.55	507	74.34
Monocotyledons	3	5.77	12	13.79	33	22.30	81	22.75	54	22.04	174	25.51
<b>Gymnosperm</b>	1	1.92	1	1.15	1	0.67	1	0.28	1	0.41	1	0.15
<b>Total</b>	52	100	87	100	148	100	356	100	245	100	682	100

The table-7 revealed that in Desert National Park, the Dicotyledonous plants dominate the flora as they contribute 77.55% species, 77.03% genera and 92.31% families. The Monocotyledons are rather more poorly represented, as only 3 families (5.77%), 22.30% genera and 22.04% species add to the Park. It is interesting to note that in both groups of Angiosperms genera : species ratio is almost identical. A comparison of DNP with floral composition of desert as whole (Bhandari, 1978, 1990) revealed that Monocotyledonous taxa are rather better represented in the desert (families 13.79%, genera 22.75% and species 25.51%); status of Gymnosperms is almost identical and the genera : species ratio among Dicotyledons and Monocotyledons almost conform to DNP.

Table-8 : Ten dominant families of flowering plants in DNP.

Families	Genera	Species
<i>Poaceae</i>	26	43
<i>Fabaceae</i>	8	24
<i>Asteraceae</i>	10	12
<i>Malvaceae</i>	4	12
<i>Amaranthaceae</i>	7	11
<i>Cyperaceae</i>	6	10
<i>Cucurbitaceae</i>	6	10
<i>Boraginaceae</i>	4	10
<i>Mimosaceae</i>	4	9
<i>Zygophyllaceae</i>	4	8

A perusal of table-8 revealed that *Poaceae* is the dominating group in DNP, as 43 species belonging to 26 genera grow here. The second position is occupied by *Fabaceae*, represented by 8 genera and 24 species. These two dominating groups mostly form plant associations in different combinations of taxa. The Compositaceous plants occupy third position. The species strength of *Malvaceae* is equivalent to *Asteraceae* but genera show lesser diversity, as such placed on 4<sup>th</sup> position. The 5<sup>th</sup> position is occupied by *Amaranthaceae* with 7 genera and 11 species. Similarly, *Cyperaceae*, *Cucurbitaceae* and *Boraginaceae* have equal strength of species, but differ in generic strength. However, the families *Mimosaceae* and *Zygophyllaceae* have equal number of genera (4) but differ slightly in species strength as former contains 9 species and latter 8 species.

Table-9 : Comparison of ten dominant families of DNP with India, Rajasthan and Desert.

India	Rajasthan	Desert	DNP
<i>Poaceae</i>	<i>Poaceae</i>	<i>Poaceae</i>	<i>Poaceae</i>
<i>Orchidaceae</i>	<i>Fabaceae</i>	<i>Fabaceae</i>	<i>Fabaceae</i>
<i>Fabaceae</i>	<i>Asteraceae</i>	<i>Asteraceae</i>	<i>Asteraceae</i>
<i>Asteraceae</i>	<i>Cyperaceae</i>	<i>Cyperaceae</i>	<i>Malvaceae</i>
<i>Rubiaceae</i>	<i>Acanthaceae</i>	<i>Convolvulaceae</i>	<i>Amaranthaceae</i>
<i>Acanthaceae</i>	<i>Euphorbiaceae</i>	<i>Malvaceae</i>	<i>Cyperaceae</i>
<i>Euphorbiaceae</i>	<i>Convolvulaceae</i>	<i>Euphorbiaceae</i>	<i>Cucurbitaceae</i>
<i>Lamiaceae</i>	<i>Scrophulariaceae</i>	<i>Acanthaceae</i>	<i>Boraginaceae</i>
<i>Apiaceae</i>	<i>Malvaceae</i>	<i>Cucurbitaceae</i>	<i>Mimosaceae</i>
<i>Brassicaceae</i>	<i>Lamiaceae</i>	<i>Amaranthaceae</i>	<i>Zygophyllaceae</i>

The table-9 indicates that first three positions occupied by the families in DNP are identical to desert as a whole and Rajasthan. However, *Cyperaceae* which occupies 6<sup>th</sup> position in DNP, stands on 4<sup>th</sup> place in Rajasthan, including desert. *Malvaceae* of 4<sup>th</sup> position in DNP is pushed back to 6<sup>th</sup> position in desert and 9<sup>th</sup> position in Rajasthan. *Amaranthaceae* of 5<sup>th</sup> position is also pushed to 10<sup>th</sup> position in desert and finds no place in Rajasthan. Similarly, *Cucurbitaceae* of 7<sup>th</sup> position occupies 9<sup>th</sup> place in desert and no place in Rajasthan. *Boraginaceae*, *Mimosaceae* and *Zygophyllaceae* which occupy 8<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup> positions have no place in desert and Rajasthan. However, *Euphorbiaceae* which finds no place in DNP, performs better in desert (7<sup>th</sup> position) and Rajasthan (6<sup>th</sup> position). A comparison of floral composition of DNP with India revealed that out of 10 dominant families, *Poaceae*, *Fabaceae* and *Asteraceae* stand at different positions in India. Rest 7 families of DNP do not find notable place in India and those find place in Indian flora, have no standing among 10 dominant families in DNP. Further, among grass species of DNP 36.94% are common to desert, 13.85% to Rajasthan and 3.17% to India. Similarly, the second dominating group of legumes shows 49.23% similarity to desert, 18.49% to Rajasthan and 2.78% to India.

A perusal of diversity in species revealed that the genera *Heliotropium* and *Indigofera* bear maximum diversity as they contain 7 species. The second position with 5 species is occupied by 7 genera viz. *Acacia*, *Amaranthus*, *Boerhavia*, *Cyperus*, *Eragrostis*, *Euphorbia* and *Tephrosia*. Five genera stand on 3<sup>rd</sup> position containing 4 species viz. *Abutilon*, *Aristida*, *Cenchrus*, *Sida* and *Tribulus*. The species of *Cenchrus*, *Citrullus*

*colocynthis*, *C. lanatus*, *Cleome gynandra*, *Cucumis melo*, *Gisekia pharnaceoides*, *Tephrosia purpurea* and *Ziziphus nummularia* show phenotypic variations in size of plant, size and shape of fruits and leaves, inflorescence, flower colour etc, suggesting genetic variability among their individuals.

A comparison of total germplasm of DNP with desert as a whole (Bhandari, 1978, 1990) revealed that 35.92 per cent species are common. Further, the ratio of Monocots to Dicots in the Park is 1 : 3.45 for genera and 1 : 3.52 for species. However, the ratio of genera to species (1 : 1.65) is very low in DNP as compared to India (1 : 7). But, it shows more or less conformity with the ratio for desert (1 : 1.9) and Rajasthan (1 : 2.4). The 22 families represented by single genus and single species include : *Aristolochiaceae*, *Bignoniaceae*, *Brassicaceae*, *Burseraceae*, *Caesalpiniaceae*, *Ehretiaceae*, *Gentianaceae*, *Geraniaceae*, *Liliaceae*, *Meliaceae*, *Menispermaceae*, *Moraceae*, *Moringaceae*, *Orobanchaceae*, *Portulacaceae*, *Rosaceae*, *Rubiaceae*, *Simaroubaceae*, *Sterculiaceae*, *Tamaricaceae*, *Vahliaceae* and *Verbenaceae*. The classification of flora of DNP based on habit revealed that trees are very poorly represented by 17 species (6.94%). The shrubs and undershrubs together constitute 17.96% (44 species) part of the flora. The vegetation of DNP is dominated by herbaceous flora (129 species), constituting 52.65 per cent part of phytodiversity. Of these herbaceous plants, about 61 species are erect, 53 species prostrate, diffuse or decumbent and 15 species climber, trailer or twinnings. *Cistanche tubulosa* is the only parasite in the area. The grasses are represented by 43 species and sedges by 10 species.

The plant species of DNP may also be classified on the basis of their relationship with physical environment. The desert environment imposes stringent constraints on the functioning of plants, resulting in complex physiological, anatomical and morphological adaptations to ensure their survival. Water is the main limiting factor determining necessary modifications in the plants viz. thick cuticle, development of water storage tissue, reduction of surface area of leaves or complete absence of leaves, position and type of stomata, hairiness, waxy coating, long root system, small diameter of vessels, presence of resin, development of chlorophyllous tissue in the stem etc. The plants of DNP may be grouped into four categories based on ecophysiology.

- (i) **Drought Escaping Plants** : This group includes the ephemeral plants which reproduce through seeds during monsoon period, complete their life-cycle within 4 to 6 weeks and disappear. Such plants are mostly herbs (70 species) and constitute 28.5% of the flora of DNP. They do not face hard conditions of desert viz. *Cleome gynandra*, *C. viscosa*, *Gisekia pharnaceoides*, *Indigofera cordifolia*, *Mollugo cerviana*, *M. nudicaulis*, *Phyllanthus fraternus*, *Polygala erioptera* ,etc.
- (ii) **Drought Evading Plants** : This group includes the plants which can survive in little moisture for longer duration. They are mostly annual herbs e.g. *Ammannia desertorum*, *Bergia ammannioides*, *Cleome scaposa*, *Corchorus tridens*, *Digera muricata*, *Indigofera linnaei*, *Pulicaria crispa*, *Tephrosia falciformis*, *T. purpurea* ,etc. This group is represented by about 73 species, constituting 29.80% flora of DNP.
- (iii) **Drought Enduring Plants** : This group includes the plants which are mostly perennial herbs and have capacity to endure or tolerate drought for longer period e.g. *Boerhavia diffusa*, *Convolvulus prostratus*, *Corchorus depressus*, *Pupalia lappacea* var. *velutina*, *Solanum virginianum*, *Tribulus terrestris*, *T. rajasthanensis* ,etc. This group is represented by about 65 species, contributing about 26.53% to the phytodiversity of Park.
- (iv) **Drought Resistant Plants** : These are the plants which have developed morphological and histological modifications e.g. bulbs, tubers, long-root system, reduction of leaf surface, overgrowths to check the

transpiration, water storage tissue, sunken stomata etc. Some examples are *Calligonum polygonoides*, *Calotropis procera*, *Capparis decidua*, *Crotalaria burhia*, *Cyperus atkinsonii*, *C. conglomeratus*, *C. rotundus*, *Dipcadi erythraeum*, *Ephedra ciliata* etc and several other shrubs, undershrubs and trees which have long root system. This group is represented by about 37 species, constituting 15.10% flora of DNP.

### PHYTOGEOGRAPHICAL ASSESSMENT

The vegetation of Rajasthan is interesting phytogeographically. There has been one school of phytogeographers who support the hypothesis of Drude (1890, 1913) that Aravalli hill constitutes the line of demarcation between Afro-Arabian and Indo-Malayan elements starting from Gulf of Cambay northwards up to Delhi ridges. In the west of Aravalli, the Afro-Arabian elements dominate and in the east the Indo-Malayan elements (Biswas & Rao, 1953; Blatter & Hallberg, 1918-21; Blatter & Sabnis, 1929; Mcher-Homji, 1962a, 1965, 1970). The other group of phytogeographers (Mulay, 1960; Nair & Kanodia, 1959; Nair & Nathawat, 1957; Ramdeo, 1969; Vyas, 1967) is of opinion that demarcation line between the elements of Afro-Arabian and Indo-Malayan origin should be shifted further east beyond the limits of Rajasthan. Besides those workers mentioned above, Meher-Homji & Bharucha (1975), Bharucha (1975a), Bhandari & Sharma (1977a), Charan (1993) etc have also made an attempt to study the biogeography of Indian desert. The common factor in both views is that the vegetation of Thar Desert situated in the west of Aravalli is considered to be dominated by Afro-Arabian elements.

Recently, Singh (1978) has reassessed the phytogeographical aspects of Rajasthan State and concluded that Afro-Arabian elements predominate the Indo-Malayan elements throughout the State, suggesting Drude's (1890, 1913) line of demarcation between two elements more towards east beyond the limits of Rajasthan, somewhere in Madhya Pradesh. He has identified four distinct elements constituting the flora of Rajasthan viz. (i) Perso-Arabian (Afro-Arabian or Western element) which includes species coming from Africa, Mediterranean region, Madagascar, North African-Indian desert belt, Western Asia, Arabia, Persia, Turkey, Indus Plain, Saharo-Sind or Sudano-Rajasthan; (ii) Indo-Malayan or Eastern element which includes the species coming from the Malaysia, Indonesia, Indo-China, Central, Eastern and South-east Asia; (iii) Indian element which includes the species of Indian origin having wide spread occurrence in subcontinent and (iv) General element consisting pantropical and pleuriregional species from various parts of the World. He recorded the ratio of Eastern and Western elements varying from 1:2.6 to 1:4.4 in desertic zones, with maximum percentage of Eastern elements 11.2% and of Western elements 43.7%. The percentage of Western elements decreases gradually as one proceeds from west to east, with increase in the percentage of Eastern elements. In the light of above observations, the phytogeographic aspects of DNP have been assessed.

Table-10. Number and percentage of various elements in Desert National Park.

	Indian	General	Afro-Arabian (Western)	Indo-Malayan (Eastern)	Ratio of Eastern and Western
<i>No. of species</i>	69	56	105	15	1 : 7
<i>Percentage</i>	28.16	22.85	42.85	6.12	

A perusal of table-10 revealed that 105 species of DNP are of Afro-Arabian origin, representing 42.85 per cent part of total vegetational cover of the Park. The second position is occupied by the Indian elements (69 species), representing 28.16 per cent of total species of the Park. The General elements occupy third position (56 species), contributing about 22.85 per cent to the phytodiversity of DNP. The Indo-Malayan elements are rather poorly represented by 15 species, forming 6.12 per cent flora of DNP.

A comparison with phytogeographical composition of desert as a whole revealed that strength of Western elements is almost equivalent in both areas as entire desert comprises 43.7 per cent Afro-Arabian elements. However, the desert contains rather more species of Indian origin (33 %) in comparison to DNP (28.16 %). On the other hand, the General elements are little more prominent in DNP (22.85 %) than whole desert (21.33 %). The percentage of the Indo-Malayan elements is 9.5 per cent in the desert, against DNP (6.12 %). A comparison of DNP with Rajasthan State (Singh, 1978) indicates that trend and pattern of distribution of different elements is almost identical. The ratio of Eastern and Western elements is about 1:4.4 in western Rajasthan and 1:1.7 to 1:3 in eastern Rajasthan. This ratio in DNP is 1:7. This indicates that the percentage of Western elements in DNP is almost double to found in rest part of desert (1:4.4). At some places, particularly in northern parts of desert (Ganganagar district), the ratio of Eastern and Western elements is highest (1:6). As one crosses Aravalli in eastern direction, the ratio of Western elements decreases against the Eastern elements (1:3). The same is true in southern direction as north Gujarat comprises 19 % and southern Gujarat only 13 % Western elements (Singh, 1978). The possible explanation for higher percentage of Afro-Arabian elements in desertic zones may be that due to great natural and biotic pressures on the vegetation in the west of Aravalli, the original natural flora of this area is being gradually eliminated and xerophytic vegetation characteristic of Perso-Arabian and African regions become pioneer to land in the modified plant climate resembling the climate of Libyan desert and Cyrenaica. Further, on the western boundary of India there is no remarkable barrier to check the migration of xerophytic elements of Afro-Arabian origin to the Indian desert. The interesting fact to note is that these adventive taxa first establish on the western boundary of desert where DNP is located and then migrate to the east in the desert. Recent collections of *Acacia nubica* (Africa), *Alysicarpus heterophyllus* (Sindh), *Hibiscus umblyocarpus* (Africa), *Pupalia lappacea* var. *velutina* and *Zaleya govindia* (Africa) from DNP support our hypothesis. However, a number of other Afro-Arabian taxa which first invaded western border of the desert (DNP) have now established in other interior parts of the desert e.g. *Anticharis senegalensis*, *Chascanum marrubifolium*, *Commicarpus verticillatus*, *Dactyliandra welwitschii*, *Dipterygium glaucum*, *Indigofera sessiliflora*, *Ipomoea verticillata*, *Monsonia senegalensis*, *Odontanthera varians*, *Polygala irregularis*, *Tephrosia villosa*, *Tribulus pentandrus* var. *macropterus*, *Seddera latifolia*, *Stipagrostis plumosa*, etc.

Further, distribution pattern of taxa is also very much correlated to the climatic conditions. The desertic zone is characterized with high temperature, high rate of evaporation and low rainfall; the temperature and evaporation gradually decrease and rainfall increases in east and southern directions. It is interesting to note simultaneous changes in the percentage of Afro-Arabian and Indo-Malayan elements i.e. decrease in Afro-Arabian elements and increase in Indo-Malayan elements. This shows that Western elements are denizen of dry habitats and Eastern elements of humid climate. The most possible means of migration of Afro-Arabian elements towards east are the high velocity winds from south-west and west towards north-east and eastern directions, birds, animals and tourists. Further, the fruits and seeds of most species of Western origin are well equipped for dissemination by these agencies. The low altitude of Aravallis towards north-east and gaps in this range near Sirohi are probably the routes of eastwards migration of xerophytic elements across Aravallis.

Such species which have recently crossed Aravallis from west include *Arnebia hispidissima*, *Dipterygium glaucum*, *Heliotropium strigosum*, *Hibiscus lobatus*, *Indigofera hochstetteri*, *Sida ovata*, etc. The Indo-Malayan taxa fail to establish in desertic environment due to different plant climate available. Further, Aravallis, extending from south to north-east direction in Rajasthan, also considerably check the westward movement of Eastern elements. Some important species which have recently crossed Aravallis towards west are : *Borreria articularis*, *Brachiaria kurzii*, *Bulbostylis barbata*, *Dichanthium annulatum*, *Pergularia daemia*, *Perotis hordeiformis*, etc. The migration pattern of taxa across Aravallis indicates that this hill range acts as an imperfect barrier.

The Indian elements, which constitute about 28.16 per cent of flora of DNP, consist the species coming from rest part of desert, Sindh, Gujarat, Punjab, Haryana, Gangetic plains and Central India, viz. *Acacia jacquemontii*, *Aeschynomene indica*, *Aristolochia bracteolata*, *Blumea lacera*, *Brachiaria ramosa*, *Cadaba fruticosa*, *Cenchrus biflorus*, *Cistanche tubulosa*, *Commiphora wightii*, *Cordia gharaf*, *Crotalaria burhia*, *Dicoma tomentosa*, *Echinops echinatus*, *Euphorbia caducifolia*, *Heliotropium marifolium*, *Hibiscus micranthus*, *Justicia procumbens*, *Kohautia aspera*, *Limeum indicum*, *Mimosa hamata*, *Moringa concanensis*, *Oropetium thomaeum*, *Pulicaria angustifolia*, *Rhynchosia capitata*, *Sida tiagii*, *Sesuvium sesuvioides*, *Striga angustifolia*, *Tribulus rajasthanensis*, *Ziziphus truncata*, etc. The Himalayan and N. E. Indian species are lacking in DNP. However, their representation in Indira Gandhi Canal Command area in desert proves changes in the plant climate of the desert. Some of these taxa are *Antirrhinum orontium*, *Arenaria serpyllifolia*, *Astragalus tribuloides*, *Gastrocotyle hispida*, *Hypocoum procumbens*, *Kochia indica*, *Lophochloa pumila*, *Malconia africana*, *Malva sylvestris*, *Myriophyllum spicatum*, *Oenanthe javanica*, *Phalaris minor*, *Plantago amplexicaulis*, *Polygonum lanigerum*, *Psammogeton canescens*, etc. These elements are presently lacking in non-irrigated areas of desert including DNP, but may replace original flora in due course if Indira lift canal is passed through DNP, as there has been a proposal. The Desert National Park is rather unlucky in having no endemic genera out of 134 dicot genera listed by Chatterji (1939) and poor representation of endemic species viz. *Anticharis glandulosa* var. *caerulea* and *Ziziphus truncata*, etc.

The General elements occupy third position (22.85%). They include a large number of cosmopolitan plants and exotics introduced from different parts of the World. Some common cosmopolitan taxa are : *Amaranthus tricolor*, *A. viridis*, *Boerhavia diffusa*, *B. procumbens*, *Chloris barbata*, *Corchorus olitorius*, *C. tridens*, *Eclipta prostrata*, *Enicostema axillare*, *Eragrostis ciliaris*, *E. minor*, *Glinus lotoides*, *Heteropogon contortus*, *Mariscus squarrosus*, *Mollugo nudicaulis*, *Phyllanthus amarus*, *P. fraternus*, *Rhynchosia minima*, *Sida cordifolia*, etc. Among the exotics, mostly the species are from America viz. *Amaranthus lividus*, *A. palmeri*, *Boerhavia erecta*, *Heliotropium bacciferum*, *Prosopis juliflora*, *Sida cordata*, *Solanum virginianum*, *Tridax procumbens*, *Xanthium indicum* etc and from Europe viz. *Amaranthus graecizans*, *Convolvulus prostratus*, *Fagonia schweinfurthii*, *F. bruguieri*, *Heliotropium europaeum* var. *lasiocarpum*, *Tamarix indica*, etc. The Australian elements are rather poorly represented viz. *Enneapogon desvauxii*, *Heliotropium subulatum*, etc. The species coming from East Indies, China, Japan, Philippines, Panama, Cuba, Russia etc are again very scanty in DNP as well as whole desert, probably due to recent rise in Himalayas and Siwaliks. Only those species which are generally very aggressive have established in the soils of DNP and desert.

### BIOLOGICAL SPECTRUM

A community consists of many species with different kinds of population fluctuations and interaction with one-another. The description of a community is considered incomplete if it is only based on floristic

listing of its species. The physiognomic forms and structural studies of land communities have been discussed in more rewarding manner by Whittaker (1975). A community is also described based on the relationship of the perennating tissues or its components to the ground surface (i.e. life-forms). The perennating tissues make possible the plant's survival during unfavorable seasons. The location of these tissues plays an important role in the plant's adaptation to climate. Life-forms of different plants reflect the general appearance of the climate. They further provide a sound base for natural ecological classification. A biological spectrum is formed when all the species of higher plants of a community are classified into life-forms and their ratio is expressed in number or percentage. Geographically widely separated plant communities can be very usefully compared with one-another on the basis of their biological spectra. Since, the life-forms are the products of the environment around the plants, the biological spectrum may be used as an indicator for the prevailing environment.

For the classification of the vegetation of different regions of the World, different systems have been proposed by several ecologists (Humboldt, 1805; Drude, 1897, 1913; Raunkiaer, 1911, 1934; Braun-Blanquet, 1932; Cain, 1950; Cabrera, 1952), but Raunkiaer's life-form system (1934) has a universal applicability. The plant climate of a region, according to Raunkiaer (1934), is characterized by the life-forms which in the biological spectrum of that region may or may not exceed the percentage of the same life-form in the normal spectrum (spectrum of the whole flora of the earth). Thus, the biological spectrum of different regions may be worked out and used to compare the widely separated plant communities in terms of their climatic adaptability.

During recent years some authors have studied the biological spectrum of the Indian desert (Das & Sarup, 1951; Mertia & Bhandari, 1978 and Charan *et al.*, 1978). Pandey *et al.* (1985) have reviewed biological spectra of Rajasthan desert and pointed out that the phytoclimate of the desert is "Thero-cryptophytic". More recently, Pandey & Parmar (1993) have analyzed the biological spectrum of Rajasthan as a whole and have again advocated "Thero-cryptophytic" phytoclimate of the State. Further, the validity of the vegetational criterion for assessing the aridity or humidity of a region has been elucidated by Meher-Homji (1964). In 1981, Meher-Homji reviewed life-form spectra of 38 regions analyzed by different workers from different parts of India and has classified these into ten main types of phytoclimates. According to him, the biological spectrum reveals "Therophytic" phytoclimate for arid zones and for intensively cultivated areas (Meher-Homji, 1962b).

Raunkiaer's system of classification of life-form classes is based mainly upon one feature i.e. adaptation of plants for surviving in unfavorable seasons, especially with regard to the degree of protection of the perennating buds or shoot apices or other bodies. In the present work, the life-form classes of Desert National Park are determined by exhaustive and detailed floristic and experimental studies in the field and laboratory on the habit, habitat, height of plants, the nature of perennating bodies and other aspects necessary to draw a biological spectrum, following the concept of Raunkiaer (1934).

### Observations

About 245 species of vascular plants of Desert National Park, belonging to 148 genera and 52 families, may be classified into following life-form classes according to Raunkiaer's system.

Table-11.: Life-form classes of plants in Desert National Park in comparison to Raunkiaer's (1934) normal spectrum.

Life-Forms	Species	%	Normal spectrum (Raunkiaer, 1934)%
Phanerophytes	62	25.31	46
Chamaephytes	9	3.67	9
Hemicryptophytes	29	11.84	26
Cryptophytes	31	12.65	6
Therophytes	114	46.53	13
Total	245	100	100

A perusal of Table-11 revealed that Phanerophytes are represented by 62 species (Ph-25.31%). The species of this major class may be further divided into subclasses viz. 5 species to mesophanerophytes (MM-2.04%), 12 species to microphanerophytes (M-4.90%), 22 species to nanophanerophytes (N-8.98%), 22 to lianas or climbers (L-8.98%), 1 species to parasites (P-0.41%). Epiphytes and megaphanerophytes are completely absent in the spectrum of Desert National Park.

Further, Chamaephytes with 9 species (Ch-3.67%) and 29 species of Hemicryptophytes (H-11.84%) are also represented in the area. About 31 Cryptophytes (Cr-12.65%), which include 19 Geophytes (G-7.75%) and 12 Halophytes (HHH-4.90%), inhabit the Park. The Hydrophytes (HH) are lacking in the present area.

Therophytes having 114 species make major class with highest percentage (Th-46.53%), including 5 species of succulents (S-2.04%).

A comparison with normal spectrum of Raunkiaer (1934) revealed that maximum number of species (114) are therophytes and their percentage is more than thrice (46.53%, incl.S-2.04%) to the normal spectrum (13%). The therophytes are mostly annual ephemerals, reproducing by the seeds, complete their life-cycle in a very short period, particularly in the monsoon. It suggests and confirms the hot, dry climate of the Park.

The second place is occupied by the Cryptophytes with 31 species (Cr-12.65%), which are just double to the normal spectrum (6%). In the Cryptophytes, the perennating bodies are buried in soil or water in the form of rhizomes, bulbs, tubers, stolons, etc. These two classes show greatest divergence from normal spectrum and suggest "Thero-cryptophytic" phytoclimate in the Park. Phanerophytes in total represent a little more than half (25.31%) of normal spectrum (46%). This indicates that in comparison to ephemeral and rhizomatous plants in the Park, the low woody bushy shrubs having maximum height up to two meters are not considerably enough in number. The low height of trees and shrubs in the area may be attributed to adverse climate and biotic pressure. The poor representation of Phanerophytes in comparison to normal spectrum indicates very adverse edapho-climatic conditions to support them.

Further, Hemicryptophytes with 29 species (H-11.84%) are little less than half to the normal spectrum (26%) and Chamaephytes with 9 species (Ch-3.67%) are further very poorly represented i.e. about 3 times less than the normal spectrum (9%). However, Das & Sarup (1951), Charan *et al.* (1978) and Meher-Homji (1981) pointed out that Chamaephytes find second place in the biological spectrum of desert and they are double to the normal spectrum. Mertia & Bhandari (1978), on the other hand, have found Chamaephytes equal to the normal spectrum. These observations are contrary to the Raunkiaer's (1934) concept also, since



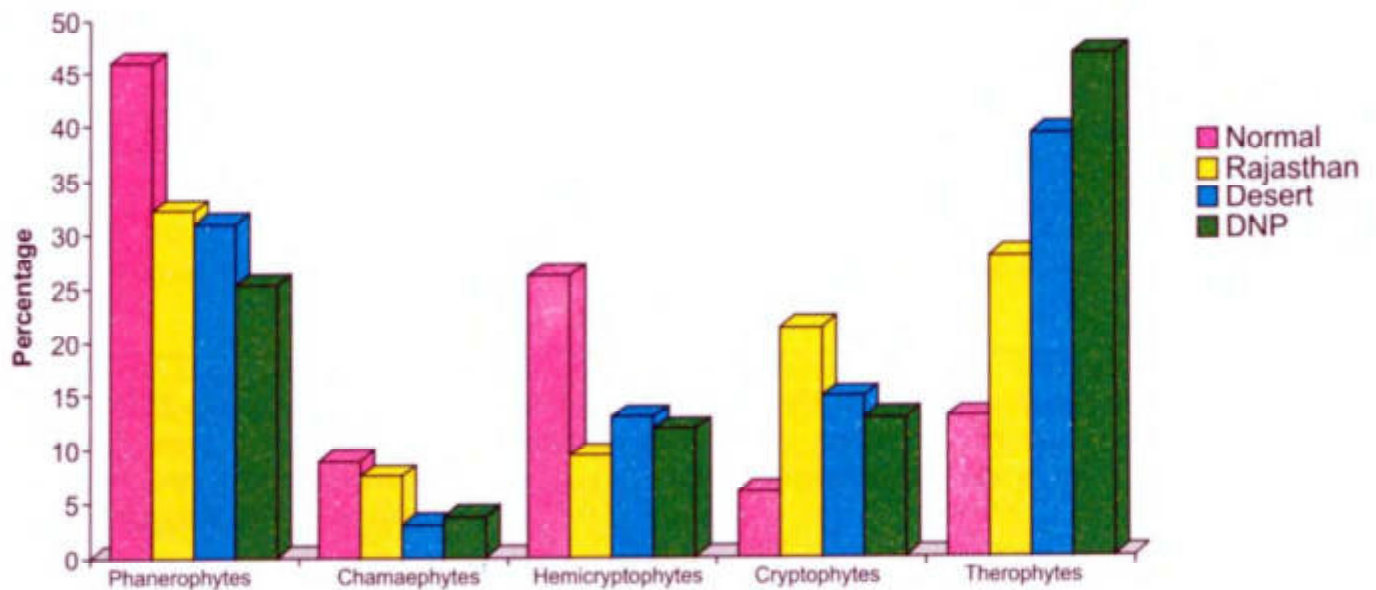


Diagram-2 : Comparison of different life-form spectra in Rajasthan.

higher percentage of Chamaephytes is the indicator of cold and dry climate, which is a characteristic of temperate and high altitudinal zones of the World. The observations of Pandey *et al.* (1985) and Pandey & Parmar (1993), however, support our concept.

Contrary results on biological spectrum and phytoclimate of desert area make magnitude of aridity debatable. Krishnan (1968a, 1968b) pointed out that area receiving less than 450 mm rainfall comes under desert. The biological spectrum, however, suggests semi-arid or semi-desertic conditions in such areas. The present study revealed that areas which receive less than 250 mm annual rainfall are real desert and located on the western extremities of the State covering the area of Desert National Park.

Thus, it is evident from the study that the therophytes constitute the largest biological spectrum class of the Desert National Park. The cryptophytes form the second highest class and two together suggest "Thero-cryptophytic" phytoclimate in the area. The biological spectrum also suggests hot and dry climate in the area and that area covered by Desert National Park falls under the real desert, and some part which we include today in desert having more than 250 mm annual rainfall, is not a desert in true sense, but a semi-desert.

### BIOPERSPECTIVE POTENTIAL

Human population, their settlement pattern, culture, occupation, developmental activities etc have direct influence on the flora and fauna of any ecosystem. As per the census of the year 1991, the human population of Desert National Park is 18,618 and the cattle population is about 38429, which includes mainly cows, goats, sheep and camels. The settlement pattern of population in the Park is scattered in the form of small villages called "Dhanis" wherein mostly the people of same caste live together. Further, the houses in the "Dhanis" are spatially located and number of houses in each "Dhani" is variable depending on the size of "Dhani". The factors governing the formation of different "Dhani" type settlements include population of village, dunish character of land surface, the scattered location of water resources, socio-cultural heritage, etc. The main castes inhabiting within the jurisdiction of Park are Rajputs and Muslims with some scheduled tribes and castes like Bhil, Raika, Sindhi, Sansi and Gavaria. Their culture and customs are almost similar due to close association between the societies. They wear very colourful dresses of different beautiful designs. The main occupation of the people of the Park is agriculture and animal husbandary. Due to scanty and uncertain rainfall, the animal husbandary is considered more secured profession than agriculture. However, flourishing tourism in the Park has generated local employment, resulting in escalating the socio-economic conditions of the people of this area. As regard food habit, Bajra (*Pennisetum americanum*) is the main cereal grown in the area along with Gwar (*Cyamopsis tetragonoloba*) and other pulses like *Vigna aconitifolia* (Moth) and *Phaseolus radiatus* (Mung). However, production depends on the occurrence of rains. The general health of residents is poor and people treat themselves by local herbs growing around them. The people in the Park also depend on plants for their livelihood viz. food, vegetable oil, gum/resin, fuel, fibre, timber, dye, etc. Due to limited resources of revenue and illiteracy, the men in the Park still live in the primitive style in seclusion from modern civilization, upholding the ancient traditions of their ancestors. They have accrued considerable knowledge about the plants and their utility by their long association with forest environment and pass this knowledge to next generation. However, their ethnobotanical knowledge is facing danger of being lost to oblivion by rapid urbanization, industrialisation, tourism and deforestation that tend to impoverish their one time prosperous culture. As such, with a view to determine the economic potential of Desert National Park and documentation of traditional knowledge, the ethnobotanic studies have been taken up.

The term "Ethnobotany" was first coined by J. W. Harshburger (1896). He applied the term to the study of plants used by primitive and aboriginal people. Earlier in 1875, Stephen Powers used the term aboriginal botany to describe the study of all forms of the vegetable World that the aborigines used for medicines, food, textile, fabrics, ornaments, etc. Later in 1916, Robbins *et al.* presented the definition of ethnobotany in broad sense beyond mere identification and cataloguing the plants used by primitive people. He attributed this discipline, a study and evaluation of the knowledge of all phases of plant-life amongst primitive societies, and the effect of vegetable environment upon life, customs, beliefs and history of people of such societies. Subsequently, C. B. Heiser, Jr. (1995) defined ethnobotany as the study of wild and cultivated plants in relation to people. Plotkin (1995) defined ethnobotany as the study of tribal people and their utilization of tropical plants. As such, ethnobotany is an interdisciplinary science drawing from different aspects of anthropology, archaeology, botany, ecology, economics, medicine and several other disciplines.

Presently ethnobotany has become an important discipline of research and development in resource management, conservation of biodiversity and socio-economic development of the region. The ethnobotanical works in organized way were started by Botanical Survey of India in 1960 in the country. Since then, the uses of plants by tribals are being recorded for a variety of purposes (Jain, 1968, 1981a, 1981b, 1991, 1995). However, the Indian desert, due to its geographical position, environment, topography and socio-economic

conditions, may be credited first which drawn the attention of King (1869, 1870) who recorded the wild plants which are used as famine food and vegetable products as food in desertic zones of the State. Subsequently, Irwin Hamilton (1895) furnished some ethnobotanical information for Ajmer, followed by Pank (1900). Afterwards, from 1960 onwards, a number of workers have contributed to the ethnobotany of India on different aspects. The voluminous literature presently available on Indian ethnobotany is not possible to be cited here for the economy of space. However, a notable contributions for Rajasthan and Thar desert in particular which need mention are those of Chopra & Handa (1960), Nathawat & Deshpande (1960), Chopra & Abrol (1964), Ganguly & Kaul (1965), Gupta (1966), Gupta *et al.* (1966), Gupta & Kanodia (1968), Kanodia & Gupta (1968), Gupta & Saxena (1968, 1977), Gupta (1970), Bhandari (1974, 1977), Roy (1976), Shrivastava (1977), Singh & Shetty (1977), Tewari (1979), Sen & Bansal (1979), Saxena (1981), Amal Raj (1982), Joshi (1982), Singh & Pandey (1983, 1985, 1986), Mahapatra (1983), Shekhawat & Anand (1984), Maheshwari (1995), etc. During recent years, Joshi (1995) and Singh & Pandey (1998) have reviewed the literature in details and added a lot to our knowledge on the ethnobotany of Rajasthan.

A perusal of literature revealed that more attention has been paid to tribal rich areas along Aravalli range and it's outliers in comparison to desertic zones in Rajasthan. Further, in desertic zones, Desert National Park, the only protected area with largest landmass in the country, has been greatly neglected in almost all aspects of biodiversity. As such, no concrete decision or action could be taken so far as regards it's notified status. Moreover, the ethnobotanical studies are essential from academic, indigenous knowledge, community and folk knowledge point of view for planning and decision making purposes. Documentation of ethnic knowledge is also necessary for protecting the bioresources and their products from biopiracy through patenting by western World. With the advancement of civilization through education, developmental activities and socio-economy, not only the traditional culture and ethnobotanical knowledge has been threatened but also the bioresources. Therefore, documentation of available folk knowledge should be taken as a campaign towards the promotion of sustainable use of plant resources, rural development and biodiversity conservation as emphasized in Convention on Biological Diversity (CBD).

Field work is one of chief tools of research in ethnobotany. As such, several intensive and extensive botanical exploration tours were taken for three years in different parts of the Park and information regarding plant parts used, purpose of use, method of preparation of drug or product and administration was collected from the inhabitants of Park, their local Vaids, Bhopas, Ojhas, etc. Further, ethnobotanical information was also collected from forest officials, postmen, tourist guides, mobile units of government physicians and veterinary doctors who have accrued enough knowledge regarding ethnobotanical uses of plants due to their long association with residents of Desert National Park. The authenticity of data was verified from different informants in different areas at different times inside and outside the Park. For further authentication of information and future reference, voucher specimens have been collected and preserved in BSJO. Local names, which sometimes help in determining the correct identity of plants referred in ancient literature and provide clues against biopiracy, have been recorded to avoid disputes. During the process of inventorisation and documentation of ethnobotanical information, the huts and houses of tribal communities were found rather more informative ethnobotanical museums where besides architecture of houses made from forest products, almost all household and occupational items of forest produce and their use and relation to their lives may be seen at a glance. Since no ethnobotanical work has been done earlier on Desert National Park, the literature has not provided any data or clues of plants and their uses, except the literature dealing with history, evolution and sociology of different tribes. The works done outside Desert National Park in desert area or Rajasthan have, however, helped in verification of information collected from the Park.

In the present work, valid botanical names of the species have been given in alphabetical order, followed by the names of families in parenthesis and local names in italics in second line. The filtered and authentic ethnobotanical information has been documented in the next paragraph under each species in a systematic manner. Map showing location of dwellings (villages) in the Park, photographs throwing light on the culture of tribals and illustrations / photographs of plants have been appended for easy determination of ethnobotanical taxa.

#### Observations :

##### *Abutilon indicum* (L.) Sweet (MALVACEAE)

*"Kanghi"*

Local inhabitants use bast-fiber extracted from the stem in making ropes and cordages. The paste of leaves and seeds with turmeric is applied on boils, abscesses and to cure syphilis. Infusion of leaves is taken orally to cure stomatitis and gonorrhoea.

##### *A. pannosum* (Forst. f.) Schlect. (MALVACEAE)

*"Kanghi-buti"*

Bast-fibre derived from the stem is locally used in making ropes and cordages for knitting cots.

##### *Acacia jacquemontii* Benth. (MIMOSACEAE)

*"Bu-bhanwali"*

Wood is used as firewood and sometimes for making toys and agricultural implements. Leaves are considered as good source of fodder especially for goats. Gum is used to cure bodyache and joint pain.

##### *A. nilotica* (L.) Willd. ex Delile subsp. *indica* (Benth.) Brenan (MIMOSACEAE)

*"Babul"* (Plate-18/1; Fig.-13).

Tribals eat roasted seeds during famine. Powdered stem-bark with seeds of *til* (*Sesamum indicum*) is also eaten by local inhabitants during scarcity of food. Gum extracted from stem is used for making *"Laddoo"* with wheat flour, sugar and ghee and are eaten to strengthen the power. Leaves and fruits serve as good fodder for cattle. Wood is used to make toys, cart and other household articles. The gum extracted from stem is mixed with dyes while dyeing cotton clothes. Powder of dry flowers with the flowers of *"Morali"* (*Lycium barbarum*) is taken orally to cure pimples. Bark is used to cure cholera. Gum is also used in local medicines for rheumatism. The decoction of stem-bark is used as antiseptic for washing cuts, sores and other skin diseases.

##### *A. senegal* (L.) Willd. (MIMOSACEAE)

*"Kumativo"* (Plate-18/2; Fig.-15).

Fruits are used to make a delicious vegetable with *"Ker"* (fruits of *Capparis decidua*) and *"Saugri"* (pods of *Prosopis cineraria*). During summers when fruits of *Mangifera indica* (Keri) are available in the market, the unripe fruits are also added with the vegetable to make it more tasty. Wood is used to make durable household articles, agricultural implements and in hut making. Gum extracted from stem is used for dyeing silk and cotton clothes and mixed with alkali during white wash of huts. It is also collected for selling in the market for earning money. Gum with wheat flour and sugar is given to ladies after delivery to protect

them from gout and rheumatism. The decoction of flowers is used to wash infected eyes. The gum dissolved in water is applied externally as an antiseptic and taken orally to cure inflamed intestine.

*Aerva javanica* (Horn. f.) Juss. ex Schult. (AMARANTHACEAE)

"Bui" (Plate-17/3).

Powdered seeds are mixed with Bajra flour and used to make breads during famine. Woolly seeds are used as stuffing material in pillows. Plants serve a good fuel-wood for the natives of DNP. Decoction of flowers is applied over swellings and taken orally for promoting urine discharge. Seeds are used in rheumatism.

*Ailanthus excelsa* Roxb. (SIMAROUBACEAE)

"Ardu"

Leaves are used as fodder, liked by goats. The wood is used to make light household articles. Decoction of leaves and bark is used as a remedy against skin eruptions.

*Alysicarpus vaginalis* (L.) DC. (FABACEAE)

"Sarui" (Plate-18/3).

Paste of roots is made and a juice is extracted which is given to the sufferers of congestion of liver, jaundice and gall-stone. It is also considered effective in curing bronchitis and pneumonia.

*Amaranthus viridis* L. (AMARANTHACEAE)

"Jangli chauli"

Tender branches and leaves are cooked as vegetable. This vegetable is considered effective in curing constipation and purifying blood.

*Amberboa ramosa* (Roxb.) Jafri (ASTERACEAE)

"Unt-kantelo"

Decoction of plant is used to cure cough.

*Ammannia baccifera* L. (LYTHRACEAE)

"Jal-bhangra" (Fig.-16).

Though painful blisters are caused by fresh bruised leaves, yet the tribals carefully crush the leaves, mix some mustard oil and apply this paste on the wounds to expel guinea worms.

*Arnebia hispidissima* (Sieber ex Lehm.) DC. (BORAGINACEAE)

"Rambui" (Plate-18/4).

Roots yield a red-purple dye, which is used for dyeing the clothes and hands and feet by ladies like "Henna" at the occasion of festivals.

*Bergia suffruticosa* (Delile) Fenzl. (ELATINACEAE)

"Kharbuji"

Plant sap is rubbed on sores and the paste is applied on broken bones by the tribals of the area.

***Blepharis linariaefolia* Pers. (ACANTHACEAE)**

"Bhangari"

Leaves and branches are given as fodder to cattle. It is believed that this fodder increases the milk production in goats and cows. Plant is also used as a tonic for sound health in the form of decoction in milk. Juice of seeds is applied in earache.

***Boerhavia diffusa* L. (NYCTAGINACEAE)**

"Chinawari, Santha"

The plant serves a good fodder during rainy season for cows. Decoction of roots and leaves is used orally to cure night blindness, asthma, jaundice and diarrhoea.

***Brachiaria ramosa* (L.) Stapf (POACEAE)**

"Murat"

Powdered grains are mixed with sugar and boiled with milk to make a local dish, called "Kheech" which is much liked by local inhabitants. It is believed to have cooling effect in the body. The grass also serves a very good fodder for cattle. Plant ash is mixed with boiled mustard oil and this paste is applied on burns as an ointment.

***Cadaba fruticosa* (L.) Druce (CAPPARACEAE)**

"Dabi"

Paste of fresh leaves is applied on boils and sores for early relief. The juice of leaves is given orally to expel worms from the digestive system, especially in children.

***Calligonum polygonoides* L. (POLYGONACEAE)**

"Phog" (Plate-19/1; Fig.-20).

Flower-buds, called "Lasson" are eaten by tribals with whey and salt in the Park area. It is locally called "Phogda ka raito" which is considered to give cooling effect to the body during summers. It can also be preserved for few days for future use if kept in cool and shady places. The plant is also used for making huts and in scarcity as fodder for camels. Wood is largely consumed as fire-wood in the Park area. The decoction of plants is used to gargle against sore-gums and leaf-juice is applied to wash the eyes.

***Calotropis procera* (Ait.) R. Br. (ASCLEPIADACEAE)**

"Aakdo"

Bast-fibre derived from the stem is used for making ropes and cordages, especially for knitting the cots. The flowers are offered to Lord Shiva. Floss of seeds is used for stuffing the pillows. Paste of roots is applied on the pimples and boils. The root-paste is also applied against scorpion-sting and walp. Latex with tobacco leaves is applied to expel guinea worms and spines if deeply entered in the feet. The latex is also rubbed or applied on gums and teeth with salt to relieve toothache.

***Capparis decidua* (Forssk.) Edgew. (CAPPARACEAE)**

"Ker" (Plate-19/2; Fig.-3).

Unripe fruits are used as vegetable and pickled. The mature fruits are eaten as such. The children suck the flowers for nectar. Wood is used as fire-wood, as it burns quickly. The wood is also believed not be

attacked by white ants and, therefore, used for making roofs of huts and small agricultural implements. The tender twigs are considered to strengthen gums and also used to relieve toothache. The decoction of root-bark is used orally to cure asthma, cough, intermittent fever, inflammation and rheumatism. The fruits are considered beneficial for cardiac troubles, if eaten for few days on maturity. The unwashed roots with sand around them are powdered, mixed with whey and applied on swellings and to relieve bodyache.

***Cenchrus biflorus* Roxb. (POACEAE)**

"Bhurat" (Fig.-23).

The grains have high percentage of sugar and protein and considered next to *Pennisetum* (Bajra). Powdered grains are mixed with Bajra flour or flour of *Citrullus colocynthis* (Tumbo) and baked to make breads, locally called "Khankara" Bhurat flour with ghee and sugar is fried to make another local delicious dish, called "Malad" It is considered good for health and muscle making. It is a good fodder grass for cattle.

***C. ciliaris* L. (POACEAE)**

"Dhaman"

The grains are used as a substitute of Bhurat grains for food and plants for fodder. *C. setigerus* Vahl (Dhaman) also finds identical uses.

***Chenopodium album* L. (CHENOPODIACEAE)**

"Bathuo"

Tender branches with leaves are cooked as vegetable. Decoction of plant is given in anaemia.

***Citrullus colocynthis* (L.) Schrad. (CUCURBITACEAE)**

"Tumbo" (Plate-19/3).

Seeds, after removing the bitterness by washing in salt-water, are powdered and mixed with Bajra flour to make breads. "Khankara" a local dish is also prepared from the seeds after mixing their flour with seed-flour of Bhurat (*Cenchrus biflorus*). The decoction of roots is pored 2-3 drops into ears to relieve earache. The root-powder is taken orally to cure jaundice and rheumatism. The natives prepare a local medicine to cure recurring acute stomachache by stuffing young fruits with salt and Ajwain (*Trachyspermum ammi*). They put such fruits for few days in dark and then eat. Seeds yield a non-edible oil, locally called "Tumba ka tail" used in paints, varnishing and in soap industry. As such, natives collect the fruits and sell them in the market of Barmer or Jaisalmer to earn money.

***C. lanatus* (Thunb.) Matsumura & Nakai var. *lanatus* (CUCURBITACEAE)**

"Matiro"

The watery fruit-pulp is sweet and edible and is used to quench thirst during summers when drinking water is not available. The powder of dried seeds is used to make breads with Bajra flour during famine. A local preparation, called "Kheech" is also made from seed-powder with milk and sugar. The roasted seeds with salt are also liked by the natives. The rind of the fruits is cooked as vegetable, called "Kheleera" The preparations of Matiro produce cooling effect in the body system of man and animals.

*C. lanatus* (Thunb.) Matsumura & Nakai var. *fistulosus* (Stocks) Chakravarty (CUCURBITACEAE)

"Tindri"

Unripe fruits are cooked as vegetable. Seed-powder is applied against scorpion sting by the local people.

*Cleome gynandra* L. (CLEOMACEAE)

"Safed-bugro" (Fig-1).

Leaves are applied in the form of paste to cure rheumatism and blisters. They also cure night blindness if eaten as vegetable for few months regularly. Seeds are used to cure cough in the form of decoction and to improve eyesight, if applied in the form of paste.

*C. vahliana* Fresen. (CLEOMACEAE)

"Madhio"

The decoction of fresh leaves is dropped in the nostrils of camel to cure worms. It is also believed to cure eczema and fungal infection on skin, if applied externally. Leaves and seeds are used to cure skin diseases, particularly eczema, scabies and leucoderma.

*C. viscosa* L. (CLEOMACEAE)

"Ragro" (Plate-12/1).

Seeds are given to children orally for effective deworming of the stomach. The paste of leaves heals up wounds quickly. The leaf-juice relieves carache.

*Cocculus pendulus* (J. R. & G. Forst.) Diels (MENISPERMACEAE)

"Pilwan"

A purple-blue dye is obtained from ripe fruits, which is used as ink and dyeing the clothes. Leaf-paste is applied externally as a remedy against oozing blood from nose. Leaf-sap with water is used to wash skin eruptions.

*Commiphora wightii* (Arn.) Bhandari (BURSERACEAE)

"Guggal" (Plate-19/4).

Stem yields "Guggal" a gum-resin, which is pale-brown in colour and used commercially in perfumery, calico-printing, dyeing silk and cotton and as an incense. The inhabitants of DNP are aware of its market value and, therefore, collect the gum-resin by making cuts in the stem and sell it in the urban markets. Decoction of plant or gum-resin in warm water is used for gargling against pyorrhoea and spongy gums. Bark-powder is given with milk to children suffering from speech defect, chronic bronchitis, cough and cold, etc. Gum-resin is also applied on cuts to stop bleeding. Fumes of gum-resin are inhaled to cure bronchitis, nasal catarrh and laryngitis. They also have insect repellent properties, particularly for flies and mosquitoes.

*Convolvulus prostratus* Forssk. var. *prostratus* (CONVOLVULACEAE)

"Santari" (Plate-20/1).

The plant has great medicinal importance as it is used as a substitute to make Ayurvedic drug "Shankhpushpi". Locally the powder of flowers with sugar is considered as a good brain tonic, purgative and laxative.



*Corchorus depressus* (L.) Vicary (TILIACEAE)

"Chamkas"

Infusion of plant and leaves is used orally as a tonic and also given in gonorrhoea, dysentery and hepatic disorders. Plants after drying in shade are powdered and taken with milk of goat to gain sexual vigour. Seeds are purgative, but effective if applied externally in the form of paste on skin eruptions.

*C. olitorius* L. (TILIACEAE)

"Chamghas"

Decoction of plant is used orally to cure gonorrhoea and syphilis for an early relief. Seeds are purgative.

*C. tridens* L. (TILIACEAE)

"Kagnasha"

Young shoots and leaves are used as pot-herb. It is believed that vegetable is good for health and protects from getting ill by strengthening the resistance.

*Cordia gharaf* (Forssk.) Ehrenb. ex Asch. (EHRETIACEAE)

"Goondi"

Mature fruits are eaten fresh or cooked as vegetable and sometimes pickled. It is believed that they cure constipation, piles and intestinal worms.

*Cressa cretica* L. (CONVOLVULACEAE)

"Rudenti"

Plant decoction is considered as a good health tonic for children and given orally for fast and regulatory growth of babies.

*Crotalaria burhia* Buch.-Ham. ex Benth. (FABACEAE)

"Sinia"

Bast-fibre obtained from the stem is used to make strong and durable ropes and cordage which are used for different purposes viz. making huts, wall, roof, doors, etc. Sometimes ropes are made by twisting the plants for tying the bundles of fire-wood or fodder. The plants serve a good fodder for camels and goats. Dry plants provide good fire-wood. Root-juice is used orally in kidney pain. Leaves and branches produce cooling effect, when used orally in the form of decoction.

*C. medicaginea* Lam. (FABACEAE)

"Gugario"

Plant is used as fodder for camels and goats in the Park area.

*Cucumis callosus* (Rottl.) Cogn. (CUCURBITACEAE)

"Kachri"

The fruits are edible raw or cooked as vegetable. The natives crush mature fruits with salt and prepare "Chutney" (sauce). The fruits are also dried and preserved for future use as vegetable. Some fruits are very bitter and considered toxic.

***C. melo* L. var. *momordica* Duthie & Fuller (CUCURBITACEAE)**

"Kachro"

Local inhabitants eat ripe fruits and cook them as vegetable. The unripe fruits are also used as vegetable and usually dried and preserved for off-season vegetable use. The paste of seeds is applied on penis to cure syphilis.

***C. prophetarum* L. (CUCURBITACEAE)**

"Khato-kucharlo" (Plate-14/3).

Fruit-pulp is highly purgative and toxic. The juice of roots is, however, used as a health tonic by man in some "Dhanis" of the Park.

***Cyamopsis tetragonoloba* (L.) Taub. (FABACEAE)**

"Gwar"

The young pods are cooked as vegetable and much liked by local inhabitants. They also dry up the fruits and preserve for future use. Plant as a whole is used as valuable fodder. Boiled grains are usually given to cattle as rich protein feed. "Gwar-gum" obtained commercially from the seeds is used in paints, printing and as an adhesive. The tribals in the Park, however, make no such use of it. Seeds are used to cure diabetes. Juice of leaves or crushed leaves is applied on the wounds to arrest bleeding. It is a cultivated crop in the area.

***Cyperus rotundus* L. (CYPERACEAE)**

"Motho" (Fig.-22).

Dried and powdered tubers are used to make breads during scarcity of food. Medicinally, the tubers are given to children to eat for deworming the intestine and to cure tonsillitis.

***Dactyloctenium scindicum* Boiss. (POACEAE)**

"Tantia-ghas"

Grains are used as food during famine, either by boiling them in water with salt and spices or in milk with sugar. They are also mixed with Bajra grains to increase the quantity of flour during famine. The grass serves a good fodder for cattle. *Dactyloctenium aegyptium* (L.) Willd. (Makra; Fig.-24) also finds similar uses in the Park.

***Datura innoxia* Mill. (SOLANACEAE)**

"Daturo" (Plate-20/2).

Paste of mature fruits or leaves is applied on swellings, boils, abscesses and on wounds of guinea-worm for early relief. Seeds are crushed and juice is used in the treatment of hydrophobia. Some people use juice of leaves for this purpose. Fruits are offered to Lord Shiva and considered poisonous.

***Desmostachyu bipinnata* (L.) Stapf (POACEAE)**

"Dab"

Leaves and culms are used to make ropes and cordages by twisting them. Culms are also tied together and brooms are made and sold in the market to earn some money.

*Dichanthium foveolatum* (Del.) Roberty (POACEAE)

"Rohis"

The grass serves a good fodder for cattle.

*Dicoma tomentosa* Cass. (ASTERACEAE)

"Vajradanti"

Roots are used as tooth-brush to cure toothache and acute pyorrhoea by the tribals in the Park area.

*Echinochloa colona* (L.) Link (POACEAE)

"Jiriu"

The grass is very much liked by cattle as fodder. The inhabitants collect the mature grains and boil them with milk and sugar to prepare "Kheer" – a delicious dish.

*Eclipta prostrata* (L.) L. (ASTERACEAE)

"Jal-bhangro"

Paste of seeds and plant is applied for blackening hairs and to give cooling effect to the brain. The leaf-juice is given orally to cure diarrhoea, dysentery and jaundice.

*Euphorbia caducifolia* Haines (EUPHORBIACEAE)

"Danda-thor"

Young leaves are sometimes cooked as vegetable. Dried stems are used as fuel-wood in the Park area. Milky latex is applied externally to cure cutaneous eruptions, leucoderma, earache and to expel guinea-worms.

*Fagonia schweinfurthii* (Hadidi) Hadidi ex Ghafoor (ZYGOPHYLLACEAE)

"Dhamaso"

The dried fruits are powdered and mixed with Bajra flour to make bread during scarcity of food. The decoction of plant is given orally to cure cough, cold and bronchitis.

*Glinus lotoides* L. (MOLLUGINACEAE)

"Bakda"

Decoction of plant is used as a remedy against urinary troubles. It is also used as a cure for indigestion. Powder of dried plant is applied on boils and wounds.

*Grewia tenax* (Forssk.) Fiori (TILIACEAE)

"Gangan" (Plate-12/3; Fig.-5).

Tribals like to eat mature fruits in the Park area. Walking sticks are made from wood, which are also used to control herds of cattle. Decoction of young stem and leaves is generally used to cure cough. Juice of leaves is applied on skin eruptions.

***Haloxylon salicornicum* (Moq.) Bunge ex Boiss. (CHENOPODIACEAE)**

"Lana"

Dried plants are used as fire-wood. Ash of young dried stem is taken orally to cure ulcer.

***Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult. (POACEAE)**

"Lapio"

Seeds are eaten to clear the urine and intestinal obstructions.

***Hibiscus micranthus* L. f. (MALVACEAE)**

Young leaves are used as vegetable during famine period by local inhabitants. Stem-bark is peeled and used for tying purposes like a rope.

***Indigofera argentea* Burm. f. (FABACEAE)**

"Neela-bekario"

The seeds are used as anthelmintic to expel the intestinal worms.

***I. cordifolia* Heyne ex Roth (FABACEAE)**

"Bekar" (Plate-20/3; Fig.-9).

During scarcity, the seeds are mixed with Bajra grains to make breads by local inhabitants. Plants serve a very good fodder for cattle. Seed-decoction is used to cure throat congestion and bronchitis.

***I. linifolia* (L. f.) Retz. (FABACEAE)**

"Lambio-bekario" (Plate-20/4; Fig.-10).

Powder of seeds is mixed with other cereal's flour and used for making breads during scarcity of food. The decoction of flowering plants is used as a wash for skin diseases.

***Lasiurus scindicus* Henr. (POACEAE)**

"Sevan"

Plants serve a valuable fodder for cattle. Due to its high fodder value, the forest department is now enhancing the production of this grass in the Park area. The grains are mixed with Bajra and their flour is made into breads during famine.

***Launaea procumbens* (Roxb.) Ramayya & Rajagopal (ASTERACEAE)**

"Rookhadi, Jangli-gobhi"

Tribal people apply the paste of plant on the teats of goats and cows to cure inflammation.

***Leptadenia pyrotechnica* (Forssk.) Decne. (ASCLEPIADACEAE)**

"Khimp"

Plant is used as a good fuel-wood. Bast-fibre extracted from the stem is used to make ropes and cordages. The whole plant is also twisted with others to make ropes for fastening the bundles of fire-wood and fodder. Plant-sap is dropped into nostrils to cure cold. Decoction of roots is used against gastric ailments. Young leaves are applied to cure scabies in the form of paste.

***Lycium barbarum* L. (SOLANACEAE)**

"Morali"

The leaves are powdered, mixed with ghee and applied on abscesses. Powdered stem-bark is introduced into nostrils to cure bronchitis in cattle.

***Maerua oblongifolia* (Forssk.) A. Rich. (CAPPARACEAE)**

"Aropa"

Unripe fruits are eaten during scarcity of food

***Mollugo cerviana* (L.) Seringe (MOLLUGINACEAE)**

"Chirya-ro-khet" (Fig.-19).

Plant is cooked as vegetable. The vegetable is also given to ladies after delivery to clear the uterus.

***Momordica charantia* L. (CUCURBITACEAE)**

"Karelo"

Unripe fruits are eaten as vegetable. Juice of fruits is considered as blood purifier and given in diabetes.

***Moringa concanensis* Nimmo ex Datz. & Gibs. (MORINGACEAE)**

"Sargu"

Unripe fruits are cooked as vegetable. Leaves serve a good fodder for cattle. Wood is used to make huts.

***Ochthochloa compressa* (Forssk.) Hilu (POACEAE)**

"Ganthia-ghas, Ghora-dhob"

Grass is a source of fodder for cattle. Decoction of plant is taken orally to cure rheumatism. It is also believed to purify blood. Flowers are considered to have blood clotting properties and used to stop haemorrhage.

***Panicum antidotale* Retz. (POACEAE)**

"Garmano. Ghirdano" (Fig.-25).

Powder of grains is mixed with the flour of other cereals and used to make breads during scarcity of food. Plant is considered as a good fodder. Ash of plant is applied on burns.

***P. turgidum* Forssk. (POACEAE)**

"Muratio"

The food value is same as of *P. antidotale* Retz., but this grass provides a rather good fodder for cattle.

***Phyllanthus fraternus* Webster (EUPHORBIACEAE)**

"Gugario"

Young stem yields a dye, which is locally used to dye the hairs of goat and sheep as an identification mark. Roots are given with "Guggal" twigs in the form of a paste to cure indigestion in camels. Leaf-paste is applied for early cure of syphilis.

***Portulaca oleracea* L. (PORTULACACEAE)**

"Kulfo, Luni, Luno"

The plant is cooked as vegetable, which is considered as an effective tonic for liver. Plants also have cooling properties, as such, the paste of plants is applied on body for relief in blisters and for protecting the body from scorching heat of summers.

***Prosopis cineraria* (L.) Druce (MIMOSACEAE)**

"Khejari"

Pods are eaten as vegetable, locally called "Sangri". They are also dried and preserved for future use. Powder of bark, mixed with Bajra flour, is used to make breads during famine. Leaves, locally called "loong" serve a good fodder for all cattle. Wood is used as fire-wood. Timber is used to make huts, called "Jhupas" agricultural implements, household articles, etc. Gum obtained from young trees, locally called "Bantaka" has cooling effect and eaten during summers. The flowers are considered as a safeguard against abortion and, therefore, eaten by pregnant ladies. Mashed leaves are applied on injury. Paste of stem-bark is also applied on injury for easy healing. Tree is worshiped and known as "Tree of Eternity" in the Park.

***P. juliflora* (Swartz) DC. (MIMOSACEAE)**

"Angreji-bavliyo"

Mature pods are eaten by the goats. The sweet pulp of ripe fruits is eaten by children. Plants serve a good fuel-wood. Wood is also used for making agricultural tools, gates of "Jhupas" etc. Gum extracted from the stem has a potential in calico-printing, but used as an adhesive by the tribals.

***Pulicaria crispa* (Forssk.) Benth. & Hook. f. (ASTERACEAE)**

"Dholo-ligru"

Dried plants are powdered and a paste is formed with water which is applied to heal up the wounds in cattle. Leaf-paste is applied to relieve headache.

***Salvadora oleoides* Decne. (SALVADORACEAE)**

"Kharo-jal"

Mature fruits are eaten. They are also dried and preserved for future use. They increase sexual potentiality. Leaves are used as fodder. Timber is used for making huts and agricultural implements. Wood serves a good fuel-wood. Roots are given in pyorrhoea and cough. Seed-paste is applied to cure rheumatism.

***S. persica* L. (SALVADORACEAE)**

"Meetha-jal, Pilu"

Fruits are edible. Young twigs are used as tooth-brush. Wood is used in making "Jhupas" and agricultural implements. Root-bark is acrid and quick vesicant. Dried fruits are given against snake-bite for inducing vomiting.

***Sida cordata* (Burm. f.) Borssum (MALVACEAE)**

"Adio-bal"

Bast-fibre obtained from the stem is used in making ropes and cordages. Dried leaves are pasted and applied in skin diseases.

*S. ovata* Forssk. (MALVACEAE)

"Balro"

Stem-bark yields fibre which is sometimes used for tying purposes. Roots have cooling effect, as such, boiled in water and decoction is used as a tonic

*Tecomella undulata* (Sm.) Seem. (BIGNONIACEAE)

"Rohira" (Plate-21/1).

The wood is called "Marwar teak" which has high timber value. It is used in making agricultural implements, furniture, cart-wheels, houses and household articles, etc. Twigs are used as tooth-brush. Stem-bark is applied to cure eczema and root-bark is taken internally by ladies to cure leucorrhoea.

*Tephrosia purpurea* (L.) Pers. (FABACEAE)

"Bivnio"

Roots and twigs are used as tooth-brush to cure toothache and pyorrhoea. Plant-sap, especially of roots, is poured into ears to cure earache. The decoction of plant is given orally to cure acute dry cough.

*Tragus roxburghii* Panigrahi (POACEAE)

"Makhni"

The grass is considered as a good fodder for goats in flowering state to increase milk production.

*Tribulus terrestris* L. (ZYGOPHYLLACEAE)

"Gokhru, Kanti" (Plate-21/2).

Seeds are powdered and mixed with Bajra flour to make breads during famine. Plant is used as fodder for camels and also dried and stored for this purpose. Decoction of plant is given in urinary gravel and also used as a remedy for impotency. The powder of fruits and *Sesamum indicum* (Til) seeds with milk and sugar also enhance sexual vigour, if taken orally.

*Zaleya govindia* (Buch.-Ham. ex G. Don) Nair (AIZOACEAE)

"Santhi" (Fig.-17).

Seeds on eating cause abortion, diarrhoea and paralysis. As such, natives of Park consider it a poisonous plant.

*Ziziphus mauritiana* Lam. (RHAMNACEAE)

"Bor" (Plate-21/3).

Local people eat ripe fruits and sell them in the market to improve their economy. Leaves are used as fodder for goats. Wood is used for making huts, toys and some household articles. The paste of bark is applied on boils. The decoction of roots and leaves is taken orally to cure diarrhoea.

*Z. nummularia* (Burm. f.) Wight & Arn. (RHAMNACEAE)

"Bor, Bardi"

Twigs are used to make screens, locally called "Tats" for keeping the huts cool. They are also used for fencing the cattle yards and agricultural fields. Ripe fruits are eaten and also dried and preserved for future

use. Local people also sell them in the market. The powder of dry fruits is mixed with Bajra flour for making breads. Leaves serve a good fodder for goats and camels. Fruits are used to cure cough and bronchitis problems.

*Zygophyllum simplex* L. ( ZYGOPHYLLACEAE )

“Luni, Luno” (Plate-21/4).

The infusion of leaves and seeds is applied to the eyes in problems of ophthalmia. The seeds are eaten for deworming the intestine.

#### Use-wise Classification of Plants

**Dye :** *Arnebia hispidissima*, *Cocculus pendulus* and *Phyllanthus fraternus*.

**Fibre :** *Abutilon indicum*, *A. pannosum*, *Calotropis procera*, *Crotalaria burhia*, *Desmostachya bipinnata*, *Hibiscus micranthus*, *Leptadenia pyrotechnica*, *Sida cordata* and *S. ovata*.

**Fire-wood :** *Acacia jacquemontii*, *Aerva javanica*, *Capparis decidua*, *Crotalaria burhia*, *Euphorbia caducifolia*, *Haloxylon salicornicum*, *Leptadenia pyrotechnica*, *Prosopis cineraria* and *P. juliflora*.

**Fodder :** *Acacia jacquemontii*, *A. nilotica* subsp. *indica*, *Ailanthus excelsa*, *Blepharis linariaefolia*, *Boerhavia diffusa*, *Brachiaria ramosa*, *Calligonum polygonoides*, *Cenchrus biflorus*, *C. ciliaris*, *C. setigerus*, *Crotalaria burhia*, *C. medicaginea*, *Cyamopsis tetragonoloba*, *Dactyloctenium aegyptium*, *D. scindicum*, *Dichanthium foveolatum*, *Echinochloa colona*, *Indigofera cordifolia*, *Lasiurus scindicus*, *Moringa concanensis*, *Ochthochloa compressa*, *Panicum antidotale*, *P. turgidum*, *Prosopis cineraria*, *P. juliflora*, *Salvadora oleoides*, *Tragus roxburghii*, *Tribulus terrestris*, *Ziziphus mauritiana* and *Z. nummularia*.

**Food and Vegetables :** *Acacia nilotica* subsp. *indica*, *A. senegal*, *Aerva javanica*, *Amaranthus viridis*, *Brachiaria ramosa*, *Calligonum polygonoides*, *Capparis decidua*, *Cenchrus biflorus*, *C. ciliaris*, *C. setigerus*, *Chenopodium album*, *Citrullus colocynthis*, *C. lanatus* var. *lanatus*, *C. lanatus* var. *fistulosus*, *Corchorus tridens*, *Cordia gharaf*, *Cucumis callosus*, *Cucumis melo* var. *momordica*, *Cyamopsis tetragonoloba*, *Cyperus rotundus*, *Dactyloctenium aegyptium*, *D. scindicum*, *Echinochloa colona*, *Euphorbia caducifolia*, *Fagonia schweinfurthii*, *Grewia tenax*, *Hibiscus micranthus*, *Indigofera cordifolia*, *I. linifolia*, *Lasiurus scindicus*, *Maerua oblongifolia*, *Mollugo cerviana*, *Momordica charantia*, *Moringa concanensis*, *Panicum antidotale*, *P. turgidum*, *Portulaca oleracea*, *Prosopis cineraria*, *P. juliflora*, *Salvadora oleoides*, *S. persica*, *Tribulus terrestris*, *Ziziphus mauritiana* and *Z. nummularia*.

**Gum and resin :** *Acacia jacquemontii*, *A. nilotica* subsp. *indica*, *A. senegal*, *Commiphora wightii*, *Cyamopsis tetragonoloba*, *Prosopis cineraria* and *P. juliflora*.

**Medicine :** *Abutilon indicum*, *Acacia jacquemontii*, *A. nilotica* subsp. *indica*, *A. senegal*, *Ailanthus excelsa*, *Alysicarpus vaginalis*, *Amaranthus viridis*, *Amberboa ramosa*, *Annona baccifera*, *Bergia suffruticosa*, *Blepharis linariaefolia*, *Boerhavia diffusa*, *Brachiaria ramosa*, *Cadaba fruticosa*, *Calligonum polygonoides*, *Calotropis procera*, *Capparis decidua*, *Chenopodium album*, *Citrullus colocynthis*, *C. lanatus* var. *fistulosus*, *Cleome gynandra*, *C. vahliana*, *C. viscosa*, *Cocculus pendulus*, *Commiphora wightii*, *Convolvulus prostratus*, *Corchorus depressus*, *C. olitorius*, *Cordia gharaf*, *Cressa cretica*, *Crotalaria burhia*, *Cucumis melo* var. *momordica*, *C. prophetarium*, *Cyamopsis tetragonoloba*, *Cyperus rotundus*, *Datura innoxia*, *Dicoma tomentosa*, *Eclipta prostrata*, *Euphorbia caducifolia*, *Fagonia schweinfurthii*, *Glinus lotoides*, *Grewia tenax*, *Haloxylon salicornicum*, *Heteropogon contortus*, *Indigofera argentea*, *I. cordifolia*, *I. linifolia*, *Lamium procumbens*, *Leptadenia pyrotechnica*, *Lycium barbarum*, *Mollugo cerviana*, *Momordica charantia*, *Ochthochloa compressa*.



*Panicum antidotale*, *Phyllanthus fraternus*, *Portulaca oleracea*, *Prosopis cineraria*, *Pulicaria crispa*, *Salvadora oleoides*, *S. persica*, *Sida cordata*, *S. ovata*, *Tecomella undulata*, *Tephrosia purpurea*, *Tribulus terrestris*, *Ziziphus mauritiana*, *Z. nummularia* and *Zygophyllum simplex*.

**Poison** : *Cucumis callosus*, *C. prophetarum*, *Datura innoxia* and *Zaleya govindia*.

**Timber** : *Acacia jacquemontii*, *A. nilotica* subsp. *indica*, *A. senegal*, *Ailanthus excelsa*, *Capparis decidua*, *Grewia tenax*, *Moringa concanensis*, *Prosopis cineraria*, *P. juliflora*, *Salvadora oleoides*, *S. persica*, *Tecomella undulata* and *Ziziphus mauritiana*.

**Miscellaneous** : *Acacia nilotica* subsp. *indica*, *Aerva javanica*, *Calligonum polygonoides*, *Calotropis procera*, *Citrullus colocynthis*, *Datura innoxia*, *Desmostachya bipinnata*, *Prosopis cineraria*, *Salvadora persica*, *Tecomella undulata* and *Ziziphus nummularia*.

### Discussion

A perusal of literature revealed that about 610 species have ethnobotanical uses in Rajasthan (Joshi, 1995; Singh & Pandey, 1998). Of these, about 242 species have been recorded from Rajasthan desert (Singh & Shetty, 1977; Singh & Pandey, 1983, 1985). The present study revealed that Desert National Park which occupies an area of 3162 sq km, i.e. 0.92 per cent of total area of Rajasthan (3, 42, 239 sq km) and 1.61 per cent of Rajasthan desert (1,96,150 sq. km), harbours 91 species of ethnobotanical interest. The area and ethnobotanical ratio falls 0.0018 species/sq km in Rajasthan, 0.0012 species/sq km in Rajasthan desert and 0.029 species/sq km in Desert National Park. The high ethno-biodiversity values in DNP provide additional support for its notified status among protected areas of the country.

Table-12. Comparative ethnobotanical values of Rajasthan State, Rajasthan Desert and Desert National Park.

USES	RAJASTHAN	RAJASTHAN DESERT	DNP
Dye	18	10	3
Fibre	50	25	10
Fire-wood	18	26	9
Fodder	21	16	29
Food & Vegetables	149	86	42
Gum & Resin	17	9	7
Medicine	365	183	68
Poison	98	98	4
Tannin	11	9	Nil
Timber	82	27	13
Miscellaneous	181	70	11
Total ethnobotanical species	610	242	91

The second clue in favour of *in-situ* conservation of biodiversity of DNP may be obtained by calculating the ratio of total number of species and species having ethnobotanical potential. In Rajasthan, out of 1910 species (Shetty & Singh, 1987, 1991, 1993), 610 species i.e. 32 per cent have ethnobotanical value. In Rajasthan desert, out of 682 species (Bhandari, 1978, 1990), 242 species i.e. 35.48 per cent and in Desert National Park out of 245 species, about 91 species i.e. 37.14 per cent have ethnobotanical potential.

A perusal of table-12 revealed that ethnomedicinal value of plants have been rather more recognized in comparison to other uses. Out 365 ethnomedicinal species found in Rajasthan, about 183 species (50.14 per cent) grow in desert area and 68 species (18.63 per cent of total and 37.16 per cent of desert species) in DNP. The second place is occupied by wild food and vegetables, as out of total 149 species of Rajasthan, 86 species (57.72 per cent) grow in desert which frequently faces the conditions of famine. Desert National Park harbours 42 species i.e. 28 per cent of total and 49 per cent of desert components. Timber yielding species are rather poorly represented in the desert, including DNP. Out of 82 species of Rajasthan, 27 species occur in desert and 13 in DNP, representing 15.85 per cent of Rajasthan and 48.15 per cent of desert, indicating that the arborescent components of this area are under great pressure of exploitation. In Rajasthan, there are about 50 species which yield bast or floss fibre; of these, 25 species (50 per cent) also occur in desert area and 36 per cent (10 species) of latter in DNP. Desert National Park, however, harbours maximum number of fodder species (29 species); of these, only 16 species (55.17 per cent) are used as fodder in rest part of desert and 72.41 per cent (21 species) in Rajasthan as a whole. The remote location of DNP and lack of fodder aid from other agencies have compelled the residents of DNP to identify more fodder species for their herds.

It is evident from the Histogram (Diagram-3) that next upmost requirement of residents of DNP is fire-wood. In Rajasthan, about 18 species of trees and shrubs have been identified for fire-wood. However, the number of fire-wood species reaches to 26 in desert because of exploitation of herbaceous taxa for fulfilling their fuel demand, since tree and shrubby fire-wood yielding species are limited and under great pressure for timber, food and fodder. Occurrence of 9 species (35 per cent of desert species) of fire-wood value in DNP indicates further high degree of biotic pressure on these species. The number of dye-yielding species of Rajasthan (18 species) is reduced to about 50 per cent (10 species) in desert and again to about 33 per cent of latter in DNP (3 species). It supports the theory that dye yielding species flourish better in comparatively high rainfall areas. Gum and resin yielding species have also followed the pattern of dyes, because gum and resin producing species are mostly trees which are rather poorly represented in desert environment. Out of 17 species of Rajasthan, 9 species (52.94 per cent) occur in desert and 7 species (77.78 per cent of desert) in DNP. Tannin yielding species are rather better represented in desert (9 species) against total 11 species of Rajasthan. No tannin yielding species could be noticed in DNP. It is due to edaphic conditions not being rocky terrain which these species prefer to grow. The poisonous contents have been identified maximum in desertic elements (98 species), equivalent to Rajasthan as a whole. In Desert National Park, however, only 4 such species have found habitat to establish.

The above discussion revealed that the area demarcated as Desert National Park is ethnobotanically rich in parameters of area : ethnobotanical species ratio (1:35), total species : ethnobotanical species ratio (2.7 : 1) and human population : ethnobiodiversity ratio (205 : 1). About 9 species viz. *Ailanthus excelsa*, *Amberboa ramosa*, *Citrullus lanatus* var. *fistulosus*, *Cleome vahliana*, *Corchorus tridens*, *Echinochloa colona*,

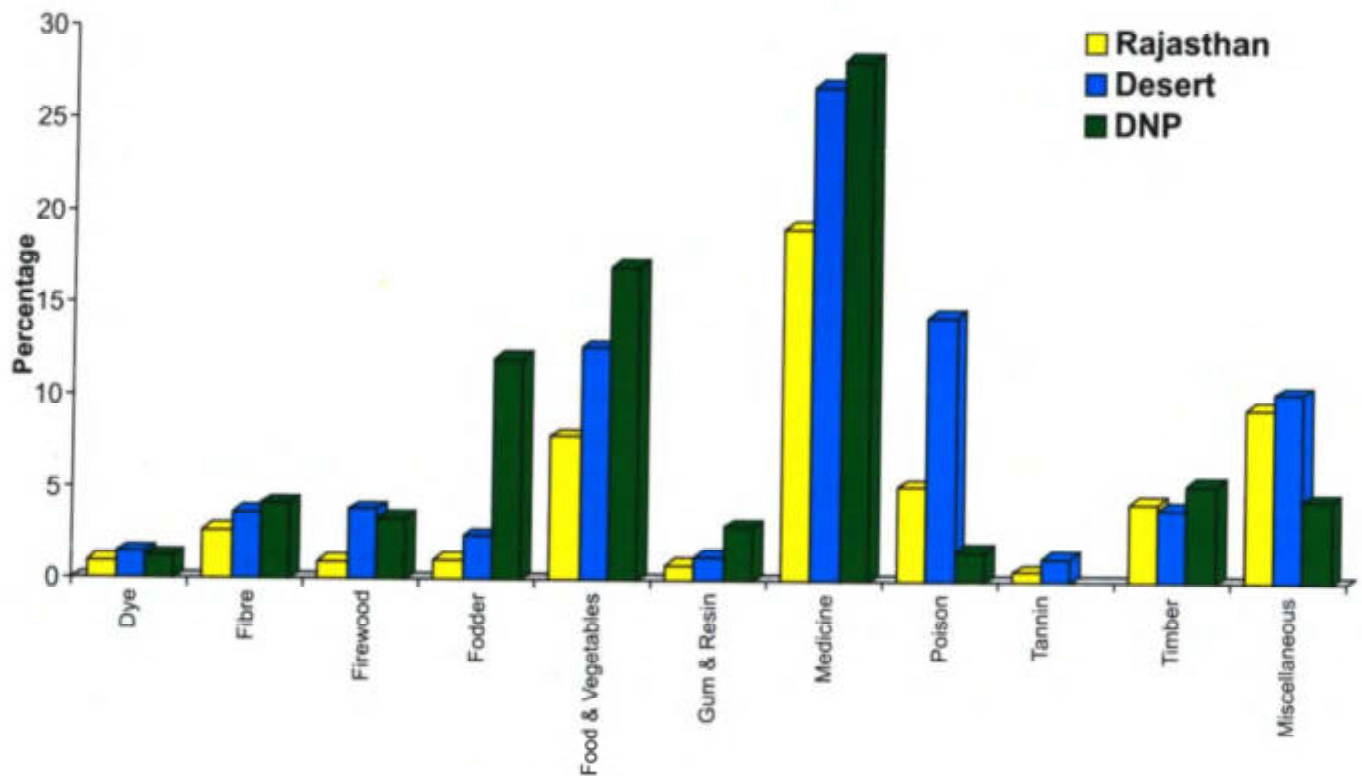
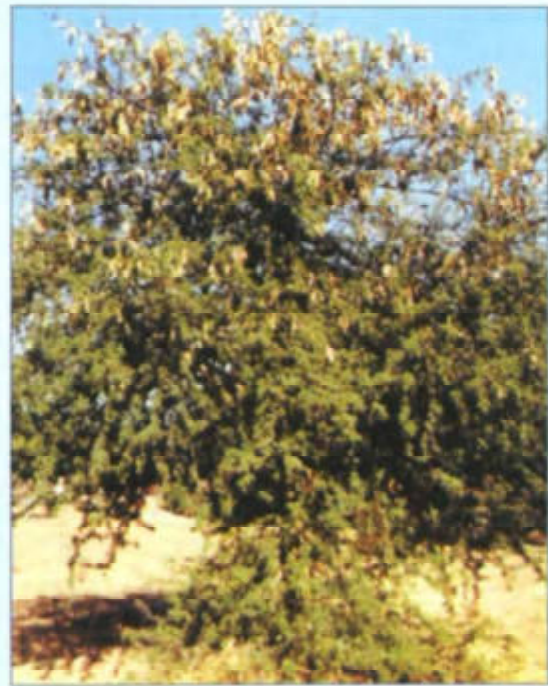


Diagram-3. Diagrammatic presentation in terms of percentage of ethnobotanic species in the floral diversity of Rajasthan, Rajasthan Desert and DNP.

*Hibiscus micranthus*, *Maerua oblongifolia* and *Tragus roxburghii* have been recorded for the first time in Rajasthan from DNP which have ethnobotanical potential. The other interesting fact to record includes the plant organs used, purpose of use and methodology are almost similar in DNP and rest part of desert, except in few cases. This again indicates that DNP in limited geographical area preserves ethnic culture heritage of vast desert.



1. *Acacia nilotica* (L.) Willd. ex Del.  
subsp. *indica* (Benth.) Brenan



2. *Acacia senegal* (L.) Willd.



3. *Alysicarpus vaginalis* (L.) DC.



4. *Arnebia hispidissima* (Sieber ex Lehm.) DC.

**Plate-18**

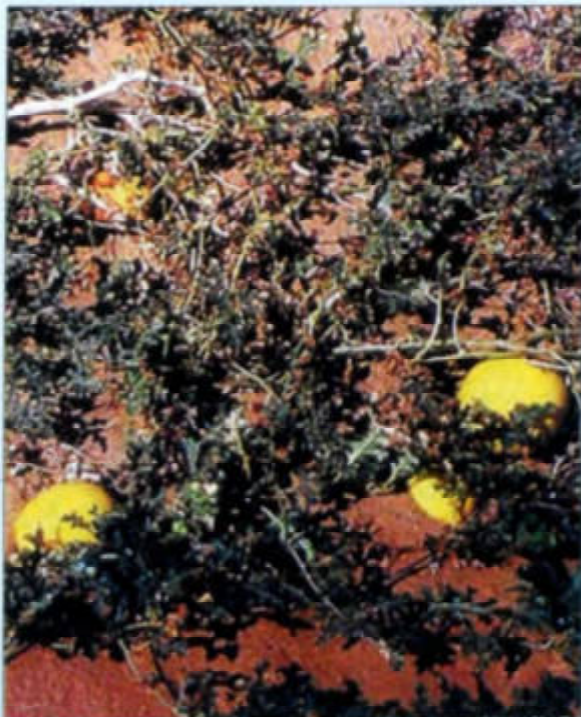




1. *Calligonum polygonoides* L.



2. *Capparis decidua* (Forsk.) Edgew.



3. *Citrullus colocynthis* (L.) Schrad.



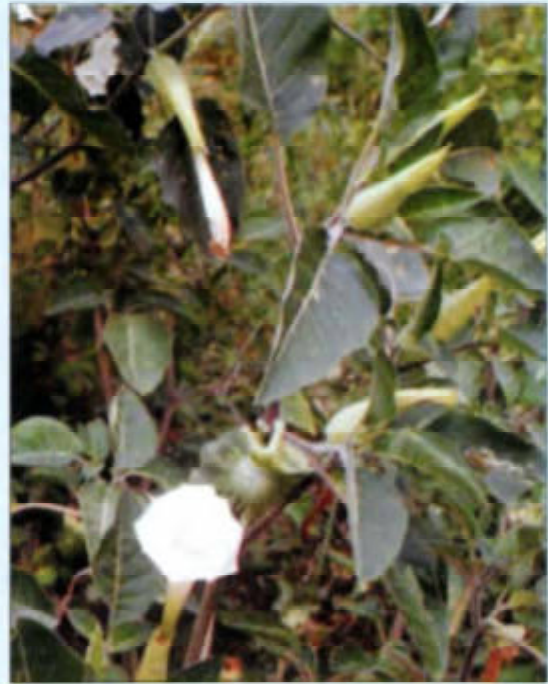
4. *Commiphora wightii* (Arn.) Bhandari

**Plate-19**





1. *Convolvulus prostratus* Forssk. var. *prostratus*



2. *Datura innoxia* Mill.



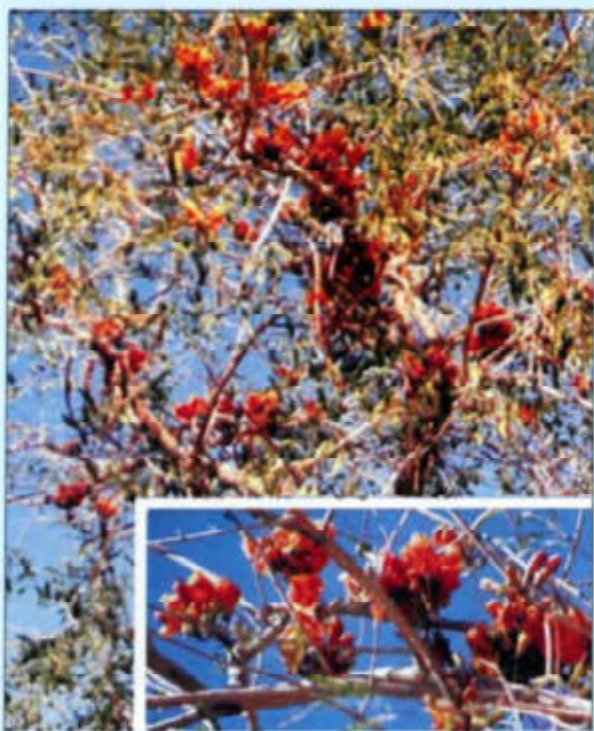
3. *Indigofera cordifolia* Heyne ex Roth



4. *Indigofera linifolia* (L. f.) Retz.

**Plate-20**





1. *Tecomella undulata* (Sm.) Seem.



2. *Tribulus terrestris* L.



3. *Ziziphus mauritiana* Lam.



4. *Zygophyllum simplex* L.

Plate-21

### THREATS TO BIODIVERSITY

Desert National Park is internationally unique, incomparable and one of the most unusual areas of the World. Uniqueness of the area is due to its geomorphological value, and the existence of rare and endangered plant and animal species further qualify DNP as one of the first wilderness areas selected for conservation. This is the only protected area in the entire World having populations of endangered Great Indian Bustard. The area also sustains a unique floral composition and harbours a variety of wildlife, characteristic to the area. Many endemic species of both plants and animals have been recorded in the Park area. Though, there is an absence of dense vegetation what characterizes a desert, the Park area shows floral and faunal richness in terms of the area it covers. The wide traditional knowledge of residents of Park regarding different uses of plants has enhanced its bioprospective value. The location of the Park on the western boundary of the country has given it an opportunity to provide first niche for settling down the Afro-Arabian elements from west. Besides characteristic landscapes within the Park, characteristic of Thar desert, the physical environment is rather more harsh than rest part of desert area, making it a more fragile ecosystem than elsewhere. Such an ecologically sensitive and biologically rich area under Desert National Park is facing multifold threats mainly due to non-implementation of laws laid down under Wildlife Protection Act, 1972 to bring a protected area under legal framework. As such, the biotic and abiotic components constituting the biodiversity of National Park are facing natural and anthropological threats to the extent that if immediate measures are not taken towards forcible implementation of conservation laws, the area will be further denuded, converting into a wasteland. Under these circumstances, there will be hardly any other location in the desert suitable for establishing a conservation unit and real desert ecosystem will become a historical event. Presently, the biodiversity of Desert National Park is facing mainly following threats leading to depletion of floral and faunal resources and ecosystem as a whole.

#### Settlement pattern and population pressure

There have been about 37 revenue villages and 48 Dhanis in the Park area scattered all over. Besides this, every family has also constructed "Jhupa" (hut) in one of his agriculture fields. As such, the families live scattered in the Park, exerting anthropological pressure all over the Park for fulfilling their requirements for livelihood. The Park houses about 18,618 human population (Census 1991). Their houses or huts are made up of mainly trees, shrubs and undershrubs viz. *Prosopis cineraria*, *Acacia nilotica* subsp. *indica*, *Calotropis procera*, *Capparis decidua*, *Crotalaria burhia*, *Leptadenia pyrotechnica* etc and few tall grasses like *Lasiurus scindicus*, *Panicum antidotale*, *Dichanthium annulatum*, etc. The residents also depend on wild food (about 42 species), since agriculture cropping is not usually possible due to irregular and scanty rainfall. The important supplementary foods collected from the wild include fruits and seeds of *Acacia senegal*, *Capparis decidua*, *Prosopis cineraria*, *Ziziphus nummularia*, *Panicum turgidum*, *P. antidotale*, *Cenchrus biflorus*, *Echinochloa colona*, etc. As such, the vegetation of Park is under pressure of residents for gum and resin, fuel, fibre, dye, medicine, food, shelter, etc. and settlement pattern is like that the conservation of biodiversity is not possible even in the core area or areas (Plate-22 & 23).

Increasing human population in the Park area is a serious stress, particularly on vegetal resources. Besides thatching material for hutments and food, the trees and shrubs and even their roots are indiscriminately cut for fuel, top feed, thorn fencing, etc. The studies revealed that requirements of woody biomass have increased with the increase in population and as such, woody biomass has decreased to lowest level in comparison to shrubs and herbaceous flora. However, low regeneration capacity and slow growth rate of tree species are also responsible for decline in tree layer to some extent. Further, with the increase of economy



of the residents, the transportation vehicles have increased which cause disturbance in natural living conditions and comfort of wild birds and animals.

### **Grazing**

The population of livestock in the Park is about 38,429, mainly cows, goats, sheep and camels (Census, 1991). Fodder from the fields is not available in sufficient quantity. As such, grazing is an unavoidable necessity in the Park. The residents of Park are little aware about the damage caused to biodiversity through grazing. As such, they first prefer agriculture fields, orans and pasture lands for grazing their cattle. But, unfortunately, the carrying capacity of these pasture lands soon fails to bear the pressure of herds and then indiscriminate grazing starts in the Park, leaving nothing green within the approach of cattle. In case of severe drought conditions, the herds of nearby villages further enhance the problem. Ultimately, the conditions compel the residents to migrate to other areas outside the Park with their cattle till the return of favourable conditions. The overgrazing not only enhances soil erosion by exposing the soil surface, but also create shortage of foraging material for herbivorous wild animals, destroy shelter of wild fauna living within the burrows, on the earth surface and on the plants, leading to death of many and substantially affecting food chain and energy flow within the Park. The overgrazing also leads to decrease in population density of therophytic plant species due to the failure of pollination and seed production in sufficient quantity. Further, the life of many pollinating agents also comes on risk. The observations revealed that the grazing also affects the habit of plants due to the damage of shoot apices, even the trees take bushy shape. Further, uprooting of plants during grazing and browsing up to base level of herbaceous ephemerals result that many species not only disappear from the ecosystem before completing their life-cycle, but are not recorded during the study of ecosystem functioning (Plate-24/2 & 25).

Another hazard that domestic livestock pose to each other and to the health of wild ungulates is by sharing common grazing ground where the domesticated and wild animals often come into contact with each other. Parasites and microbes, which cause some serious ailments in domestic livestock, like rinderpest, foot and mouth disease etc, find the wild ungulates easily accessible hosts. Thus, a single action of grazing leads to multiple reactions in the ecosystem in a slow but inexorably deleterious manner.

### **Military activities**

It is very unfortunate for DNP that it is situated near international border between India and Pakistan. At the time of high tension between two countries, the military activities increase and result in degradation of natural living conditions of wildlife in the Park area. During the year 2001-02, the Military occupied the area for about eleven months continuously – the longest period in the history of independent India, and degraded the ecosystem to great extent.

### **Tourism**

Recently, the number of visitors to the Park has increased rapidly. Huge sand-dunes of different sizes and orientations, camel safari, folk dances and songs, jhupas etc attract the tourists not only from India but also from foreign countries. The increasing interest in wildlife tourism and the geographical location of the DNP in desert land have made this area internationally popular. Film industry persons for picturising film scenes, songs, private albums and TV advertisements etc are also giving priority to the Park and nearby areas. These all have resulted in a chaotic increase in the number of visitors to the Park, resulting in high level human

interference. Most of the tourists are ignorant of the forest and wildlife laws and rules of the protected areas (example – the subjudice case of film actor Shri Salman Khan). Increasing tourism activities have resulted into high pressure of transport vehicles, which are noisy and also pollute the air. These visitors also throw away plastic bags, tin cans, waste material, food left over, cigarette butts, bottles etc that can cause ill effects on the health of wild animals. Thus, the tourism is also one of the main causes of degradation of ecosystem and pollution in Desert National Park (Plate-26 & 27).

### Poaching & Hunting

Poaching within the Park is neither a common practice nor has posed any serious problem to the biodiversity. A few hunting incidences have, however, been recorded since the establishment of Park, carried out illegally by the residents of the Park and nearby areas. The main targets of shooters are Chinkara, Desert fox, Desert cat and Great Indian Bustard for their meat and skin. The control on such illegal poaching and hunting done by local people is a very difficult task to the managers of the Park and may pose serious threats to some wildlife species in future. After the incidents of hunting of Great Indian Bustard and Lesser Bustard by Arab Sheikhs of Abu Dhabi in 1969 and Prince Khalifa of the United Arab Emirates and Party in 1978, using trained falcons for hunting the birds, no big incident done by non residents has been on the record of National Park. As such, the wildlife is rather safe and in better position in the DNP than vegetation. But, degradation of latter is posing serious threats for food, water and shelter to the wildlife which desert does not offer in sufficient quantity.

### Drought

Like other deserts of the World, the drought is inevitable in Thar Desert. So, DNP is also facing problems of frequent drought and severe famines, which have been regarded as a grand natural disaster to the desert. The extent and degree of famine dispersion is better revealed in a famous Rajasthani local couplet :

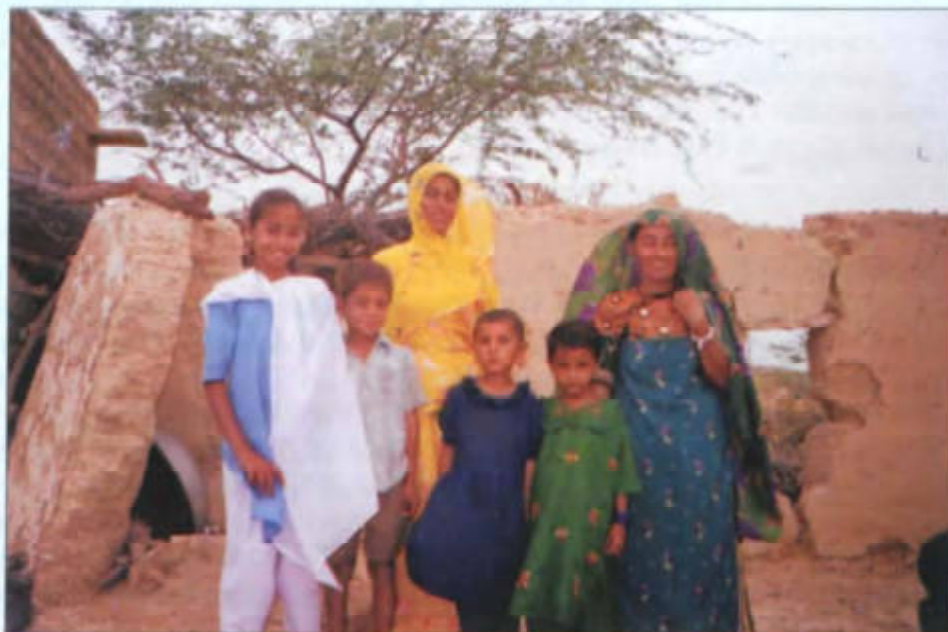
“Pug pungal, Sar Merte, Udraj Bikaner  
Bhoola chooka Jodhpur, Thayo Jaisalmer”

(i.e. Famine keeps it legs in Poongal region, head in Merta, standing in Bikaner, may move to Jodhpur and stays forever in it's hometown Jaisalmer).

Drought destroys the vegetation cover in DNP and ultimately results into human and animal sufferings or deaths. During drought, the cattle populations eat every blade of grass, the tree-climbing goats eat the last bit of greenery, leaving behind wooden skeletons for the firewood gatherers. The pockets of vegetation and patches of rangelands are severely degraded. The quality of rangeland vegetation declines and the more palatable and productive plants are nudged out by less desirable species, leading to drastic changes in natural ecosystem. Recent invasion of typical xeric plant species viz. *Acacia nubica*, *Dactyliandra welwitschii* and *Tribulus pentandrus* var. *macropterus* in the ecosystem of DNP are good examples.

### Wind erosion

Inspite that vegetation of DNP is dominated by therophytes and large number of seeds are produced by them, the vegetation density is very poor. The reasons for it are that seeds do not get favourable conditions to germinate i.e. water and temperature. Secondly, a large number of seeds either get buried deep under the shifting sand or are blown far away. The roots of shallow-rooted plants are usually exposed, leading to unusual death of plants due to erosion. Sometimes even big trees growing over dunes face this problem (Plate-24/1).



1. Village and inhabitants.

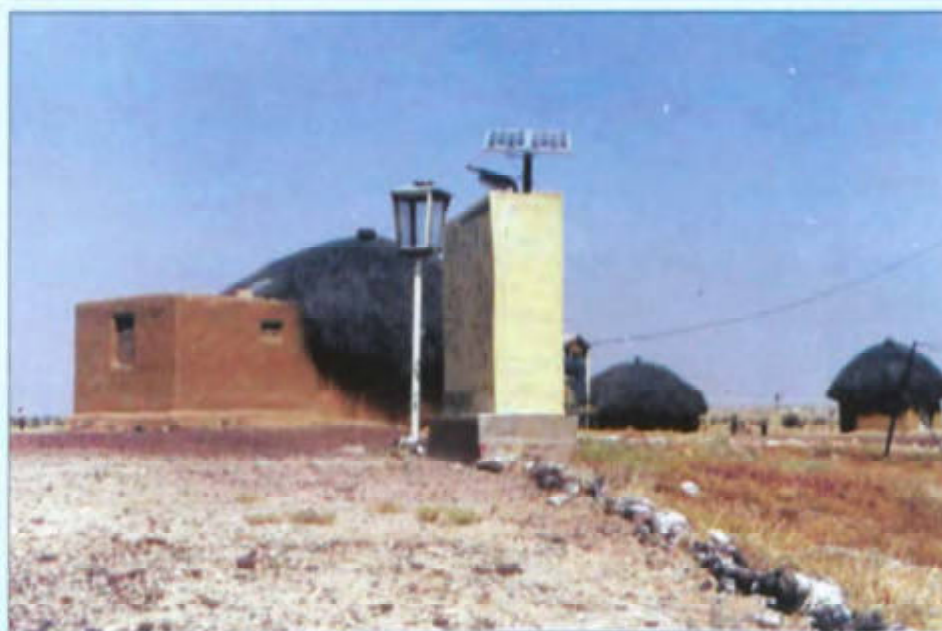


2. Collection of drinking water - a challenge for residents.

**Plate-22**  
Settlement pattern and polulation.



1. Scattered houses and Dhans - a common settlement pattern.



2. Solar system in the Park.

**Plate-23**

Settlement pattern and developmental activities - serious threats to biodiversity.





1. *Moringa concanensis* Nimmo ex Dalz. & Gibs. – an uprooted tree due to wind erosion.



2. Grazing – a serious threat to biodiversity by goats and sheep.

**Plate-24**

Wind erosion and grazing pose threats to biodiversity.



1. Grazing – a threat to biodiversity by cows.



2. Browsing – Camels feed on trees top.

**Plate-25**

Grazing – a serious threat to biodiversity and soil erosion.



1. Tourism – a gathering of tourists near Sam.



2. Tourism – temporary houses for film shooting near Sam.

**Plate-26**

Tourism – a major threat to biodiversity.





1. Camel – waiting for tourists.



2. Desert ship towards tourist's camps.

**Plate-27**

Tourism – a major source of revenue.



### CONSERVATION AND MANAGEMENT STRATEGIES

The threats to the biodiversity and ecosystem discussed earlier have badly damaged the ecological system of the Park upon which entire life support system is based. Unfortunately, the stress on the desert environment and its natural living resources is increasing day by day with the developmental activities and advancement of civilization, eroding the natural ecosystems and biological wealth. Desert National Park harbours several economic and medicinal plants, wild relatives of crop plants, endemics and other plants and animals facing threat in the desert ecosystem. The importance of biodiversity may be understood, but, it is not easy to define the value of biodiversity and very often difficult to estimate. There are innumerable species, the potential of which is not yet known. It would, therefore, be prudent to not only conserve the species we already have information about, but also the species we have not yet identified and described from economic point of view. Bhandari (1999) has also stressed upon assessment of status, trends and options for conservation and sustainable use of biological diversity in the Indian desert. Desert National Park has been established with the point of view to provide *in-situ* conservation to all known flora and fauna and typical desert ecology and topography. However, the threatened species, wild relatives of crop plants and endemics need special protection.

#### Endemic plants

Due to the characteristic topography, geology, edaphic and climatic factors, the desert maintains a peculiar type of vegetation, not found elsewhere in India. Endemism is also a very common phenomenon in the desert. Pandey *et al.* (1983), Pandey (1984), Pandey & Shetty (1985), Singh (1985), Singh & Pandey (1997) and Singh & Pandey (1999) have identified 16 taxa of plants endemic to desert ecosystem which is one of the two centers of speciation in the State of Rajasthan. During present study, two species (i.e. 12.5 per cent) of endemics viz. *Anticharis glandulosa* var. *caerulea* and *Ziziphus truncata* were collected from the Desert National Park. To determine the IUCN category of threat, the population studies through quadrat method were carried out in 100 quadrates of 1 x 1 m size within the Park and very low frequency (5 %), density (0.005) and abundance (1, almost negligible) of *Z. truncata* were recorded. This species shows similar pattern of distribution in rest part of desert. As per IUCN Red List Criteria (1995), this taxon comes under Critically Endangered Category.

The another species *Anticharis glandulosa* var. *caerulea* is herbaceous and ephemeral which completes its life-cycle during monsoon and post monsoon months. This taxon was collected by B. V. Shetty during 1977 from DNP (Harchandari). In spite of our best efforts we could not collect this species. Moreover, this taxon is rather very poorly represented in the desert as a whole. So far known locality of its occurrence is Jaisalmer. This species is under Critically Endangered stage of threat and may disappear forever if conservation strategy was not developed.

The sparse distribution of both species and short life-cycle of *Anticharis glandulosa* var. *caerulea* suggest that these endemic taxa are not much safe in the DNP because of biotic pressure on the Park. As such, the germplasm of both taxa needs preservation in *ex-situ* conditions in Botanical gardens and gene banks. Further, besides conventional methods of propagation by seeds, biotechnological techniques need to be applied. Unfortunately no work has been done in this direction on these two species to produce more and more reproductive bodies/samplings and rehabilitation of latter in natural habitats to have more populations.

### Threatened plants

According to the reports of International Union for Conservation of Natural Resources (IUCN), about 20,000-30,000 species of vascular plants are rare or under threat in the World. In India, more than 1000 threatened and endangered plant species have been identified and documented in Red Data Books and other reports and publications. Pandey *et al.* (1983), Pandey (1984), Pandey & Shetty (1985), Singh (1985) Singh & Pandey (1997), Singh & Pandey (1999) have reported 43 taxa (including endemics) from Rajasthan under various degrees of threats which need conservation. Sharma (1983) has, however, reported 103 endemic and rare plants from S. E. Rajasthan. A perusal of lists revealed that IUCN concept for identifying threatened taxa has not been followed and several taxa have been included which are neither endemic to Rajasthan nor facing any threat. Moreover, it is interesting to record that majority of really threatened plants are denizen of desertic environment, probably due to harsh climatic and edaphic conditions and increasing biotic pressure on the desert ecosystem and biodiversity which lead to degradation of environment. Industrialization and developmental activities like roads, railway lines, mining, canal irrigation system, urbanization, etc have also played vital role in degradation of desert ecosystem. During recent years, there has been an attraction of people towards Ayurvedic, Homeopathic and Unani traditional systems of medicines. As such, a number of herbal medicine men have grown up in the desert area also, and are posing threats to the biodiversity. The craze of the people, especially women, towards herbal cosmetic products have directed the manufacturers towards desert biodiversity which possesses maximum mucilaginous and essential oil-yield plants needed for this purpose. Moreover, during present study 15 taxa (excluding endemics) were recorded in the threatened condition in the Park. Of these, about four species were previously endemic to desertic zone. These taxa have comparatively wide range of adaptability and, therefore, have migrated to neighbouring States and a few have crossed even western international boundary. These taxa include : *Ammannia desertorum* (Devikot, Jaisalmer), *Convolvulus auricomus* var. *volubilis* (Jodhpur), *Sida tiagii* (Mingaria, Barmer) and *Tribulus rajasthanensis* (Jodhpur). Their occurrence in DNP suggests the route of migration in western direction, since places of their origin (given in parenthesis) are located far east of the Park. The danger of extinction of such elements is although low, but need conservation since population density and abundance is rather low in the entire range of their distribution and they inhabit specific habitats and all are herbaceous in habit. These taxa may be grouped under Conservation Dependent Category of IUCN.

Further, *Tephrosia falciformis*, a threatened endemic species of Pakistan origin (Sindh), has recently migrated eastwards to DNP area and more recently individuals of this taxon have been collected further east in the desert. No thick population of this taxon could be observed in the area of study; isolated individuals contribute to the grass communities. This is in a highly vulnerable stage and also needs conservation. *Ex-situ* conservation of this taxon may give better results, since grasses and pasture lands are under great pressure of domestic and wild animals even in protected areas.

Another interesting species which needs mention under threatened plants is *Pupalia lappacea* var. *velutina*. This species was first collected in 1849 from Peninsular India. Later, King (1879) reported it's occurrence from Rajputana, followed by Blatter & Hallberg (1919) based on King's report. Since then, this taxon is being included in the flora of Rajasthan based on above mentioned reports. No one could collect the specimens for last 125 years from Rajasthan. During present study, the author spotted a population of this taxon with about five individuals. As such, this species is under high risk and may be placed under Critically Endangered Category.

*Brachiaria kurzii* is another grass species which has been collected after 37 years in Rajasthan from DNP area. Earlier, it was collected from Bihar and Bengal (Hooker, 1896). In Rajasthan, it was collected from

Jodhpur in 1951 by Sarup, between 1960-1965 from Jaisalmer (Amar Sagar) by Wadhwa and in 1967 by Vyas from Alwar. It's records reflect wide distribution pattern, but rarity. It's protection in the Park area under present situations of high grazing pressure seems risky. As such, seeds of this taxon have been collected and are being tried in the Desert Botanic Garden of this institution. The results will be published elsewhere.

*Moringa concanensis* is a rare tree in DNP, growing on large sand-dunes near Khuri village. The high velocity winds expose the root-system and trees fall down or due to lesser mechanical strength, the stem fails to bear the force of wind and break down. One or two trees are losing their lives every year and it's populations are now rare and need *in-situ* conservation. It falls in Conservation Dependent Category of IUCN as per our studies.

*Odontanthera varians* and *Dipcadi erythraeum* are also on the verge of extinction due to climatic stress and their populations have decreased to low level. The perennating bulbs of *Dipcadi erythraeum* dry up due to high temperature and less moisture in the soil and fail to regenerate. The exposed seeds of *Odontanthera varians* lose viability in long term high temperature of the desert. These taxa are also Conservation Dependent and need immediate attention.

The other group of threatened plants in the Park is woody in habit and due to their over-exploitation, the plants are facing serious threats. The populations of these taxa are gradually shrinking not only in the Park area but also outside in the desert for various reasons. These taxa include :

(i) *Calligonum polygonoides* (Phog) : It is a typical plant of sand-dunes, reproducing by seeds as well as through long root-suckers. The plants are in the easy approach of everybody for fire-wood and thatching. Usually people in the Park, as well as outside, try to uproot the plants. As such, in a single gathering, many plants are uprooted and damaged. This practice has brought this taxon in rather threatened category of low risk. Further, the seeds are collected by the residents to mix with flour of other cereals. As such, limited reproduction through seeds is also the factor for the decline of it's populations. The shifting sand of the dunes exposes the root-system of the plants, leading to the death of individuals.

(ii) *Citrullus colocynthis* (Tumbo) : The seeds of this species yield a non volatile oil which has found a reputable place in soap industry. About 8 oil mills are operating in Barmer and Jodhpur. Recently, Gujarat and Maharashtra have also started oil extraction and source of raw material is Rajasthan desert. As such, the seeds have found a good market. The inhabitants of the Park collect mature fruits during post monsoon season and sale them in the market. Since the plants reproduce by seeds, the populations are shrinking in the Park as well as outside to the vulnerable stage in nature. *In-situ* conservation of this taxon in nature is a stupendous task due to it's revenue value. As such, to reduce pressure on natural populations, it's cultivation with Bajra and Gwar crops is suggested herewith. Being deep-rooted, it will have no competition with fibrous-rooted crops of desert and being a creeper, it will minimize evaporation of water from soil and will act as a soil binder.

(iii) *Commiphora wightii* (Guggal) : The plant yields gum-resin which is used in Aggarbatti industry, perfumery, medicine, etc. Local market is available for the products. The residents of Park extract gum-resin by making cuts on the stem in non-scientific way, and during recent years they have started applying the chemical Copper sulphate on the cuts to increase yield, which results in the death of the plant. Secondly, due to the presence of gum-resin even fresh green twigs burn easily. As such, this species is being used as fire-wood on large scale. This double stress on this taxon has brought it's populations in vulnerable category of IUCN. Observations revealed that this species is under threat in it's entire range of distribution in Rajasthan

and Gujarat. The produce from wild has failed to keep pace with market demand during recent years. As such, it's cultivation has been started and scientific techniques for extraction have been developed. So, presently the pressure on natural populations has considerably reduced. But, the plant still needs conservation since very limited biomass is left in the nature and there have been several strains in the populations, indicating genetic diversity.

(iv) *Ephedra ciliata* : This is the only living gymnosperm in DNP and desert as a whole. The plant is on the verge of extinction due to it's wide use as fire-wood. Inadequate reproduction is another factor controlling it's populations, since number of female individuals is very limited to produce seeds. It's distribution and population sizes from Syria to India ensure it's endangered status according to IUCN.

(v) *Tecomella undulata* (Rohira, Marwar Teak) : It is the main source of timber in the Park as well as outside, therefore, under great pressure. The regeneration capacity of tree is very low and growth is extremely slow. As such, the chances for renewal of loss of biomass are negligible and populations are standing in vulnerable stage in nature. Afforestation of this species is an unavoidable method to preserve it's germplasm of variable strains even in protected areas.

#### Wild relatives of cultigens

The genetic material having potentiality for the improvement of crops/cultivated plants has been considered as important as endemic, rare, threatened and endangered plants in the Biodiversity Convention. Such wealth of agri-horticultural importance occurs as component of disturbed bio-edaphic communities within major vegetation types. Preliminary efforts to identify such components were made by Arora & Nayar (1983). In Rajasthan, including desert area, Singh & Pandey (1996, 1999) have identified 65 wild relatives of 46 species of cultivated plants which have close genetic relationship with crop plants and may be utilized for transfer of genetic material for the improvement of crops through new genotypes. During present study, it was recorded that DNP harbours about eleven species having genetic potentiality.

Table-13. Wild relatives of crops and cultivated plants.

Cultivated plants	Wild relatives
<i>Amaranthus caudatus</i>	<i>Amaranthus viridis</i> & <i>A. tricolor</i>
<i>Citrullus lanatus</i>	<i>Citrullus colocynthis</i>
<i>Corchorus capsularis</i>	<i>Corchorus olitorius</i>
<i>Cucumis melo</i>	<i>Cucumis prophetarum</i>
<i>Cucumis sativus</i>	<i>Cucumis callosus</i>
<i>Allium cepa</i>	<i>Dipcadi erythraeum</i>
<i>Eleusine coracana</i>	<i>Ochthochloa compressa</i>
<i>Moringa oleifera</i>	<i>Moringa concanensis</i>
<i>Solanum melongena</i>	<i>Solanum virginianum</i>
<i>Vigna radiata</i>	<i>Vigna trilobata</i>

Singh & Pandey (1999) pointed out that in Rajasthan cereals and legumes show maximum cytogenetic relationship with wild plants. It is also true for desert as a whole (Singh & Pandey, 1998). But in DNP, Cucurbitaceous crops, which stand on third place in whole desert of Rajasthan, occupy first position in DNP, indicating conservation potentiality. These taxa fall in Low Risk Category of IUCN.

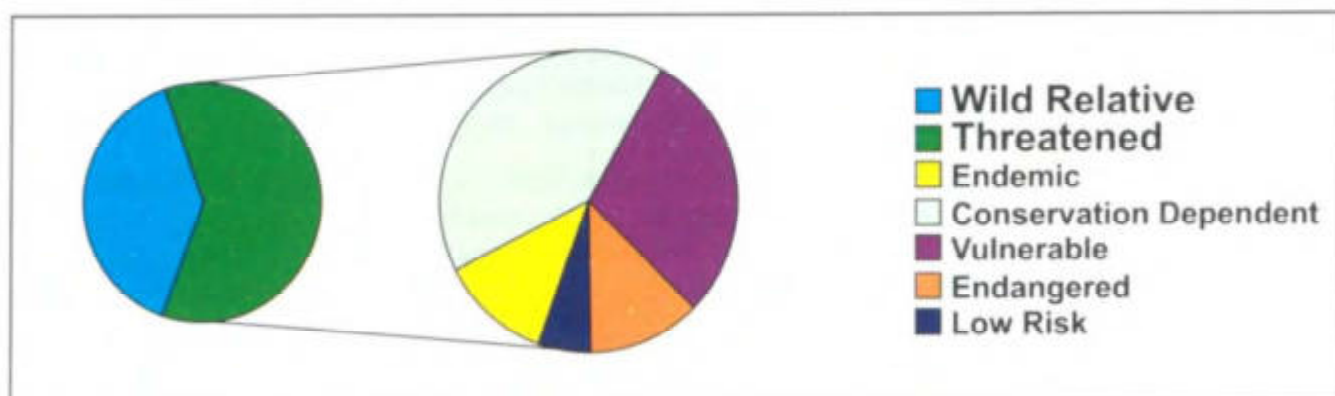


Diagram-4 : Diagrammatic presentation of threatened taxa as per IUCN Red List Criteria (1995).

During present study while focusing on the management programmes and practices being followed in DNP, in relation to the local problems, it was realized that management of DNP is little different and difficult from other National Parks. DNP is located in greatly disturbed ecosystem in the desert; there have been no natural barriers like forest belts, hills, etc; the residents are illiterate and economically poor, having no alternatives for their livelihood; the biodiversity is dominated by ephemeral herbaceous flora; the biotic components are very sparsely distributed leaving large barren areas in between and abiotic components are on the extreme sides. Under these conditions, based on our experiences, some conservation strategy points are being put forth in the next paragraphs.

### Management strategies

Desert National Park has been established on the best site in the desert to offer *in-situ* conservation to the unique habitats, flora and fauna of the desert. To overcome the present deteriorated situation, some suggestions are offered here under:

**Notification of status :** The present National Park was primarily notified as Wildlife Sanctuary in 1980 under Wildlife Protection Act, 1972. Again, in 1981, it was notified as National Park. In 1988, the area was selected to be designated as Biosphere Reserve. The last proposal could not be materialized so far. The indefinite status of this protected area is responsible for non implementation of legal bindings forcibly in the protected area by the managers, resulting in deterioration of conditions. The notification and declaration of stable and definite status will also help in deciding the rights of residents accordingly, formulation of planning and strategies for management. Based on settlement pattern of residents, distribution pattern of flora and fauna and magnitude of threats to biodiversity, the area may be recommended to be declared as Biosphere Reserve with minicore area concept.

**Education, training and awareness :** No programme of conservation of biological diversity can succeed until awareness is not created among the local communities and visitors, which is presently lacking in DNP. Attempts should be made to present the value of bioresources contained in the Park and role of people living in and around the protected area in conservation. The people are also not aware about the environmental laws framed by government, which result in many forest crimes. As such, education to local population that their short term gains from natural resources today would turn out to be a major catastrophe of tomorrow is necessary. Further, participation of local communities in planning and management like partners will ensure successful conservation and management. Thus, there is a need to develop a platform for meaningful interaction between managers and local inhabitants as a step towards launching a mass movement in this regard. The modern scientific knowledge about the functioning of complex biodiversity rich ecosystems is also very inadequate to the managers.

**Research and monitoring :** To achieve the goal of conservation in the protected area, basic information about the structural components of the Park and changes taking place from time to time in structure and functioning will help the managers in management practices. Thus, data generated from interdisciplinary and inter-institutional research on social, economic and ecological aspects of the Park may provide a tool to develop a modeling system for conservation and management. Present study is an attempt in this direction, since, even basic data is not available about DNP, as a result of which the conservation and management of the Park is suffering. Such studies will also be helpful in identification of threatened taxa, their sustainable utilization and rehabilitation, socio-economic uplifting of communities and development of communication system between users and managers.

**Eco-tourism and recreation :** The geographical position, topography and spectacular biological diversity of DNP has attracted the local and foreign tourists since long back. During recent years, it has become an important employment oriented income generation tool for local communities on one hand and environment degradation factor to the Park on the other hand. This situation in the Park is due to the lack of co-ordination between the government departments of Tourism and Forest and Environment, which is, however, necessary to have a fine balance between requirements of tourism and ecology to fulfill the needs of local communities and proper management of protected area. As such, a short training to the tourists visiting DNP is necessary. The use of non-degradable disposable items in the Park should be strictly banned. The use of diesel vehicles and blowing horns and loud music should be stopped. The tourism activity should be restricted to a limited area and tourists should not feel free for using the sites at their disposal, as happening presently.

**Upliftment of local communities :** There is immediate necessity of health, drinking water and education facilities to be provided to local communities. Further, attention should be given to provide alternative sources for the items they depend on biodiversity. Most important is the compensation to the landlords from whom the land is acquired and their appropriate rehabilitation. Such packages will avoid confrontation between managers and local communities and add to hormonal relationship which is necessary for proper management of Park.

**Wildlife health care and population management :** Very scanty scientific information is available on the biology of wildlife of DNP and no measures have been adopted to treat their ailment and management of their population within the Park. As such, there has been always a risk for epidemic diseases among the wild animals.

To get high conservation status, it is necessary to have Annual Action Plan for Desert National Park based on research data in different fields and their implementation.





# Faunal Diversity





The flora and fauna are two facets of biodiversity of an ecosystem which covers variety and variability of species and their co-existence. They interact with each other in various ways. Ghose (1996) and Prakash (1996) have discussed avenues of faunal diversity and research in Thar desert. To understand the interdependency of flora and fauna, food-web and flow of energy in Desert National Park, the faunal diversity of the Park was studied with the help of Zoological Survey of India, Jodhpur.

In spite of the fact that climatic and edaphic conditions of Desert National Park are very harsh, it exhibits a vivid and spectacular biodiversity. Besides 245 species of plants, there have been almost an equal number of animal species (270 species), representing 1 : 1.1 ratio of plant and animals.

## REVIEW OF LITERATURE

### INVERTEBRATES

- (i) **Nematoda** : They play an important role in the ecosystem in which they are found either as parasites on plants or in maintaining the balance (Jairajpuri & Ahmad Wasim, 1992; Hunt, 1993 & Siddiqi, 2000). Khera (1966), Khera & Bhatnagar (1977), Swarup & Sethi (1977), Nand Kumar & Khera (1969, 1971), Mathur (1969, 1977), Nama & Tikyani (1977), Prasad (1977), etc have studied the Nematodes of Indian desert. Baqri (1996) has recently reviewed the nematology literature and recorded 55 species of phytophagous Nematodes from Thar desert. Recently, Baqri & Bohra (2001) and Bohra & Baqri (2004) have discussed plant and soil Nematodes of DNP (8 spp.).
- (ii) **Mollusca** : Ray & Mukherjee (1969) have added to our knowledge about the Molluscs of Rajasthan, including desert area. Roonwal (1982) and more recently, Subba Rao (1996) have further updated the findings from desert area by documenting 23 species under 15 genera and 9 families. Recently, Surya Rao *et al.* (2004) have studied the Molluscs of DNP (6 spp.).
- (iii) **Arthropoda** : This is the largest phylum of animal kingdom. It is represented by 2 classes in DNP viz. Insecta and Arachnida.

**Insecta** : This is the largest class of animals which has been highly neglected due to the concealing habit and lack of expertise of this group. Special efforts are needed for their collection and identification. What we know today about insects, is far less than truly occurs in nature. The notable contributions on the insects of Thar desert are those of Roonwal (1982) and Tandon (1996). The insects of DNP belong to various subordinate groups (orders) viz.

(a) **Thysanura** : The first record of Thysanura from India is that of Escherich (1903) who recorded two species viz. *Lepisma indica* and *L. gyriiformis*. Subsequently, Silvestri (1913, 1938, 1948), Wygodzinsky (1954, 1972), Hazra (1980, 1993), etc have contributed to Indian Thysanura group. Mendes (1990) has discussed zoogeography of this group of insects. The Thysanura of Rajasthan (including Thar desert and DNP) were not known at all. Recently, Hazra *et al.* (2004) have, however, made a preliminary attempt to study the diversity of Thysanura in DNP. They have recorded 3 species from DNP, belonging to 2 genera under one family.

(b) **Odonata** : A good information is available on Odonate fauna of Indian desert. The notable contributions are those of Fraser (1933, 1934, 1936), Agarwal (1957), Bose & Mitra (1976), Prasad & Thakur (1981), Thakur (1985), Tyagi & Miller (1991) etc. Recently, Prasad & Varshney (1995) and Prasad (1996) have

further added to our knowledge about the insects (32 spp.) of this group from Thar desert. However, no records of occurrence of Odonata are published from DNP, except Prasad (2004) who reported 11 species.

(c) *Orthoptera* : Considerable information is available on Orthoptera insects of Rajasthan, including desert area. Pruthi (1951) and Pruthi & Bhatia (1952) have recorded invasion of locusts in Rajasthan. Further, Bhanotar (1975), Bhatia (1937, 1940) and Bhargava (1996) have contributed on taxonomy and ecology of desert locusts. Again, Bhowmik (1969, 1971, 1977), Kushwaha & Bharadwaj (1977), Parihar (1996), Tandon & Shishodia (1976), Venkatesh (1977) etc have also added to the faunal diversity of Rajasthan, especially Thar desert. So far, 38 species of Orthoptera are known from Thar desert. Unfortunately no work has been done on this group in DNP, except Shishodia (2004a) who recorded 11 species.

(d) *Dermoptera* : This is a very poorly represented group of insects. Srivastava (1988) has recorded about 7 species from Rajasthan, but none from desert area. Recently, Srivastava (2004) has recorded occurrence of *Nala lividipes* in DNP area.

(e) *Dictyoptera (Mantodea)* : This is again a poor group of insects. Recently, Roonwal (1982), Bohra & Rathore (1996) and Tandon (1996) have studied Dictyoptera fauna of Thar desert and recorded 20 species of cockroaches and mantids. The only contribution from DNP is of Shishodia (2004b) who reported two species.

(f) *Isoptera* : The termites are small, fragile, soft-bodied, social insects. A number of publications are available on this group, but notable are those of Roonwal & Bose (1964), Roonwal & Verma (1977), Verma & Thakur (1977), Rathore (1989, 1995, 1998), etc. Roonwal (1976) has studied field ecology and ecobiogeography, Parihar (1981) the pest control, Roonwal & Rathore (1974) and Rathore & Kumar (2005) biology and Rathore (1996) worked on faunal diversity of termites in Thar desert. So far, about 44 species have been recorded from Thar desert. Recently, Rathore & Tak (2004) have contributed to DNP area, documenting 16 species.

(g) *Diptera* : This is a quite large order of Insecta, but poorly studied in Thar desert. The notable contributions are those of Kaul *et al.* (1973), Vazirani & Advani (1976, 1977), Joseph & Parui (1990), Nandi (1990), Parihar (1993), Kumar & Kumar (1996), etc. So far, 75 species have been reported from Thar desert. Recently, Kumar (2004) has reported one species viz. *Apoclea rajasthanensis* from DNP.

(h) *Lepidoptera* : The notable systematic accounts on this order of Insecta are those of Macpherson (1927), Vyas (1996), Arora (1974) and Gupta & Thakur (1986). So far, 161 species have been reported from Thar desert. Recently, Maulik (2004) has recorded 3 species of Lepidoptera from DNP.

(i) *Hymenoptera* : Bingham (1903) has studied Indian Hymenoptera in greater details. Recently, Chhotani & Ray (1976) have recorded 89 species from Rajasthan, including Thar desert. Other subsequent contributors to this group are Hayat (1977a, 1977b), Tak (1995), Tak & Rathore (1996), etc. So far, about 95 species are recorded from Thar desert. Recently, Tak & Rathore (2004) and Tiwari *et al.* (2004) have recorded 22 species from DNP.

(j) *Coleoptera* : The notable contributions on Coleoptera of desert are of Vazirani (1970, 1977). So far, 96 species have been reported from Thar desert. Recently, one species viz. *Pimelia indica* has been recorded from Desert National Park during present study.

**Arachnida** : Tikedar & Bastawade (1983) reported 106 species of scorpions from India, belonging to five families. Of these, three families also occur in Rajasthan, including desert area. No other account on scorpions

of Thar desert is available. However, Bastawade (2004) has reported 8 species (including two endemics) from DNP. Recently, Sivaperuman & Rathore (2004) have added 29 species of spiders to the faunal diversity of DNP. The ticks (Metastigmata) form small group of acarines, having medical and veterinary potentiality. However, no systematic study on the ticks of Thar desert ecosystem has been done, except by Kaul *et al.* (1978) and Sanyal & De (1996). So far, 12 species have been recorded from Thar desert. Recently, Sanyal & De (2004) have studied the Acarina fauna of DNP and recorded 2 species of *Hyalomma* Koch.

The faunal studies in Desert National Park still need more attention since many groups of lower animals, well represented in Rajasthan and Thar desert, have not been recorded from DNP.

## VERTEBRATES

- (i) **Amphibia** : Mansukhani & Murthy (1970) are first who provided detailed account of frogs and toads of Rajasthan, including desert area. They reported 8 species of Amphibians. Subsequently, Bohra *et al.* (1983) provided keys for the identification of 8 species of desert Amphibians. Recently, Chanda (2004) has documented Amphibian fauna (1 sp.) from Desert National Park.
- (ii) **Reptilia** : Sharma (2002, 2003) has contributed considerably to the Reptilian fauna of India. The notable contributions on the Reptiles of Thar desert are those of Krishna & Dave (1960), Krishna (1975), Rathore (1969), Prakash (1972), etc. Detailed taxonomy of testudines, lizards and snakes has been reviewed by Sharma (1996). So far, 51 species of Reptilian fauna have been recorded from desert. Recently, Sharma & Rathore (2004) and Das & Rathore (2004) have documented the Reptiles of Desert National Park and reported 16 species.
- (iii) **Aves** : Adams (1899) first of all furnished an exhaustive list of birds of Indian desert. Subsequently, Whistler (1938), Biswas (1947), Faruqi *et al.* (1960), Prakash & Ghosh (1964), Sharma (1969a, 1969b), etc added to our knowledge regarding habitat and breeding in birds of desert. Ali (1975, 1981) discussed adaptations among the birds of Indian desert. Rahmani (1986, 1989a, 1989b, 1996a, 1996b, 1997a, 1997b) and Rahmani & Soni (1997) described avifaunal changes in Thar desert. Mukherjee (1995) has provided an exhaustive list of 322 bird species (47 endemic, 118 resident and 157 migratory). However, after the works of Kapoor (1985) and Rahmani (1996b, 1997a), no published account is available on the avian fauna of DNP, except Kankane (2004a) who documented 106 species of birds from Desert National Park.
- (iv) **Mammalia** : A huge literature is available on the Mammals of Indian desert, especially on their conservation and ecology (Prater, 1980; Prakash, 1994). Some other important publications are those of Alfred & Agrawal (1996), Prakash (1956a, 1956b), Krishna & Prakash (1955, 1956), Rana & Prakash (1979), etc. Sinha (1975, 1976a, 1976b, 1977a, 1977b, 1977c, 1980a, 1980b, 1981, 1983) has contributed to the Bats of Indian desert. Reproductive biology of the Indian Desert Hare was studied by Prakash & Taneja (1969), Primates by Roonwal *et al.* (1984) and Mohnot & Srivastava (1996), Carnivora by Kankane (1996), Black buck and Chinkara by Rahmani & Sankran (1991) and Rodentia by Prakash & Ghosh (1975) and Ghosh (1975). Agrawal (1967) has also added to mammalian fauna of Indian desert. So far, about 45 species of Mammalia have been reported from Thar desert. Recently, Kankane (2004b) has documented 21 species of mammals for DNP.

A perusal of literature on faunal diversity revealed that vertebrates are rather better known in DNP than invertebrates. The former have all representative groups in DNP, except Pisces. However, about 25 species

of fishes are on record from Thar desert (Datta & Majumdar, 1970; Dutta Gupta *et al.*, 1961; Mathur & Yazdani, 1969, 1970, 1973; Yazdani & Bhargava, 1969).

## ENUMERATION OF SPECIES

### INVERTEBRATES

#### NEMATODA

The Nematodes are thread-like or worm-like animals, constituting second largest group of invertebrates after Arthropoda. They are found in various ecological niche viz. terrestrial and aquatic. They may be free-living, found in soil, fresh water and sea water where they feed on bacteria and detritus. As such, they play critical ecological role as decomposers, predators on micro-organisms and as parasites on man, animals, insects and plants. The phytophagous Nematodes (those parasitise the plants) obtain their food through anteriorly located sclerotised spear or stylet, which is well adapted for penetration into plant cell-wall and thus becomes instrumental in transferring cell sap into alimentary duct of Nematode. They are mostly dioecious. In Desert National Park, 8 species of Nematodes have so far been reported. However, a thorough survey may add more taxa to this group.

Name of superfamily, family & species	Suborder	Order	Locality/Remarks
<i>Hoplolaimoidea</i> (sup. fam.)	Tylenchina	Tylenchida	
<i>Hoplolaimidae</i>			
<i>Hoplolaimus indicus</i> Sher			Harsani, Sam
<i>Aphelenchoidea</i> (sup. fam.)	Aphelenchina	Aphelenchida	
<i>Aphelenchidae</i>			
<i>Aphelenchus avenae</i> Bastian			Sam
<i>Dorylaimoidea</i> (sup. fam.)	Dorylaimina	Dorylaimida	
<i>Qudsianematidae</i>			
<i>Discolaimium mukhtarpuriense</i> Baqri & Jairajpuri			DNP
<i>Dioscolaimoides bulbiferus</i> (Cobb) Heyns			Sam
<i>Discolaimus major</i> Thorne			Sam
<i>Labronema virgo</i> Monteiro			Sam
<i>Noridiidae</i>			
<i>Kochinema farodui</i> Baqri & Bohra			DNP
<i>Tylencholaimoidea</i> (sup. fam.)			
<i>Tylencholaimidae</i>			
<i>Tylencholaimus suryawanshii</i> Ali & Chisty			Harsani

## MOLLUSCA

The Molluscs are very successful group and occupy third position among invertebrates after Arthropods and Nematodes. They are found in nearly all habitats. In sea, they occur from deepest ocean trenches to intertidal zone. They may be found in fresh water as well as on land where they occupy a wide range of habitats. Molluscs are soft bodied and most of them have a prominent shell and are dioecious. Many species are important to human; a large number of Bivalves and some Snails are important source of protein; Oysters produce pearls; other species are pests in gardens and to the crops and some are essential components in the life-cycle of human parasites. The Molluscs also play a wide variety of essential ecological roles. As common herbivores, they can have a significant impact on the plant species present in an area. As predators, they may have a similar effect on animals, especially other Molluscs. As prey, they provide food to large number of organisms, including many vertebrates. They also make the water clear through their feeding habit. About six species of Mollusca belonging to class Gastropoda have been reported from Desert National Park.

Name of family & species	Order	Class	Locality/Remarks
<i>Viviparidae</i>	Mesogastropoda	Gastropoda	
<i>Bellamya dissimilis</i> (Mueller)			DNP
<i>Bithyniidae</i>			
<i>Digoniostoma pulchella</i> (Benson)			DNP
<i>Thiaridae</i>			
<i>Thiara (Melanoides) tuberculata</i> (Mueller)			DNP
<i>Planorbidae</i>	Basommatophora		
<i>Indoplanorbis exustus</i> (Deshayes)			DNP
<i>Subulinidae</i>	Stylommatophora		
<i>Zootecus estellus</i> (Benson)			DNP
<i>Zootecus insularis</i> (Ehrenberg)			DNP

## ARTHROPODA : Insecta

The insects include a great majority of the species of animals on the earth. They form a tremendous successful group, found in almost all terrestrial and fresh water habitats from driest desert to fresh water ponds and from tropical rain forests to arctic zone. A few species are even marine. Their food includes any substance that has nutritive value. Mostly they are dioecious and fertilization is internal in most of the species. The insects are highly valuable to man, and are fundamental part of ecosystem. They are the main pollinating agents for most higher plants, decomposition agents of organic materials facilitating the recycling of carbon, nitrogen and other essential nutrients, controller of populations of harmful invertebrate species including other insects, direct producers of certain foods like honey and manufacturer of useful products like silk and shellac. The negative aspects include that they eat our food, feed on our blood, contaminate our dwellings and transmit horrible diseases. About 73 species of insects, belonging various groups have been reported so far from Desert National Park (Plate-28/1 & 2).

Name of superfamily, family, subfamily & species	Suborder	Order	Locality/Remark
Superfam.- <i>Lepismatoidea</i>	Zygentoma	Thysanura	
<i>Lepismatidae</i>			
<i>Acrotelsa collaris</i> (Fabricius)			Barna, Khuri
<i>Ctenolepisma longicaudata</i> Escherich			Barna, Harsani
<i>Ctenolepisma ciliata</i> Dufour			Barna, Girab, Khuri
Superfam.- <i>Coenagrionoidea</i>	Zygoptera	Odanata	
<i>Coenagrionidae</i>			
<i>Agriocnemis pygmaea</i> (Rambur)			Girab
<i>Ischnura aurora aurora</i> (Brauer)			Girab
<i>Ischnura senegalensis</i> (Rambur)			Girab
<i>Rhodischnura nursei</i> (Morton)			Girab
Superfam.- <i>Aeshnoidea</i>	Anisoptera		
<i>Aeshnidae</i>			
<i>Anax guttatus</i> (Burmeister)			Girab
Superfam.- <i>Libellulidea</i>			
<i>Libellulidae</i>			
<i>Acisoma panorpoides panorpoides</i> Rambur			Girab
<i>Bradinopyga geminata</i> (Rambur)			Barna, Sudasari
<i>Crocothemis servilia servilia</i> (Drury)			Girab, Sam, Sudasari
<i>Orthetrum sabina sabina</i> (Drury)			Girab
<i>Pantala flavescens</i> (Fabricius)			Sam
<i>Selysiothemis nigra</i> (Van der Linden)			Sam
Superfam.- <i>Acridoidea</i>		Orthoptera	
<i>Pyrgomorphidae</i>			
<i>Chrotogonus (Chrotogonus)</i> <i>trachypterus</i> (Blanchard)			Barna, Magra, Girab
<i>Acrididae</i>			
Subfam.- <i>Truxalinae</i>			
<i>Truxalis eximia eximia</i> Eichwald			Girab
Subfam.- <i>Gomphocerinae</i>			
<i>Ochrilidia geniculata</i> (Bolivar)			Girab
Subfam.- <i>Dedipodinae</i>			
<i>Acrotylus humberianus</i> Saussure			Sam, Barna, Sudasari
<i>Oedaleus senegalensis</i> (Krauss)			Girab
<i>Sphingonotus longipennis</i> Saussure			Sudasari, Girab
<i>Scintharista notabilis pallipes</i> Uvarov			Sam

Subfam.- <i>Cyrtacanthacridinae</i>		
<i>Anacridium rubripinum</i> (Bej-Bicako)		Girab
<i>Schistocerca gregaria</i> (Forsk.)		Sudasari
Subfam.- <i>Eyprepocnemidinae</i>		
<i>Heteracris littoralis</i> (Rambur)		Barna
Superfam.- <i>Grylloidea</i>		
<i>Gryllidae</i>		
<i>Acheta domesticus</i> Linn.		Magra, Turvi
<i>Labiduridae</i>	Dermaptera	
<i>Nala lividipes</i> (Dufour)		Magra, Turvi
Superfam.- <i>Mantoidea</i>	Dictyoptera	
<i>Eremiophilidae</i>		
<i>Eremiophila sacra</i> (Thunb.)		Nahar Singh ki Dhani, Sam
<i>Hodotermidae</i>	Isoptera	
<i>Anacanthotermes macrocephalus</i> (Desneux)		Sam, Pithla, Berisiyala
<i>Rhinotermitidae</i>		
Subfam.- <i>Coptotermitinae</i>		
<i>Coptotermes heimi</i> (Wasmann)		Pithla
Subfam.- <i>Heterotermitinae</i>		
<i>Heterotermes indicola</i> (Wasmann)		Nahar Singh ki Dhani
Subfam.- <i>Psammotermitinae</i>		
<i>Psammotermes rajasthanicus</i> Roonwal & Bose		Sam Turvi
<i>Termitidae</i>		
Subfam.- <i>Termitinae</i>		
<i>Amitermes belli</i> (Desneux)		Turvi
<i>Eremotermes paradoxalis</i> Holmgren		Barna, Pithla
<i>Eremotermes neoparadoxalis</i> Ahmad		Pithla
<i>Microcerotermes raju</i> Roonwal & Bose		Turvi
<i>Microcerotermes tenuignathus</i> Holmgren		Girab
<i>Microcerotermes laxmi</i> Roonwal & Bose		Harsani
Subfam.- <i>Macrotermitinae</i>		
<i>Odontotermes obesus</i> Rambur		Bhopa



<i>Microtermes mycophagus</i> (Desneux)		Sam, Girab, Turvi
<i>Microtermes obesi</i> Holmgren		Berisiyala, Pithla, Harsani
<i>Microtermes unicolor</i> Snyder		Turvi
<i>Tenebrionidae</i>	Coleoptera	Sam
<i>Pimelia indica</i> Sen		
<i>Asilidae</i>	Diptera	
Subfam.- <i>Asilinae</i>		
<i>Apoclea rajasthanensis</i> Joseph & Parui		Baleva
<i>Papilionidae</i>	Lepidoptera	
Subfam.- <i>Papilioninae</i>		
<i>Princeps (Menelaides) polytes</i> <i>romulus</i> (Cramer)		Girab
<i>Pieridae</i>		
Subfam.- <i>Pierinae</i>		
<i>Colotis phisadia protractus</i> (Butler)		Sam
<i>Nymphalidae</i>		
Subfam.- <i>Danainae</i>		
<i>Danaus (Anodia) chrysippus</i> (Linn.)		Girab
<i>Formicidae</i>	Hymenoptera	
Subfam.- <i>Dorylinae</i>		
<i>Dorylus (Typhlopone) labiatus</i> Shuckard		Harsani
<i>Dorylus (Alaapone) orientalis</i> Westwood		DNP
Subfam.- <i>Formicinae</i>		
<i>Acantholepis frauenfeldi</i> subsp. <i>bipartita</i> Forel		Girab, Turvi, Barna, Pithla
<i>Camponotus (Tanaemyrmex)</i> <i>compressus</i> Fabricius		Harsani, Barna
<i>Camponotus (Tanaemyrmex)</i> <i>irritans</i> Fr. Smith		Harsani
<i>Camponotus (Dinomyrmex)</i> <i>angusticollis</i> Jerdon		Barna
<i>Cataglyphis bicolor setipes</i> Emery		Girab, Turvi, Khuri, Sudasari
Subfam.- <i>Myrmicinae</i>		
<i>Crematogaster (Acrocoelia)</i> <i>brunnea</i> var. <i>contemta</i> Mayr		Nahar Singh ki Dhani

<i>Messor barbarus himalayanum</i> Forel	Girab, Turvi, Harsani
<i>Monomorium (Holcomyrmex)</i> <i>glabrum</i> Ern. Andre	Harsani, Turvi
<i>Monomorium (Holcomyrmex)</i> <i>scabriceps</i> Mayr.	Girab, Pithla
<i>Monomorium (Xeromyrmex)</i> <i>salomonis indica</i> Forel	Girab, Harsani, Turvi Sam, Khuri
<i>Monomorium (Parholcomyrmex)</i> <i>destructor</i> Jerdon	Harsani, Barna
<i>Monomorium (Parholcomyrmex)</i> <i>gracillimum</i> var. <i>mayri</i> Forel	Girab, Barna
<i>Pheidole (Pheidole) sulcaticeps</i> Roger	Khuri
<i>Pheidole (Pheidole) wroughtoni</i> Forel	Turvi, Harsani
<i>Tetramorium salvatum</i> Forel	Harsani
<i>Apidae</i>	
<i>Apis (Micrapis) flarea</i> Fabricius	Turvi
<i>Apis (Megapis) dorsta</i> Fabricius	Sam
<i>Xylocopidae</i>	
<i>Xylocopa (Ctenoxylocopa) fenestrata</i> (Fabricius)	Girab
<i>Eumenidae</i>	
<i>Eumenes dimidiatipennis</i> Saussure	Girab
<i>Sphecidae</i>	
<i>Chlorion regale</i> Smith	Girab
<i>Mutillidae</i>	
<i>Apterogyna mutilloides</i> Smith	Sudasari

Besides above, some taxa have been collected recently from Desert National Park which need identification up to species level viz. *Hambertiella* sp. (family-*Mantidae*; order-*Dictyoptera*); *Microcerotermes* sp. and *Odontotermes* sp. (family-*Termitidae*; order-*Isoptera*) and *Mutilla* sp. (family-*Mutillidae*; order-*Hymenoptera*).

## Arachnida

Arachnida constitutes another large class of Arthropoda which includes spiders, scorpions, ticks, harvestmen, etc. Spiders usually have 5-segmented abdomen. Some of them use their silk for making web for capturing the prey. Others which do not spin web, stalk or ambush their prey. Some are camouflaged within the flowers due to their bright colours and capture the visiting insects. Large spiders even capture small birds for their food. The scorpions, on the other hand, have a sharp sting with a pair of poison glands

which can paralyze prey, usually insects or small rodents or may deliver a painful sting to incautious men. Most scorpion stings are painful, leading to swelling in immediate region of the sting. They are mostly nocturnal and live under the rocks, in crevices or within burrows during day. Acari (ticks and mites) usually feed on vertebrate's hair or blood. Some are good carrier of disease organisms (bacteria). Others are rather unpleasant parasites and cause diseases like mange and scabies. However, most mites are free living, found in soil, plant litter and few in water. Those Acari which parasitize agricultural pests, are beneficial. So far two species of Acari are reported from Desert National Park. The class Arachnida is represented by about 39 species in DNP (Plate-28/3).

Name of family & species	Order	Locality
<i>Buthidae</i>	Scorpionida	
<i>Androctonus australis finitimus</i> (Pocock)		Sam
<i>Compsobuthus acutecarinatus rugosus</i> (Pocock)		Turvi (endemic)
<i>Mesobuthus tamulus indicus</i> (Pocock)		Pithla
<i>Orthochirus krishnai</i> Tikader & Bastawade		Pithla, Sam, Khuri
<i>Orthochirus pallidus</i> (Pocock)		Pithla, Sam, Khuri
<i>Vachonus astrostriatus</i> (Pocock)		Pithla, Sam (endemic)
<i>Vachonus rajasthanicus</i> Tikader & Bastawade		Pithla, Khuri
<i>Lycosidae</i>	Araneida	
<i>Lycosa madani</i> Pocock		
<i>Pardosa heterophthalmus</i> (Simm)		
<i>Pardosa pusiola</i> (Thorell)		
<i>Pardosa sumatrana</i> (Thorell)		
<i>Araneidae</i>		
<i>Herennia ornatissima</i> (Dol.)		
<i>Thomisidae</i>		
<i>Oxyptila chandosienis</i> Tikedar		
<i>Heteropoididae</i>		
<i>Heteropoda fabrei</i> Simon		
<i>Erisidae</i>		
<i>Stegodyphus sarasinorum</i> Karch		
<i>Gnaphosidae</i>		
<i>Drassodes luridus</i> (Cambridge)		
<i>Drassodes parvidens</i> Caporiacco		
<i>Poecilochroa sedula</i> (Simon)		
<i>Zelotes nasikensis</i> Tikader & Gajbe		
<i>Zelotes desioi</i> Caporiacco		
<i>Uroctidae</i>		
<i>Uroctea indica</i> Pocock		
<i>Solifugae</i>	Solifugida	
<i>Galeodis agilis</i> Pocock		Berisiyala (common species on cattle)
<i>Ixodidae</i>	Acarina	
<i>Hyalomma annatolicum annatolicum</i> Koch	(Metastigmata)	
<i>Hyalomma dromedarii</i> Koch		



***Stenodactylus orientalis*** Blanford (Squamata, subord. Sauria *Gekkonidae*)

"Sind or Rajasthan Sand Gecko"

This nocturnal, burrowing lizard prefers to live on dunes and tracts of fine loose sand with sparse vegetation. Breeding season is from March to May. Food comprises a variety of soft-bodied insects. It was seen near Turvi, Bandera and Miajlar villages.

***Agama agilis*** Oliver (Squamata, subord. Sauria *Agamidae*)

"Brilliant Agama, Desert Agama"

It inhabits flat, open sandy plains covered with scattered shrubs of *Calligonum polygonoides*, *Calotropis procera*, *Leptadenia pyrotechnica*, etc. It is a diurnal animal. The breeding season is from May to August. It feeds on large insects like crickets and grasshoppers. It was noticed between Turvi and Girab villages.

***Calotes versicolor*** (Daudin) (Squamata, subord. Sauria *Agamidae*)

"Indian Garden Lizard"

It is basically a diurnal arboreal and lives on the trees and shrubs, but is equally comfortable on ground and walls also. The breeding season is from April to June. It feeds on spiders, grasshoppers, butterflies and other large insects. During rainy season, it was seen feeding on termite alates of *Microcerotermes raja* and *Odontotermes obesus*. It was seen near Bandera, Turvi, Bhopa and Harsani villages (Plate-29/1).

***Phrynocephalus laungwalansis*** Sharma (Squamata, subord. Sauria *Agamidae*)

"Jaisalmer Toad Agama"

This species is endemic to Thar desert. It is diurnal and inhabits loose sand- dunes, sandy and gravelly plain areas with little vegetation. Toad Agama is an insectivorous and the food comprises mainly the small ants and larvae of beetles. During rainy season, it was seen feeding on termite alates of *Eremotermes paradoxalis* near Barna, Pithla and Sam (Plate-29/2).

***Uromastix hardwicki*** Gray (Squamata, subord. Sauria *Agamidae*)

"Indian spiny-tailed Lizard, Sanda"

It inhabits sparse grasslands and flat sandy areas. It is terrestrial and lives in colonies in self-dug burrows with semicircular entrance. Breeding season is from March to July and 8-14 eggs are laid at a time. The species is diurnal and strictly vegetarian. The young grasses, flowers and leaves constitute it's food. It was seen near Pithla, Sudasari, Barna and Sam villages. It is an endangered species, being exploited for oil which has medicinal value (Plate-29/3).

***Ophiomorus raithmai*** Anderson & Leviton (Squamata, subord. Sauria *Scincidae*)

"Sand Fish"

It is a nocturnal animal, endemic to Thar desert. It's main habitats are sandy areas with fine loose sand and scanty vegetation. During the period of inactivity, the lizard rests under the bushes or the rocks, but when active, leaves sinus tracks on the soft sand. It is generally diurnal and insectivorous. It's main food consists of ants, termites, ant-lions and other small insects. Breeding starts in April. It was noticed near Pithla, Sam and Balewa (Plate-29/4). It is sometimes confused for *Ophiomorus tridactylus* (Blyth) which, however, does not occur in DNP.

***Acanthodactylus contouris contouris*** Gunther (Squamata, subord. Sauria-*Lacertidae*)

## "Indian fringe-toed Sand Lizard"

This is a diurnal lizard inhabiting sand-dunes and gravel areas. It makes its burrows in clusters of xerophytic vegetation. The breeding season is from March to July. It feeds on crickets, grasshoppers, butterflies, caterpillars, beetles and many other insects. Seen near Khuri, Bandera, Sudasari and Barna villages.

***Ophisops jerdoni*** Blyth (Squamata, subord. Sauria *Lacertidae*)

## "Punjab Snake-eyed Lacerta"

This is a small, diurnal, terrestrial, lacertian lizard which makes burrows. It is the most agile and secretive lizard and feeds on termites, caterpillars, spiders, ants, orthopterans and their eggs. The breeding season ranges from June to August. It may be seen in day time also on loose sandy soils in DNP near Berisiyala and Pithla villages.

***Varanus bengalensis*** (Linnaeus) (Squamata, subord. Sauria *Varanidae*)

## "Indian Monitor, Goh"

The main habitats in DNP area are crevices of rocks, nallas, dense xerophytic vegetation around pools and other water bodies and hollows of large trees. This monitor lizard is diurnal and generally comes out of shelter about two hours after sun rise and remains in the open till day becomes hot. The breeding season is July to August. Food comprises a variety of arthropods, arachnides, small mammals and reptiles. It was noticed between Turvi, Girab, Miajlar to Khuri villages (**Plate-29/5**).

***Varanus griseus*** (Daudin) (Squamata, subord. Sauria *Varanidae*)

## "Indian Desert Monitor"

This is a large monitor living in burrows in undulating sandy plains with sparse vegetation cover. Its breeding season is from July to August. It is totally insectivorous, seen near Khuri village.

***Eryx johni*** Russell (Squamata, subord. Serpentes *Boidae*)

## "Indian Sand Boa"

The sand Boa is a nocturnal, very docile, gentle and sluggish snake. It prefers to live in flat sandy areas with loose soil and sparse grass cover. Breeding season is from April to September. It is a viviparous snake and 5-14 young ones are produced at a time. It feeds on small mammals, lizards, birds and insects. It was observed between Sudasari and Miajlar villages (**Plate-29/6**).

***Echis carinatus*** Schneider (Squamata, subord. Serpentes *Viperidae*)

## "Saw-scaled Viper"

It lives in variety of habitats viz. rocky, sandy and alluvial plains with xerophytic vegetation having dense grasses and scrubs. It is a diurnal snake during rainy and cool weather, but nocturnal during the hot season. This snake may be seen climbing on *Euphorbia caducifolia*, *Acacia jacquemontii*, *A. nilotica*, *Prosopis cineraria*, etc during rainy season. Breeding season is from March to August. It is a viviparous snake, producing 9-14 young ones at a time. It feeds on insects, small mammals and other vertebrates like frogs, toads and reptiles.

*Argyrogena ventromaculatus* (Gray & Hardwicke) (Squamata, subord. Serpentes Colubridae)

"Glossy-bellied Racer"

This is a little, slender, terrestrial, nocturnal snake which prefers to live under stones and *Euphorbia caducifolia* clumps. Breeding season is from April to July. The food comprises small mammals, birds and lizards. It was seen near Miajlar and Sam villages.

## AVES

Located at the Irano-turanian subregion of Palaearctic adjoining to the Oriental region, DNP in Thar desert shows high avian diversity. During present study, the conservation status, migratory status, foraging guild and habitat of birds inhabiting Desert National Park were recorded in collaboration with Zoological Survey of India, Jodhpur and with the help of literature at our disposal to determine the plant-animal relationship in the Park. Unfortunately, precise information is available on their ecology, reproduction biology, physiological adaptations, etc required for wildlife conservation (Plate-30 & 31).

Name of the order, family and species	Local name	MS	FG	Habitat	Status
Ciconiiformes					
<i>Ardeidae</i>					
<i>Bubulcus ibis</i> (Linn.)	Cattle Egret	R	I	W/M	C
<i>Egretta garzetta</i> (Linn.)	Little Egret	R	I	W	C
Anseriformes					
<i>Anatidae</i>					
<i>Aythya nyroca</i> (Guldenstadt)	Ferruginous Pochard	M	I	W	C
<i>Aythya fuligula</i> (Linn.)	Tufted Pochard	M	I	W	C
Falconiformes					
<i>Accipitridae</i>					
<i>Elanus caeruleus</i> (Desf.)	Black-shouldered Kite	R	C	D/G	C
<i>Milvus migrans govinda</i> (Sykes)	Black Kite	R	C	M	C
<i>Accipiter badius</i> (Gmelin)	Shikra	R	C	F	C
<i>Buteo rufinus</i> (Cretzschmar)	Long-legged Buzzard	M	C	D	C
<i>Buteo buteo vulpinus</i> (Gloger)	Common Buzzard	M	C	D	C
<i>Butastur teesa</i> (Franklin)	White-eyed Buzzard	M	C	D/G	C
<i>Aquila rapax vindhiana</i> (Franklin)	Tawny Eagle	R	C	D	C
<i>Aquila nipalensis</i> Hodgson	Steppe Eagle	M	C	D	C
<i>Aquila pomarina</i> Brehm	Lesser Spotted Eagle	M	C	D	Rr
<i>Sarcogyps calvus</i> (Scopoli)	Red-headed Vulture	R	S	D/G	Rr
<i>Aegyptius monachus</i> (Linn.)	Cinereous Vulture	R	S	D/G	C
<i>Gyps indicus</i> (Scopoli)	Long-billed Vulture	RM	S	D	C
<i>Gyps bengalensis</i> (Gmelin)	India white-backed Vulture	R	S	D	C

<i>Neophron percnopterus</i> (Linn.)	Egyptian Vulture	M	S	D/G	C
<i>Circus macrourus</i> (Gmelin)	Pallid Harrier	R	C	D/G	C
<i>Circus pygargus</i> (Linn.)	Montagu's Harrier	M	C	D/G	C
<i>Circus aeruginosus</i> (Linn.)	Western Marsh Harrier	M	C	W	C
<i>Circaetus gallicus</i> (Gmelin)	Short-toed Snake Eagle	R	C	D/G	C
<i>Falconidae</i>					
<i>Falco jugger</i> J. E. Gray	Laggar Falcon	R	C	D	Rr
<i>Falco chicquera</i> Daudin	Red-headed Falcon	R	C	D/G	Rr
<i>Falco tinnunculus</i> Linn.	Common Kestrel	R	C	D/G	C
Galliformes					
<i>Phasianidae</i>					
<i>Francolinus pondicerianus</i> (Gmelin)	Grey Francolin	R	G	D/G	C
<i>Coturnix coturnix</i> (Linn.)	Common Quail	R	G	G	C
<i>Coturnix coromandelica</i> (Gmelin)	Rain Quail	R	G	G	C
<i>Pavo cristatus</i> Linn.	Indian Pheasant	R	G	M	C
Gruiformes					
<i>Gruidae</i>					
<i>Grus grus</i> (Linn.)	Common Crane	M	G/I	W	C
<i>Grus virgo</i> (Linn.)	Demoiselle Crane	M	G/I	W	C
<i>Orididae</i>					
<i>Ardeotis nigriceps</i> (Vigors)	Great Indian Bustard	R	O	D/G	E
<i>Chlamydotis undulata</i> (Jacquin)	Houbara Bustard	M	O	D/G	E
Charadriiformes					
<i>Charadriidae</i>					
<i>Vanellus indicus</i> (Boddaert)	Red-wattled Lapwing	R	I	W	C
<i>Charadrius alexandrinus</i> Linn.	Kentish Plover	M	I	W	C
<i>Charadrius mongolus</i> Pallas	Lesser Sand Plover	M	I	W	C
<i>Charadrius dubius</i> Scopoli	Little Ringed Plover	M	I	W	C
<i>Scolopacidae</i>					
<i>Calidris minuta</i> (Leisler)	Little Stint	M	I	W	C
<i>Calidris temminckii</i> (Leisler)	Temminck's Stint	M	I	W	C
<i>Burhinidae</i>					
<i>Burhinus oedienemus</i> (Linn.)	Stone Curlew	R	I	D	C
<i>Glareolidae</i>					
<i>Cursorius cursor</i> (Latham)	Cream-coloured Courser	M	I	D	C
<i>Cursorius coromandelicus</i> (Gmelin)	Indian Courser	R	I	G	C
<i>Glareola pratincola</i> (Linn.)	Collared Pratincole	M	I	W	C
Columbiformes					
<i>Pteroclididae</i>					



<i>Pterocles exustus</i> Temminck	Chestnut-bellied Sandgrouse	R	G	D	C
<i>Pterocles senegallus</i> (Linn.)	Spotted Sandgrouse	M	I	D/W	C
<i>Pterocles orientalis orientalis</i> (Linn.)	Imperial Sandgrouse	M	G	D/W	C
Columbidae					
<i>Columba livia</i> Gmelin	Blue Rock Pigeon	R	G	M	C
<i>Streptopelia decaocto</i> (Frivaldsky)	Eurasian Collared Dove	R	G	M	C
<i>Streptopelia senegalensis combayensis</i> (Gmelin)	Little Brown Dove	R	G	M	C
Cuculiformes					
Cuculidae					
<i>Clamator jacobinus</i> (Boddaert)	Pied-crested Cuckoo	M	I	M	C
Strigiformes					
Strigidae					
<i>Asio flammeus flammeus</i> (Pontoppidan)	Short-eared Owl	M	C	M	V
<i>Athene brama</i> (Temminck)	Spotted Owlet	R	I	M	C
Coraciiformes					
Meropidae					
<i>Merops orientalis</i> Latham	Small Green Bee-eater	R	I	D	C
<i>Merops persicus</i> Pallas	Blue-checked Bee-eater	M	I	D	C
Coraciidae					
<i>Coracias garrulus semenowi</i> (Loudon & Tschudi)	European Roller	M	I	D/G	C
<i>Coracias benghalensis</i> (Linn.)	Indian Roller	R	I	M	C
Upupidae					
<i>Upupa epops</i> (Linn.)	Common Hoopoe	R	I	G	C
Piciformes					
Picidae					
<i>Jynx torquilla</i> (Linn.)	Eurasian Wryneck	R	I	F	C
<i>Dendrocopos mahrattensis</i> (Latham)	Yellow-fronted Pied Woodpecker	R	I	F	C
Passeriformes					
Alaudidae					
<i>Eremopterix nigriceps</i> (Gould)	Black-crowned Sparrow-Lark	R	G/I	D	C
<i>Eremopterix grisea</i> (Scopoli)	Ashy-crowned Sparrow-Lark	R	G/I	G	C

<i>Ammomanes phoenicurus</i>	Rufous-tailed	R	G/I	G	C
<i>phoenicurus</i> (Franklin)	Finch-Lark				
<i>Alaemon alaudipes</i> (Desf.)	Greater Hoopoe Lark	R	G/I	D	V
<i>Calandrella brachydactyla</i> (Leisler)	Greater short-toed Lark	M	G/I	G	C
<i>Melanocorypha bimaculata</i> <i>torquata</i> Blyth	Eastern Calandra Lark	M	G/I	G	C
<i>Galerida cristata</i> (Linn.)	Common Crested Lark	R	G/I	G	C
<i>Mirafra erythroptera</i> Blyth	Red-winged Bush Lark	R	G	G	C
<i>Hirundinidae</i>					
<i>Hirundo rustica</i> Linn.	Common Swallow	M	I	M	C
<i>Motacillidae</i>					
<i>Anthus campestris</i> (Linn.)	Tawny Pipit	M	I/G	G	C
<i>Anthus similis</i> Jerdon	Brown Rock Pipit	M	I/G	G	C
<i>Motacilla flava</i> Linn.	Yellow Wagtail	M	I/G	W	C
<i>Pycnonotidae</i>					
<i>Pycnonotus leucotis</i> (Gould)	White-checked Bulbul	R	I	F	C
<i>Pycnonotus cafer</i> (Linn.)	Red-vented Bulbul	R	I	M	C
<i>Laniidae</i>					
<i>Lanius excubitor</i> (Linn.)	Great Grey Shrike	R	I	M	C
<i>Lanius vittatus</i> Valenciennes	Bay-backed Shrike	R	I	M	C
<i>Muscicapidae</i>					
<i>Turdinae</i> (subfam.)					
<i>Luscinia svecica</i> (Linn.)	Northern Bluethroat	M	I	M	C
<i>Cercotrichas galactotes</i> (Temminck)	Rufous-tailed Scrub Robin	R	I	M	C
<i>Phoenicurus ochruros</i> (Gmelin)	Black Redstart	M	I	M	C
<i>Saxicola macrorhyncha</i> (Stoliczka)	Stoliczka's Bushchat	R	I	D	E
<i>Saxicola torquata</i> (Linn.)	Common Stonechat	RM	I	M	C
<i>Saxicola caprata</i> (Linn.)	Pied Bushchat	RM	I	M	C
<i>Oenanthe isabellina</i> (Temminck)	Isabelline Wheatear	M	I	D	C
<i>Oenanthe deserti</i> (Temminck)	Desert Wheatear	RM	I	D	C
<i>Oenanthe picata</i> (Blyth)	Variable Wheatear	M	I	D	C
<i>Oenanthe xanthopyrmyna kingi</i> (Hume)	Rufous Wheatear	M	I	D	V
<i>Timaliinae</i> (subfam.)					
<i>Turdoides caudatus</i> (Dumont)	Common Babbler	R	G/I/N	D	C
<i>Turdoides malcolmi</i> (Sykes)	Large Grey Babbler	R	G/I	M	C

<i>Sylviinae</i> (subfam.)						
	<i>Prinia inornata</i> Sypes	Plain Prinia	R	I	M	C
	<i>Prinia gracilis</i> (Lichtenstein)	Graceful Prinia	R	I	M	C
	<i>Sylvia hortensis jerdoni</i> (Blyth)	Orphean Warbler	R	I	M	C
	<i>Sylvia curruca minula</i> Hume	Common Lesser White throat	R	I	D	C
	<i>Sylvia nana</i> (Hemprich & Ehrenberg)	Desert Warbler	M	I	D	C
	<i>Cisticola juncidis</i> (Rafinesque)	Streaked Fantail Warbler	R	I	G	C
	<i>Hippolais caligata</i> (Lichtenstein)	Booted Warbler	R	I	M	C
	<i>Phylloscopus collybita</i> (Vieillot)	Common Chiffchaff	M	I	M	C
<i>Nectariniidae</i>						
	<i>Nectarinia asiatica</i> (Latham)	Purple Sunbird	R	N	M	C
<i>Estrildidae</i>						
	<i>Lonchura malabarica</i> (Linn.)	White-throated Munia	RM	G/I/N	M	C
	<i>Amandava formosa</i> (Latham)	Green Munia	M	G/I	F	C
<i>Passeridae</i>						
	<i>Passer domesticus</i> (Linn.)	House Sparrow	R	G	M	C
	<i>Petronia xanthocollis</i> (Burton)	Yellow-throated Sparrow	R	G	M	C
<i>Sturnidae</i>						
	<i>Sturnus roseus</i> (Linn.)	Rosy Starling	RM	I/N	F/G/W	C
	<i>Sturnus vulgaris</i> Linn.	Common Starling	M	G/I	F	C
	<i>Acridotheres tristis</i> (Linn.)	Common Myna	R	O	M	C
	<i>Acridotheres ginginianus</i> (Latham)	Bank Myna	RM	O	W	C
<i>Dicruridae</i>						
	<i>Dicrurus leucophaeus</i> Vieillot	King Crow or Black Drongo	RM	I/C	M	C
<i>Corvidae</i>						
	<i>Corvus corax</i> Linn.	Common Raven	R	O	D	C

MS	Migratory Status	FG	Foraging Guild	Habitat	Conservation Status
	R : Resident		C : Carnivore/Prey birds	D : Desert (barren)	C : Common
	M : Migrant		G : Grainivore/Herbivore	F : Forest (scrub)	E : Endangered
	RM: Resident Migrant		I : Insectivore	G : Grassland	Rr : Rare
			N : Nectarivore	M : Miscellaneous	V : Vulnerable
			O : Omnivore	W : Wetland	
			S : Scavenger		

**MAMMALIA*****Hemiechinus collaris* (Gray) (Insectivora *Erinaceidae*)**

“Desert Hedgehog, Indian Long-eared Hedgehog, Jhau, Jhawla, Sehla”

Desert Hedgehog is a nocturnal animal living in burrows made under the shrubs and bushes like *Calotropis procera*, *Capparis decidua*, *Grewia tenax*, *Lycium barbarum*, *Mimosa hamata*, *Pupalia lappacea*, *Tamarix indica*, *Ziziphus nummularia*, etc. It is nocturnal in habit and rests in burrows during day time to escape from heat.

It is common through out the Park, feeding on a variety of insects, eggs of ground birds, young birds, small mammals and sometimes it's own youngings. It also attacks on venomous scorpion and snakes. Mongoose, jackals and foxes are known to feed on it. It's best way of self defence is to roll into a ball and lies still till danger exists.

***Hemiechinus micropus micropus* (Blyth) (Insectivora *Erinaceidae*)**

“Pale Hedgehog, Jhau Chua, Sehla”

It is very rarely seen in DNP area. It lives in short burrows dug by self. Sometimes it lives under the piles of woods and under the shrubs, particularly *Aerva javanica*, *Calligonum polygonoides*, *Capparis decidua* and *Ziziphus nummularia*. It is a carnivorous animal, feeding on frogs, lizards, eggs and young birds. Sometimes, in the scarcity of food, it feeds on the fruits of *Ziziphus nummularia*. It is usually preyed by fox and mongoose (Plate-32/I).

***Suncus murinus* (Linnaeus) (Insectivora *Soricidae*)**

“Grey Shrew, Chhuchhundar, Chakchundi”

It is commonly found in the fencing around fields, scrub-lands and grasslands. It is a nocturnal animal, venturing out of it's hideouts at dusks, enters houses freely and moves along the walls. It has acute sense of smell, but is poor in eye-sight. It mainly feeds on insects, particularly on crickets, grasshoppers, cockroaches, etc. It also feeds on small frogs and scorpions. Among plants, it likes the leaves of *Mimosa hamata*. In houses, the vegetables, bread and cheese are the main foods liked by it. Owl is the main enemy, feeding on it.

***Canis aureus* Linnaeus (Carnivora *Canidae*)**

“Jackal, Asiatic Jackal”

Jackal usually lives in burrows, but in rocky habitats it makes it's home under the thickets of shrubs and bushes of *Aerva javanica*, *Calligonum polygonoides*, *Crotalaria burhia*, *Grewia tenax*, *Panicum antidotale*, *Ziziphus nummularia*, etc. Basically, Jackal is a carnivorous animal, feeding on dead bodies of other animals. Sometime, it also preys kids of goats, sheep, deer and black buck. Insects, rodents, chameleon and lizards are also relished by it. Jackal was also noted happily feeding on the fruits of *Citrullus lanatus* var. *lanatus*, *Cucumis melo* and *Ziziphus nummularia*. Jackal population is very low in the Park because of earlier extensive poaching for it's pelt.

***Vulpes bengalensis* (Shaw) (Carnivora Canidae)**

"Indian Fox, Lomri, Lonkdi, Lonki"

It is a threatened species, living in burrows in open scrubby country. It also prefers to stay on the fringes of cultivated fields and near villages. It is nocturnal and carnivorous, feeding on rodents, ground birds and their eggs, lizards, scorpions and insects. Among plants, it prefers during scarcity the fruits of *Citrullus lanatus* var. *lanatus*, *Cucumis melo*, *Salvadora oleoides*, *Vigna trilobata* and *Ziziphus nummularia*. Rather common in Sudasari area and may be seen during day time also.

***Vulpes vulpes pusilla* Blyth (Carnivora Canidae)**

"Red Fox, Desert Fox"

Red fox is an endangered animal, living in burrows having 4-5 openings. It usually makes underground holes among the clumps of *Calligonum polygonoides*, *Calotropis procera*, *Capparis decidua*, *Leptadenia pyrotechnica*, *Ziziphus nummularia*, etc to reside. It is a carnivorous animal, feeding on rats, snakes, lizards, birds and several invertebrates, including termite, scorpion and large spiders. Red fox was noted relishing the fruits of *Citrullus lanatus* var. *lanatus* and *Ziziphus nummularia*. It shows more diurnal behaviour and prefers to live alone rather than in groups. It is extensively poached for its pelt which is sold at a very high rate in Kashmir and Nepal. Rarely seen in Sudasari and Sam areas (Plate-32/2).

***Felis silvestris ornata* Schreber (Carnivora Felidae)**

"Desert Cat"

Desert cat is an endangered species. It prefers sandy habitats and lives in burrows with 4-5 openings. The burrows are usually made in thickets of shrubs and undershrubs of *Cadaba fruticosa*, *Capparis decidua*, *Maerua oblongifolia*, *Prosopis juliflora*, *Ziziphus nummularia*, etc and grasses like *Cenchrus ciliaris*, *Dichanthium annulatum*, *Heteropogon contortus*, *Panicum turgidum*, etc. The cat feeds on lizards, ground birds, nestling eggs of birds, field rodents, insects etc. Sometimes, in the scarcity of food, it feeds on herbaceous plants viz. *Amaranthus viridis*, *Boerhavia diffusa*, *Brachiaria ramosa*, etc (Plate-32/4).

***Herpestes javanicus auropunctatus* (Hodgson) (Carnivora Herpestidae)**

"Small Indian Mongoose, Nevla, Noyla"

It is a threatened species, living in burrows excavated by it, but is also a good climber. Near habitations, it lives in ruined buildings, assemblage of stones and sewers. It is a carnivorous animal, feeding on invertebrates like insects, scorpions, spiders, centipedes and vertebrates like frogs, lizards, snakes, birds and their eggs, rodents etc. Rarely, it feeds on halophytic herbaceous plants in the scarcity of food viz. *Chenopodium album*, *Haloxylon salicornicum* and *Portulaca oleracea*. It is a very courageous animal and is not afraid of man.

***Herpestes edwardsii* (E. Geoffrey Saint-Hilaire) (Carnivora Herpestidae)**

"Indian Gray Mongoose, Common Mongoose"

It is comparatively larger Mongoose than *H. javanicus auropunctatus*. It also lives in burrows excavated by it and feeding habits are same. However, it can easily climb on trees in search of eggs and birds. It has also been noticed feeding on cave bats, poultry and their eggs. It kills a rat in no time. Snake charmers domesticate young Mongoose and train it to fight with tamed Cobra to earn money through shows for their livelihood. Common throughout the Park (Plate-32/3).

***Gazella bennettii bennettii*** (Sykes) (Artiodactyla Bovidae)

"Indian Gazella, Chinkara"

Chinkara is the State animal of Rajasthan. This species is most common in DNP and is well adapted to live in arid and semi-arid regions. It usually browses young shoots and leaves of trees and shrubs viz. *Acacia senegal*, *Calligonum polygonoides*, *Capparis decidua*, *Crotalaria burhia*, *Lycium barbarum*, *Prosopis cineraria*, *Salvadora oleoides*, *Ziziphus nummularia*, etc. Chinkara was also noted relishing fallen flowers of *Tecomella undulata* and digging up the base of *Calotropis procera* stumps in search of sprouting buds. During monsoon period, many herbaceous plants viz. *Cyperus arenarius*, *C. conglomeratus*, *C. rotundus*, *Dactyloctenium scindicum*, *Fagonia schweinfurthii*, *Indigofera cordifolia*, *Lasiurus scindicus*, *Panicum turgidum*, *Tribulus terrestris*, *Vigna trilobata*, etc are preferably grazed by it. During summers, Gazella digs up the loose sandy soil of the dunes to expose the roots of *Dipterygium glaucum*, which are eaten as the moisture laden root-bark quench the thirst. The highest density of Chinkara was noticed in Sudasari area, however, it may be frequently seen in the southern part of the Park (Plate-32/5).

***Boselaphus tragocamelus*** (Pallas) (Artiodactyla Bovidae)

"Blue Bull, Nilgai"

The Blue Bull lives in open plains in herds of 3 to 20 animals. Usually a male leads the group of females and young ones. It usually feeds on the crops grown in the area viz. *Cyamopsis tetragonoloba*, *Pennisetum americanum*, *Phaseolus radiatus* and *Vigna aconitifolia*. It enters the fields at night and damage the crop, besides feeding. It possesses a never ending appetite and also prefers flowers of *Tecomella undulata* and leaves of *Grewia tenax*, *Salvadora oleoides*, *Ziziphus mauritiana*, *Z. nummularia*, etc. The animal can live without water for many days. It is very rare in DNP, found near Sudasari.

***Funambulus pennantii*** Wroughton (Rodentia – *Sciuridae* subfam. *Sciurinae*)

"Five-striped Palm Squirrel"

The squirrel usually lives on trees near human habitations. It also moves freely on ground and can easily climb over walls. It makes its nest in the cavities of the trees (*Acacia nilotica*, *Prosopis cineraria*, *Salvadora oleoides*, *Tecomella undulata*, etc), crevices in walls and other hollow domestic unused structures. It is diurnal and prefers seeds and fruits of all kinds, particularly the crops grown in the area. Among wild foods, the mature fruits of *Capparis decidua*, *Ziziphus mauritiana*, *Z. nummularia*, sometimes *Prosopis cineraria* and *P. juliflora* are liked by it. Rarely seen feeding on the insects. It is not very common in DNP area.

***Gerbillus gleadowi*** Murray (Rodentia *Muridae* subfam. *Gerbillinae*)

"Hairy-footed Gerbil, Chhoti Ratod"

Gerbil is abundant in the Park in sand-dune rich areas. It lives in small burrows and establishes a colony with other individuals. It feeds on herbaceous vegetation, particularly the underground rhizomes and bulbs of *Cyperus arenarius*, *C. atkinsonii*, *C. conglomeratus*, *C. rotundus*, *Desmostachya bipinnata*, *Dipcadi erythraeum*, *Ephedra ciliata* etc. It also prefers the fruits of *Citrullus lanatus* var. *lanatus* and *Salvadora oleoides* to meet its water requirements. Sometimes, it also feeds on insects. It is preyed upon by owls, cats, foxes and snakes.

***Gerbillus nanus*** Blanford (Rodentia *Muridae* subfam. *Gerbillinae*)

"Baluchistan's Gerbil"

This species is rather rare in DNP and it prefers to live in burrows made in sandy plains and inter-dunal areas. Basically it is herbivorous, feeding on herbaceous plants like *C. gleadowi*, but also prefers the plants having leathery leaves like *Portulaca oleracea* and *Trianthema triquetra*, probably to meet the water requirements. Rarely, it also feeds on insects. The fallen fruits of *Prosopis cineraria*, *Ziziphus mauritiana* and *Z. nummularia* are also liked by this species. Its enemies are same as mentioned for *C. gleadowi*.

***Meriones hurrianae*** Jerdon (Rodentia *Muridae* subfam. *Gerbillinae*)

"Indian Desert Gerbil, Safed Chuha"

It lives in extensive burrow system spread over three tiers. The animal feeds on every plant available, but chiefly herbaceous ones like *Borreria articularis*, *Citrullus lanatus* var. *lanatus*, *Cleome viscosa*, *Corchorus depressus*, *Dipterygium glaucum*, *Farsetia hamiltonii*, *Indigofera hochstetteri*, *Portulaca oleracea*, *Tephrosia subriflora*, *Vigna trilobata*, *Zygophyllum simplex*, etc. During monsoon months, the Desert Gerbil becomes selective and prefers grasses like *Eragrostis minor*, *Oropetium thomaeum*, *Tragus roxburghii*, seeds of *Brachiaria ramosa*, *Dactyloctenium aegyptium*, *D. scindicum*, *Echinochloa colona*, etc. It was observed that Safed Chuha eats less but destroys more and, thus, is a potential agent for desertification.

***Tatera indica*** (Hardwicke) (Rodentia *Muridae* subfam. *Gerbillinae*)

"Indian Gerbil, Ratod"

It is the largest Gerbil found in the desert. Indian Gerbil is diurnal and lives in extensive burrow systems spread over 3-tiers, up to 1 m deep. During summers, the animal comes out of burrows in the morning and evening only. Contrarily, during winters, it remains out only when day is sunny. It feeds on every plant available in the desert during summers and winters. However, during monsoon, it becomes selective and feeds preferably on grasses like *Brachiaria ramosa*, *Cenchrus biflorus*, *Lasiurus scindicus*, *Perotis hordeiformis*, *Tetrapogon tenellus*, *Tragus roxburghii*, etc. It causes serious damage to the crops.

***Millardia gleadowi*** Murray (Rodentia *Muridae* subfam. *Murinae*)

"Field Rat"

It is an animal of crop fields. It forms simple burrows with 3-4 openings in the thorn-clade mud, fencing boundaries of fields and open scrub-lands. It builds nesting chambers inside the burrows which are sometimes lined with twigs and grasses. It feeds on all kinds of seeds and herbaceous plants (crop and wild). In wild, the most favourite food plants are the grains of *Dactyloctenium aegyptium*, *D. scindicum*, *Panicum antidotale*, *P. turgidum*, fruits of *Citrullus lanatus* var. *lanatus*, *Cucumis melo*, *Ziziphus nummularia* and green young plants of *Aerva javanica*, *Fagonia schweinfurthii*, *Tribulus terrestris*, etc. It is a serious pest of standing crops. It is preyed by owls, mongoose, foxes, cats and snakes.

***Mus musculus*** Linnaeus (Rodentia *Muridae* subfam. *Murinae*)

"House Mouse"

It lives with man in residential houses, godowns, every household articles like under boxes, behind almirah, etc. It runs very fast and can climb over rough surface of walls. It can hide in a very small space. It also makes holes in walls and floor to live. It feeds all types of human food available in the house. It has a habit of cutting papers and clothes and is, thus, a serious pest. It breeds throughout the year and produces

1-8 youngs at a time. It is a nocturnal animal, but may be easily seen during day time. Cats, snakes and birds are the main enemies.

***Rattus rattus*** (Linnaeus) (Rodentia *Muridae* subfam. *Murinae*)

“Common House Rat, Chua, Mushak, Undra”

It is also known as roof rat. It lives in houses, godowns, warehouses, in the vicinity of villages and cities, in crop fields, gardens, railway lines, railway yards and sometimes in trains. It is nocturnal in habit, but very active in day time also. It digs holes in walls, ground or take shelter under and behind household articles. It is a social rodent and lives in large groups. It is omnivorous, feeding on all vegetable items of human food and meat, eggs, insects, young birds, etc. Due to its versatile feeding habit, it is one of the major pests. It destroys more than what it consumes. It is also a vector of number of diseases. It produces up to 12 youngs at a time. Cats and snakes are its main predators.

***Hystrix indica*** Kerr (Rodentia *Hystricidae*)

“Crested Indian Porcupine, Seh, Sehi”

It is a nocturnal animal, living in burrows excavated by it, particularly in large fixed sand-dune areas. Sometimes, it rests in thickets formed of shrubs and grasses viz. *Abutilon indicum*, *Aerva javanica*, *Cadaba fruticosa*, *Capparis decidua*, *Culligonum polygonoides*, *Maerua oblongifolia*, *Pavonia zeylanica*, *Pergularia daemia* and grasses like *Dichanthium amulatum*, *Digitaria ciliaris*, *Heteropogon contortus*, *Panicum antidotale*, etc. It is a herbivorous animal, feeding on stems, roots, rhizomes and tubers of several plants viz. *Cocculus pendulus*, *Cyperus rotundus*, young twigs of *Borreria articularis*, *Convolvulus prostratus*, *Crotalaria medicaginea*, *Hibiscus* (3 spp.), *Moringa concanensis*, *Sida* (4 spp.), *Tamarix indica* and grasses like *Aristida* (4 spp.), *Eragrostis* (5 spp.), *Tetrapogon tenellus*, etc. The Porcupine may rush at sufficient speed in the backward direction also. It protects itself from its enemies by erecting its crest and quills.

***Lepus nigricollis-dayanus*** Blanford (Lagomorpha *Leporidae*)

“Desert Hare, Khargosh, Sassa, Khirga”

The Desert Hare is an endangered species. It prefers grasslands of *Lasiurus scindicus*, associated with *Aristida adscensionis*, *Cenchrus ciliaris*, *C. setigerus*, *Elyonurus royleanus* and some legumes like *Indigofera cordifolia*, *Rhynchosia minima*, *Tephrosia purpurea*, etc to live. It also hides under thickets and large bushes of *Capparis decidua*, *Ephedra ciliata*, *Ziziphus nummularia*, etc. It often makes burrows to live. This species is totally herbivorous, feeding mostly on legumes and young grasses like *Aristida* (4 spp.), *Cenchrus* (4 spp.), *Dactyloctenium aegyptium*, *Indigofera cordifolia*, *I. linnaei*, *Perotis hordeiformis*, *Rhynchosia minima*, *Tetrapogon tenellus*, *Vigna trilobata*, etc. It was also observed feeding on fallen flowers of *Tecomella undulata* and *Moringa concanensis* and fruits of *Salvadora oleoides*, *Ziziphus mauritiana* and *Z. nummularia*. During summers, it debarks the trees at ground level. It is frequent in agricultural areas (Plate-32/6).

### STATISTICAL SYNOPSIS

The fauna of Desert National Park is represented by about 270 species belonging to 200 genera and 98 families. Of these, 126 species belonging 96 genera and 48 families belong to Invertebrata and 144 species belonging to 104 genera and 50 families to Vertebrata. The division Invertebrata is represented by 3 phyla viz. Nematoda, Mollusca and Arthropoda. Of these, the class Insecta of phylum Arthropoda is largest containing 73 species belonging to 55 genera and 24 families. Among insects, the order Hymenoptera (including suborder



Aculeata), containing about 24 species belonging to 15 genera and 6 families, dominates the insect diversity. The second position is occupied by the order Isoptera which contains 16 species belonging to 9 genera and 3 families. The orders Odonata with 11 species, 10 genera and 3 families and Orthoptera with 11 species, 11 genera and 3 families occupy third position. Rest orders viz. Dermaptera (1 sp.), Diptera (1 sp.), Coleoptera (1 sp.), Dictyoptera (2 spp.), Thysanura (3 spp.) and Lepidoptera (3 spp.) are rather poorly represented in DNP. The phylum Nematoda with 8 species, 8 genera and 5 families and class Arachnida (including acarians, scorpions and spiders) of phylum Arthropoda with 39 species, belonging to 28 genera and 14 families, are rather well represented in DNP. The phylum Mollusca finds lowest position with 6 species, belonging to 5 genera and 5 families.

The division Vertebrata is represented by 4 classes. Of these, the class Aves (Birds) dominates the faunal diversity, as it contains 106 species belonging to 71 genera and 31 families. The Mammalia occupies second place in vertebrates with 21 species, 17 genera and 10 families. The Reptilia (including lizards) occupies third position having 15 species, belonging to 14 genera and 8 families. The class Amphibia is rather poorly represented by 2 species, 2 genera and 1 family.

Table 14. Statistical analysis of fauna of DNP and comparison with Thar desert.  
(The taxa identified up to generic level are included here).

Group	Number of species				
	Thar Desert	DNP			
		Family	Genera	Species	%
<b>Invertebrata</b>					
Protozoa	82	—	—	—	—
Porifera	7	—	—	—	—
Platyhelminthes	50	—	—	—	—
Nematoda	55	5	8	8	14.54
Mollusca	23	5	5	6	26.08
Annelida	12	—	—	—	—
<b>Arthropoda</b>					
Diplopoda	1	—	—	—	—
Chilopoda	12	—	—	—	—
Crustacea	45	—	—	—	—
<b>Insecta</b>	702	24	55	73	10.39
Thysanura	—	1	2	3	—
Odonata	32	3	10	11	34.37
Orthoptera	38	3	11	11	28.94
Dermaptera	—	1	1	1	—
Dictyoptera (Mantoidea)	20	2	2	2	10.00

Isoptera (Termites)	44	3	9	16	36.36
Mallophaga	40	—	—	—	—
Anoplura	9	—	—	—	—
Hemiptera	53	—	—	—	—
Thysanoptera	21	—	—	—	—
Neuroptera	13	—	—	—	—
Coleoptera	96	1	1	1	1.04
Diptera	75	1	1	1	1.33
Siphonaptera	5	—	—	—	—
Lepidoptera	161	3	3	3	1.86
Hymenoptera (incl. Aculeata)	95	6	15	24	25.26
Arachnida (Scorpions, Spiders and Acarines)	—	14	28	39	—
<b>Vertebrata</b>					
Pisces	25	—	—	—	—
Amphibia	8	1	2	2	25.00
Reptilia	51	8	14	15	29.41
Aves	322	31	71	106	32.92
Mammalia	45	10	17	21	46.66

A perusal of table 14 revealed that the fauna of DNP has not been so far well explored, particularly invertebrates. Certain groups which are well represented in Thar desert viz. Protozoa (82 spp.), Porifera (7 spp.), Platyhelminthes (50 spp.) and Annelida (12 spp.) have no representative in DNP. Further, the classes belonging to phylum Arthropoda viz. Diplopoda (1 sp.), Chilopoda (12 spp.) and Crustacea (45 spp.) are also lacking in DNP. Among insects, about 50 per cent orders viz. Mallophaga (40 spp.), Anoplura (9 spp.), Hemiptera (53 spp.), Thysanoptera (21 spp.), Neuroptera (13 spp.) and Siphonaptera (5 spp.) which constitute major part of the insect diversity, have found no place in DNP. However, it is interesting to record that the order Dermoptera (1 sp.) of insects and the class Arachnida which includes scorpions (8 spp.), spiders (29 spp.) and Acarina (2 spp.) inhabit DNP alone, as they have not been recorded outside the Park. The order Thysanura with 3 species, belonging to 2 genera and 1 family, is endemic to DNP in Thar Desert.

The presently known invertebrates in DNP show poor diversity in comparison to rest part of Thar desert. The comparative percentage of various groups in DNP is : Nematoda (14.54%), Mollusca (26.08%) and Insecta (10.39%). In latter group, Isoptera (36.36%), Odonata (34.37%), Orthoptera (28.94%) and Hymenoptera (25.26%) are rather better represented than Dictyoptera (10%), Coleoptera (1.04%), Diptera (1.33%) and Lepidoptera (1.86%). Thus, out of 989 species of invertebrates found in Thar desert, only 12.34% invertebrates are represented in DNP.

Among vertebrates, Mammals contribute 46.66% faunal diversity to DNP, Aves 32.92% and Reptiles 29.41%. The Amphibians of DNP represent only 25% fauna common to Thar desert. Thus, out of 435 species of vertebrates found in Thar desert, only 33.56% are represented in DNP.



1. *Pimelia indica* Sen (Creeping Beetle)



2. *Mesobuthus tamulus indicus* (Pocock) (Scorpion) Courtesy : ZSI, Jodhpur



3. *Galeodis agilis* Pocock (Spider) Courtesy : ZSI, Jodhpur

**Plate-28. Arthropods.**





1. *Calotes versicolor* (Daudin)  
(Indian Garden Lizard) Courtesy: ZSI, Jodhpur



2. *Phrynocephalus laungwalansis* Sharma  
(Jaisalmer Toad Agama) Courtesy: ZSI, Jodhpur



3. *Uromastix hardwicki* Gray  
(Indian Spiny-tailed Lizard)



4. *Ophiomorus raithmai* Anderson &  
Leviton (Sand fish)



5. *Varanus bengalensis* (Linnaeus)  
(Indian Monitor)



6. *Eryx johni* Russell  
(Indian Sand Boa)

**Plate-29. Reptiles.**



1. *Aquila rapax vindhiana* (Franklin)  
(Tawny Eagle)



2. *Sarcogyps calvus* (Scopoli)  
(Red-headed Vulture) Courtesy: ZSI, Jodhpur



3. *Gyps indicus* (Scopoli)  
(Long-billed Vulture)



4. *Neophron percnopterus* (Linn.)  
(Egyptian Vulture)



5. *Coracias benghalensis* (Linn.)  
(Indian Roller)



6. *Ardeotis nigriceps* (Vigors)  
(Great Indian Bustard)

**Plate-30. Birds.**





1. *Pavo cristatus* Linn.  
(Indian Peafowl) Courtesy: ZSI, Jodhpur



2. *Burhinus oedipnemus* (Linn.)  
(Stone Curlew)



3. *Merops orientalis* Latham  
(Small Green Bee Eater)



4. *Vanellus indicus* (Boddaert)  
(Red-wattled Lapwing)



5. *Buteo rufinus* (Cretschmar)  
(Long-legged Buzzard)



6. *Upupa epops* (Linn.)  
(Common Hoopoe) Courtesy: ZSI, Jodhpur

**Plate-31. Birds.**



1. *Hemiechinus micropus micropus* (Blyth)  
(Pale Hedgehog) Courtesy: ZSI, Jodhpur



2. *Vulpes vulpes pusilla* Blyth  
(Desert Fox) Courtesy: ZSI, Jodhpur



3. *Herpestes edwardsii* (E. Geoffrey  
Saint Hilaire) (Common Mongoose)  
Courtesy: ZSI, Jodhpur



4. *Felis silvestris ornata* Schreber  
(Desert Cat) Courtesy: Dr. P.L. Kankane, ZSI, Dehra Dun



5. *Gazella bennettii bennettii* (Sykes)  
(Chinkara)



6. *Lepus nigricollis dayanus* Blanford  
(Desert Hare)

**Plate-32. Mammals.**



## CONSERVATION AND MANAGEMENT

The discussion on faunal wealth of DNP revealed that it harbours highly variable fauna which is under various degrees of threats inspite of highly specialized deserticolous adaptations and protection. The important threats to the biodiversity of DNP viz. settlement pattern and population pressure, grazing, military activities, tourism, poaching and hunting, drought, etc have already been discussed in this work which influence the flora and fauna of the Park, resulting in imperfect functioning of the ecosystem due to ecological imbalances. Any loss to phytodiversity is also a direct loss to fauna, since vegetation is the initial starting point for the flow of energy. The animals which have been facing serious threats in the Park and desert as a whole include both vertebrates and invertebrates.

### THREATENED FAUNA

**Nematodes :** The plant and soil Nematodes are found in soil around the roots of grasses which are surface feeders and have fibrous root-system. The dry and hot climatic conditions of the desert are probably the factors responsible for loss as well as controlled populations of Nematode fauna in desert, particularly for the species like : *Discolaimus major* whose populations are limited (known only from Sam area in DNP in India). *Tylencholaimus suryawanshii* is another Nematode which has recently migrated to Rajasthan in DNP area. The populations of endemic species *Discolaimium mukhtarpuriense* are also very limited. *Labronema virgo* collected for the first time from DNP in India is also in vulnerable state and needs conservation. It is interesting to note that very limited male individual of these Nematodes could be collected so far. It indicates that scarcity of male counter part acts as a reproductive barrier, resulting in controlled populations. As such, these taxa have fair chances of extinction.

**Insects :** The insects constitute the largest group of invertebrates. They have great variability and adaptability. Thar desert due to it's specialized ecological and environmental conditions harbours a number of endemic insects in DNP, but with very limited populations. The insects *Ctenolepisma longicaudata*, *C. ciliata* and *Acrotelsa collaris*, belonging to the order Thysanura, have been collected for the first time from Desert National Park in Rajasthan. The former species inhabits the libraries and houses in tropical and subtropical parts and is facing threat due to regular fumigation and use of insecticides throughout the range of distribution. The second taxon is a tropicopolitan synanthropic species, found among household articles. It is under threat due to regular cleaning of habitat and use of insecticides, insect repellent, etc. *Acrotelsa collaris* is free living, found in the forest floor, under bark of trees, in the nests of ants and termites, etc. It finds cosmopolitan distribution, but under threat in it's desert home due to the pressure of insectivores and climatic conditions.

The insect *Selysiotermis nigra*, belonging to the order Odonata, is a rare insect in DNP. Earlier it has been reported from Jammu & Kashmir only in India. Occurrence of this taxon in two different and contrasting eco-geographical zones, indicates it's adaptive potential to climatic change. Similarly, *Anacanthotermes macrocephalus*, popularly called White Ant, is a typical deserticolous of India and Pakistan, belonging to the order Isoptera. It damages and collects grass blades, seeds, etc to store in small chambers made between the residential tunnels. This species is a good food of insectivores, particularly birds and hence populations remain under check. *Microcerotermes raja* and *M. laxmi* are endemic species of Thar desert, poorly represented in DNP due to extremely dry conditions and other adverse factors. Their populations are shrinking due to insectivore pressure of birds like Red-vented Bulbul, House Sparrow, etc and frogs. They are presently known in desert from DNP, Jodhpur, Nagaur and Bikaner only.



Another endemic species of Thar desert is *Apoclea rajasthanensis*, belonging to the order Diptera of class Insecta, which also needs conservation as it is a good predator on insects. The species like *Monomorium (Parholcomyrme) destructor* - a native of desertic zones of the World, and *Tetramorium salvatum* of Himalayan region, belonging to the order Hymenoptera, have recently invaded DNP and are struggling for survival.

**Arachnids :** Some species of scorpions and spiders viz. *Vachonus rajasthanicus*, *Orthochirus krishnui* and *Galeodes agilis*, belonging to the class Arachnida, are endemic to Thar desert and are in urgent need of conservation to safeguard their dwindling populations.

**Reptiles :** *Phrynocephalus laungwalensis* (Jaisalmer Toad Agama) is endemic to Thar desert, inhabiting the most sandy western parts of Jaisalmer district where dry, almost barren, vegetation less, shifting type of sand-dunes exist. At present, it's populations are in growing stage and need no protection. However, any change in present desertic conditions, viz. introduction of Indira Gandhi Canal, etc, may produce serious threat for it's survival.

*Ophiomorus raithmai* (Sand Fish) is endemic to Thar desert. It's population density and abundance are remarkably low throughout the desert. Since, it mostly lives in vegetation free dune or plain sandy open areas, scarcity of food and danger of predators are the main factors for it's loss in desert. It may be placed under vulnerable category at present, particularly in Indian desert. *O. tridactylus* (Indian Sand Swimmer) is another species, found in Gujarat, Afghanistan, Iran and Pakistan, under threat. However, it has not so far been reported from Thar desert, especially from DNP.

*Uromastix hardwicki* (Indian spiny-tailed Lizard, Sanda) has been included among the threatened taxa in Red Data book. The main causes of depletion are habitat loss and it's exploitation for oil which has medicinal potential. The census data of DNP revealed that it's number has greatly increased in the Park during last ten years (163 in 1996, 248 in 1999, 908 in 2002 and 507 in 2004, see table-16). Yet, as a safe-guard, the taxon may be listed as conservation dependent.

**Birds (Aves) :** *Ardeotis nigriceps* (Great Indian Bustard, Godawan) is an endangered bird which finds distribution in north-west India and eastern parts of Pakistan. About fifty per cent populations of Great Indian Bustard live in Thar desert of Rajasthan. The best place to observe in DNP is Sudasari area where it breeds freely due to suitable grassy habitats. The populations of Bustard are decreasing rapidly throughout it's range of distribution. The main causes of threat are habitat destruction and ineffective protection. The poachers and hunters also illegally visit the area for Houbara Bustard and Sandgrouse, but shoot Great Indian Bustard as well for meat if they find it. Government of Rajasthan has declared it as a State Bird in 1992. It has also find place in the 13 rare species of Indian Board of Wildlife, in Wildlife Protection Act, 1972 and in Schedule I of October, 1977. The effect of protection measures may be assessed from the census records of DNP (table-16); the number of Great Indian Bustard was 39 in 1995, 78 in 1997, 94 in 1999, 93 in 2001, 84 in 2003 and 110 in 2004.

*Chlamydotis undulata* (Houbara Bustard, Lesser Bustard) is a migrant bird from Central Asia via Pakistan. Arab Sheikhs have shot thousands of birds during last few years in Pakistan. As such, the number of birds visiting India has decreased to lowest level. Although it is fully protected in India, but some illegal poaching in desert area has pushed this taxon to endangered stage. According to the census reports of 1985, the number of individuals was 66 which has gone down to 49 in 1999, 23 in 2002 and 42 in 2003 (table-16).

*Saxicola macrorhyncha* (White-browed Bushchat) is an endemic bird of arid and semi-arid areas of north-west India and Pakistan. It's populations have decreased very rapidly during last few decades not only in India but also in Pakistan where it has been supposed to be extinct.

*Sarcogyps calvus* (Red-headed Vulture) finds distribution from Pakistan eastwards to Malaysia and Indo-China. It is sparsely distributed in Rajasthan and Gujarat and it's populations are declining in other parts of India also, except Western Himalaya. It frequents open country, often near human habitations. The populations are declining because of wild ungulates, intensification of agriculture, increased poisonous disposed waste, direct persecution and diseases. CITES has included this taxon in Appendix-II as a threatened species.

*Aegyptius monachus* (Cinereous Vulture) is basically European, widely distributed up to North Africa and S. E. Asia. The Cinereous Vulture resides over many types of habitats, including desert, grasslands and base mountains and lives singly or in pairs. The main factors for declining it's populations are habitat destruction, scarcity of food, poisonous food and illegal hunting. It has been included in Appendix-II of CITES as a threatened species.

In DNP, there occur 5 species of Vultures and total number of individuals was 540 as per census report of 1997. In the year 2000, only 219 individuals could be observed. However, the number increased to 455 in 2001, 396 in 2002, 801 in 2003 and 307 in 2004 (table-16). The fluctuating census data in different years need to be noted which indicates that all species of Vultures are facing threat and need conservation.

**Mammals :** *Vulpes vulpes pusilla* (Desert Fox) finds distribution from Iraq to Thar desert. During last 3 decades it's populations have drastically declined in Thar desert due to persecution for pelt, loss of habitat and striking escalation of human as well as live-stock numbers in the desert region. It now belongs to endangered category of threatened mammals. The number of individuals was maximum (413) in 1996, which decreased to 157 in 1998, 140 in 2000, 203 in 2002 and 147 in 2004 (table-16). As such, the number of individuals has been constantly decreasing during last few years.

*V. bengalensis* (Indian Fox) is another species of *Vulpes* under threat. Though species finds wide distribution in arid and semi-arid areas of the country, but facing great threats from carnivorous animals and men for it's pelt and meat. The populations have shrunked to alarming state throughout it's range of distribution. Habitat loss has further enhanced the problem. In DNP, about 28 individuals were recorded during the census year 1997. Subsequent records of this species are not available with Forest Department, probably could not locate till 2001 when 34 individuals were recorded. In 2002 only 18 individuals and in 2003 and 2004 38 and 28 individuals respectively could be censused from DNP (table-16).

*Felis silvestris ornata* (Desert Cat) finds distribution in north-west desertic parts, Central India and eastern parts of Pakistan. It belongs to endangered category of threatened fauna due to it's declined populations. Probably destruction of habitats and scarcity of food are the main causes for population loss, otherwise it breeds round the year and delivers two or three kittens at a time. After the establishment of DNP, it's populations have not increased in the Park, but considerably decreased. The number of individuals was 38 in 1996, 13 in 1998, 6 in 2000 and 15 in 2002 and 7 in 2004 (table-16).

*Lepus nigricollis dayanus* (Desert Hare) is endemic to Thar desert, inhabiting grasslands and scrub forested areas. The populations are decreasing due to habitat loss and large scale predatory pressure of man, carnivorous animals and larger birds. Being nocturnal in habit, carnivorous animals easily prey upon it. It is in endangered stage due to carnivorous dominated food chain in desert area. In spite of protection in DNP,

the number of individuals could not increase notably during last 10 years. About 26 individuals were reported in 1993, 38 in 1997 and 2000, 37 in 2002 and 31 in 2004 (table-16).

*Herpestes javanicus auro-punctatus* (Small Indian Mongoose) is confined to the desertic areas. The populations are declining at an alarming rate (vulnerable) due to habitat loss resulting in scarcity of food. Only 27 individuals could be recorded during 1997 census, 21 in 2001, 11 in 2002, 44 in 2003 and 27 in 2004 (table-16).

*Hemiechinus micropus micropus* (Pale Hedgehog) finds distribution in desertic zones of Punjab, Gujarat and Rajasthan. The predatory pressure of foxes and mongooses at night is the main cause of population loss in desert. Sometimes, the carnivorous predators pull it out from the burrows which are very short and unsafe. Further, due to vegetation loss, the presence of burrows is easily located by predators. It is in vulnerable stage at present but likely to become endangered in near future. The number of individuals was 3 in 1993 and 1997, 4 and 3 in 2003 and 2004 respectively as per census reports of DNP. No individual could be reported between 1998 to 2002.

*Gerbillus nanus* (Baluchistan's Gerbil) is an herbivorous mammal feeding in day time. Due to predatory activity of owls, cats, foxes and sometimes snakes, etc, the populations of this taxon have declined to great extent (vulnerable) during last few years.

Table-15. Statistical synopsis of threatened fauna.

Groups	Number of species
<b>Invertebrata</b>	
Nematoda	4
Arthropoda	
Insecta	
Thysanura	3
Odonata	1
Isoptera	3
Diptera	1
Hymenoptera	2
Arachnida (incl. Spiders)	
Scorpionida	2
Solifugida	1
<b>Vertebrata</b>	
Reptilia (Squamata)	3
Aves	
Falconiformes	2
Gruiformes	2
Passeriformes	1
Mammalia	
Insectivora	1
Carnivora	4
Lagomorpha	1
Rodentia	1
<b>Total</b>	<b>32</b>

A perusal of Wildlife census reports of DNP from 1995 to 2004 regarding Vertebrates revealed that Great Indian Bustard was in abundance (199) during the year 1996. After that its number decreased notably and reached little above one hundred till 2004 (110). Further, Houbara Bustard is rather more poorly represented in the Park. It could be noticed only in 3 years out of ten years and number was below fifty. Falcon, Kite, Peacock, Sand grouse and Partridge show increasing trend in general. But, populations of Eagle and Vultures show great fluctuations in different years. Quail also has increasing trend, but unexpectedly only 12 birds could be observed during the year 2004. Fluctuations in the yearly strength of Imperial Sand grouse, Peacock, Chinkara, Blue Bull and Monitor lizard may also be assessed from the table-16.

Table-16. The Wildlife census figures of Desert National Park during last 10 years.

Name of the animals	Census years									
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Great Indian Bustard	39	199	78	61	94	92	93	97	84	110
Houbara Bustard					49			23	42	
Sandgrouse		309	411			533	658	897	1372	1145
Imperial Sandgrouse							463		248	
Partridge						233	243	455	424	383
Falcon						45	67	39	93	107
Eagle						13	36	43	70	45
Kite							26	33	37	41
Vultures			540			219	455	396	801	307
Quail							182	281	259	12
Peacock	125	413			382	315	468	425	821	888
Chinkara	1166	4776	1815	2218	2115	2083	2066	2979	1806	1969
Desert Cat	20	38	32	13	26	6	9	15	11	7
Desert Fox	165	413	103	157	182	140	160	203	192	147
Indian Fox			28				34	18	30	28
Desert Hare			38			38	43	37	36	31
Blue Bull			122	68	237	55	102	175	44	76
Small Indian Mongoose			27				21	11	44	27
Pale Hedgehog			3						4	3
Monitor Lizard						19	26	13	21	27
Spiny-tailed Lizard (Sanda)		163			248	342	846	908	832	507

Sources : (i) Conservator of Forests, Desert National Park, Jodhpur.

(ii) Deputy Director, Desert National Park, Jaisalmer.

Among mammals, Chinkara shows highest density. Desert Cat has gradual decreasing trend and census data of Desert Fox is almost identical in different years except during 1996 when highest number (413) was recorded. Indian Fox is, however, poorly represented as it's number hardly exceeded 35 during last ten years. Similar position is occupied by Desert Hare and Mongoose whose populations fluctuate between 30 and 50 individuals. The census records revealed that Pale Hedgehog was considerably better represented up to 1985. However, after wards up to 2002 (except 1997), no individual could be recorded in DNP. It was during 2003 and 2004 that 4 and 3 individuals respectively could be recorded. The strength of Blue Bull has greatly fluctuated between 44 to 237 individuals in different years.

Among lizards, Spiny-tailed Lizard is rather better represented than Monitor Lizard in DNP. A comparison of present census data with pre 1995 data revealed that the population density of Houbara Bustard, Falcon, Eagle, Kite, Mongoose, Pale Hedgehog and Desert Cat has decreased considerably between 1995-2004.

## MANAGEMENT

A perusal of threatened taxa within Desert National Park, which occupies tiny part of desert area and desert fauna, is enough to evaluate critical position of fauna in whole desert which is on it's last legs. In spite of having the protected areas like DNP, Tal Chapar Sanctuary, Gajner Sanctuary etc, promulgation of protection laws and formation of organizations such as Wildlife Boards and holding Wildlife weeks, the relentless destruction of Desert wildlife is continuing it's merry course unhindered. If things continued like present, it is merely a question of time when wildlife will virtually disappear like many other animals. We feel that management of wildlife is a highly specialized subject. As such, wildlife conservation should be managed by trained, professional conservationists with adequate scientific background, particularly of biology and ecology. Secondly, the wildlife conservation should be invariably accompanied by intensive research on ecology, biology, habit, behaviour, population pattern, etc of the wildlife to be conserved. If the prevailing system of leaving it on the mercy of the Forest Departments continued, which have no scientific information about fauna and flora required for conservation, is bound to lead to failure. The present study will provide adequate information to the managers of DNP to take effective measures for the conservation of desert flora and fauna.

Another step to conserve the rare and threatened species within DNP is to identify areas with assemblage of various representative habitats and also high floral and faunal species richness and abundance. These areas can be protected like Mini Cores within the Park. However, there is no core area concept for National Parks and Sanctuaries as entire area gets almost total legal protection after the amendment of the Act in 1991. The concept of core area is relevant to Biosphere Reserves. But, the location of the Desert National Park in a non forested area with barren sand-dunes and with scanty scrub vegetation on sand-dunes or sandy or hummocky plains, incomplete settlement work, climate and edaphic conditions and distribution pattern of flora and fauna within the Park is different than elsewhere. As such, the idea of Mini Core areas is relevant to provide strict protection for atleast threatened plant and animal species in present situations. The declaration of Park as Biosphere Reserve will certainly enhance it's conservation potentiality.

Further, habitat improvement through increasing water availability and managing vegetation cover may also lead to better conservation of wildlife as discussed earlier under floral diversity. Nevertheless, in order to improve the water availability for wild animals, especially during summers (i) de-siltation and deepening of existing water bodies, (ii) creation of artificial water points, (iii) plantation of trees like *Capparis decidua*, *Salvadora oleoides*, *Ficus* species and *Azadirachta indica* near water points to avoid excessive evaporation and (iv) construction of check-dams to enhance the capacity of area to retain more water may be the programmes for habitat improvement.

### PLANT-ANIMAL RELATIONSHIP

Flora and fauna are two biotic components of biodiversity which depend on each other for their survival and interact in nature in a sustainable manner. Any imbalanced interaction leads to structural changes in ecosystem and adversely effects sustainability of it's components. In Desert National Park, the biodiversity components are of two types viz. domesticated and wild. The domesticated plants and animals are under the control of men who domesticate them for their livelihood, particularly for medicine, food, cloth and shelter. The domesticated animals are mostly herbivorous and depend on cultivated crops and wild vegetation for food. In turn, they provide food and other items for livelihood to men. Men also fulfill their requirements from wild flora (details are under the chapter Bioperspective Potential) and fauna, but pay nothing to them. As such, there has been a flow of energy from vegetation to domesticated animals to men. This short food chain ensures the greater availability of energy. The domesticated animals are ultimately disposed off by scavenger birds, mammals and some invertebrates. The remaining organic matter is decomposed by microbes.

During present study it was observed that dependency of wild fauna on vegetation is mainly for two items viz. food and shelter. The Amphibians represented by two species in DNP are insectivorous and live in water or under the mud. They have no direct relationship with flora. However, the species on which Amphibians feed may be herbivorous. Reptiles are represented by 15 species, of which 12 species are lizards and 3 snakes. Among the lizards, 4 species are nocturnal and rest diurnal and all, except *Uromastix hardwicki*, are insectivorous. The latter species feeds on grasses like *Aristida adscensionis*, *A. juniculata*, *A. mutabilis*, *Brachiaria ramosa*, *Cenchrus ciliaris*, *Dactyloctenium aegyptium*, *Eragrostis ciliaris*, *Panicum turgidum*, *Tragus roxburghii*, flowers of *Tecomella undulata*, leaves of *Indigofera cordifolia*, *Senna italica*, *Tribulus terrestris*, etc. Most species of lizards live in burrows or on earth surface and need no vegetation for shelter. However, *Agama agilis* and *Acanthodaactylus contortis contortis* prefer to make their shelter under the bushy plants viz. *Leptadenia pyrotechnica*, *Calligonum polygonoides*, *Calotropis procera*, *Capparis decidua*, etc.

Of the three species of snakes, two are nocturnal and one is diurnal. They are all carnivorous or insectivorous and viviparous. They have no direct dependency on vegetation for food. However, *Echis carinatus* and *Argyrogena ventromaculatus* prefer to make their shelter in dense clumps of *Euphorbia caducifolia* and sometimes may be seen on the trees like *Acacia nilotica* subsp. *indica*, *A. jacquemontii*, *Prosopis cineraria*, etc, as they are good climbers.

A perusal of discussion made under mammalian group revealed that out of 21 species of mammals found in DNP, 9 are basically carnivorous and 12 herbivorous. Due to limitation of food in the Park, 8 carnivorous species viz. *Suncus murinus*, *Canis aureus*, *Vulpes bengalensis*, *V. vulpes pusilla*, *Herpestes edwardsii*, *H. javanicus auro-punctatus*, *Felis silvestris ornata* and *Hemiechinus micropus micropus* have also developed vegetarian food habit and, thus, may be placed under omnivorous group. The strictly carnivorous mammal in the Park is *Hemiechinus collaris*. Again, among the herbivorous taxa, *Rattus rattus* has developed carnivorous habit. As such, the food-chain of the Park has been very complicated.

The study revealed that although the carnivorous food habit dominates in the Park, yet, it was recorded that about 83 species of plants are relished by wild fauna. It is interesting to record that about 14 species of mammals live in burrows usually made by them. Of these, 8 species prefer to make burrows in open areas devoid of much vegetation and rest 6 species make their burrows under the thickets of shrubby plants. One species lives directly on shrubs and trees and rest 6 species reside in open scrub-lands, hiding themselves under the thickets formed of shrubs, herbs and grasses. The study revealed that about 37 species of plants provide either direct shelter or shelter locations to make the burrows. Of these shelter providing plants, 21

species also have food and fodder potentiality. This indicates that about 16 species of plants exclusively provide shelter for wild fauna and 62 exclusively food and fodder, indicating food selection habit of fauna. Among the palatable plants, 3 are cultivated main crops of the area viz. Bajra, Gwar and Mung and rest are wild. Of the wild taxa, 7 species are trees, 19 shrubs or undershrubs, 25 herbs, 4 sedges and 25 grasses. This shows that grasses and herbs are under more biotic pressure than perennial woody taxa. However, for shelter, shrubs (18 spp.) provide better protection than herbs (4 spp.), grasses (10 spp.) and trees (5 spp.).

The birds constitute largest group among vertebrates and have wide range of adaptability as regard their feeding habit and habitats. Out of 106 species found in DNP, 41 species are migratory, landing from Central Asian countries in DNP for short duration, particularly during winters and rainy season. About 57 species are resident and a few (8 species) are migratory residents which have no fix time or term to reside in the Park. Though water resources are very limited in the Park, yet, about 16 species prefer aquatic and marshy habitats. Two species viz. *Pterocles senegallus* (Spotted Sandgrouse) and *P. orientalis orientalis* (Imperial Sandgrouse), both migratory, show wide adaptability as they equally prefer water and desertic land. Similarly, *Sturnus roseus* (Rosy Starling) may live in grasslands, scrub forests as well as in water. About 24 species prefer to live in open, preferably barren sandy plains or in dunal areas. They mostly lay eggs on the ground. About 16 species show adaptability to live in barren desert as well as in grasslands. About 13 species are strictly resident of grasslands dominated by the grasses viz. *Lasiurus scindicus*, *Aristida adscensionis* and *Cenchrus biflorus*. Such bird species lay eggs in the nests formed of grasses on the ground. The number of bird species in scrub forested areas is rather limited and only 6 species have been observed in such habitats. Most of these species make their nests on the trees and shrubs. About 30 species live in miscellaneous habitats like near human habitations, ruined buildings, crop fields, etc.

Thus, about 34 per cent birds prefer to live in association with vegetation in one way or other. This number corresponds to the feeding habit of birds. About 12 species feed on grains, preferably grasses like *Panicum turgidum*, *P. antidotale*, *Tragus roxburghii*, *Digitaria ciliaris*, *Dichanthium annulatum*, *Brachiaria ramosa*, *Cenchrus ciliaris*, *C. biflorus*, *Dactyloctenium aegyptium*, *D. scindicum*, *Lasiurus scindicus*, etc. Besides this, they also feed on the fruits of *Ziziphus mauritiana*, *Z. nummularia*, *Salvadora persica*, *S. oleoides*, *Prosopis juliflora*, etc. Sometimes, the grainivorous birds also eat the tips of young seedlings of plants. Some birds viz. *Sturnus roseus* (Rosy Starling), though insectivorous, also suck the nectar of flowers of *Tecomella undulata*, etc. The bird *Turdoides caudatus* (Common Babbler) and *Lonchura malabarica* (White-throated Munia) feed on grains, nectar and insects.

About 47 species of birds are insectivorous and 17 species carnivorous, feeding on lizards, snakes, amphibians and small mammals. The scavengers are represented by five species of vultures viz. *Sarcogyps calvus* (Red-headed Vulture), *Aegyptus monachus* (Cinereous Vulture), *Gyps indicus* (Long-billed Vulture), *G. bengalensis* (Indian white-backed Vulture) and *Neophron percnopterus* (Egyptian Vulture). About 19 species have omnivorous habit feeding on grains and insects and 4 species feed on insects as well as rodents, lizards, snakes and frogs.

The observations revealed that among the birds about 70 per cent feed on other animals, about 18 per cent on animals as well plants and about 13 per cent are strictly herbivorous or grainivorous. Among Amphibians and Reptiles, only one lizard is herbivorous and rest feed on animals. In higher group, like mammals, about 87 per cent animals basically feed on other animals and only 13 per cent are herbivores. As such, the food web of DNP is dominated by animal and insect eaters.

**Food Web**

The interdependency among the faunal species and the vegetation in DNP, based on feeding habits, may be sketched in the form of food web. The study revealed that due to the scarcity of food many taxa have developed feeding habits other than their basic habits, resulting in complicated flow of energy.

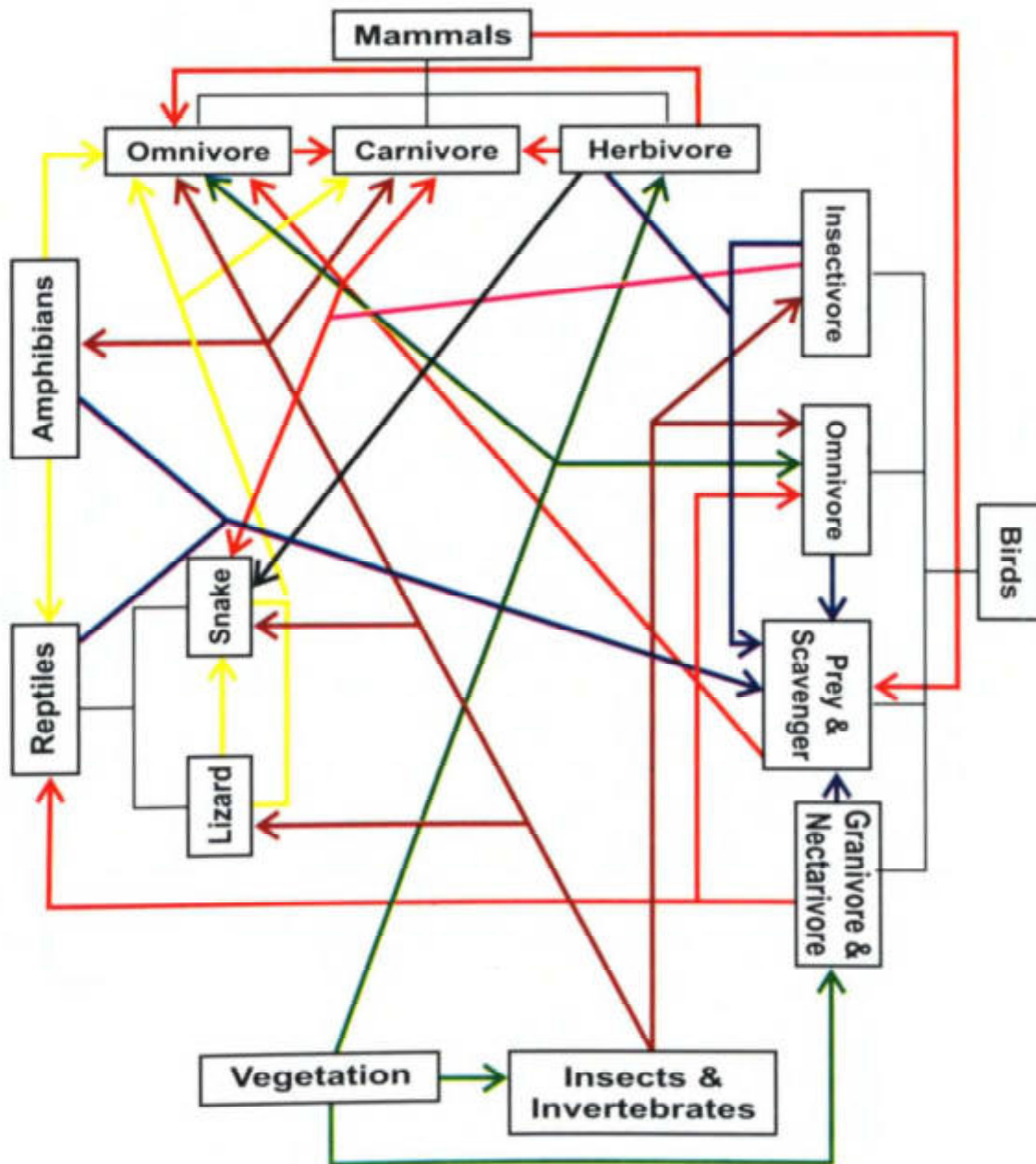


Diagram-5. Wildlife food web and flow of energy in DNP.



As usual, the vegetation of DNP is the primary producer and initial point for flow of energy. The primary consumers are insects and other invertebrates, grainivorous and omnivorous birds and herbivorous and omnivorous mammals and other vertebrates. The energy flows from producers to primary consumers to secondary and tertiary consumers. The insects and invertebrates constitute primary center of energy among consumers as they provide food to reptiles, amphibians, insectivorous and omnivorous birds and omnivorous and carnivorous mammals. As such, they play a vital role in energy flow. The birds, particularly grainivorous and omnivorous are preyed by carnivorous birds and so also the insectivorous, constituting internal flow system of energy among Aves. The herbivorous mammals provide energy to carnivorous and omnivorous mammals at one end and to birds (prey birds) and reptiles (snakes) on the other hand. Carnivorous mammals also receive energy directly from omnivorous ones. Like birds, there has been a continuous flow system of energy among lizard, snakes and amphibians. The reptiles also receive energy from birds, particularly insectivorous and grainivorous birds. Thus, birds, reptiles and amphibians become the main energy storage centers at this secondary stage after insects and other invertebrates of primary stage.

Now, the energy flows from secondary centers of energy to tertiary and final consumers, particularly to carnivorous birds and mammals. The reptiles and amphibians provide food to them from one center and the birds, which constitute another center, provide food to carnivorous mammals – the final consumers. The scavenger birds, some mammals and invertebrates feed on dead mammals and other animals and reduce the job of decomposers in the food web. From this point, detritus food chain starts as dead organic matter goes into micro-organisms and then to detritus feeding organisms (detritivorous) and their predators.

The study revealed that there have been several trophic levels in the food web of DNP. As such, quite a high percentage of potential energy is lost (losses) between energy flow at different transfer points in food web. It is of considerable ecological interest in reference to component populations as well as to whole trophic levels.

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## INDEX TO THE LOCAL NAMES - FLORA

- Aakdi-bel 121  
 Aakdo 119, 209  
 Aandhi-jharu 142  
 Adio-bal 51, 217  
 Adio-bekario 75  
 Agio 94  
 Ajwain 210  
 Andho-khimp 156  
 Angreji- bavliyo 93, 217  
 Ankh-phootani 101  
 Ankh-phutani-ki-bel 101  
 Ardu 63, 208  
 Aropa 43, 216  
 Babul 87, 207  
 Bagro 40, 211  
 Bajra 100, 205, 208, 210, 282  
 Bakda 107, 214  
 Bakdha 59  
 Bal 52  
 Balro 52, 218  
 Bathuo 148, 210  
 Bekar 75, 215  
 Bhangari 137, 209  
 Bhinda-anwal 85  
 Bhurat 169, 210  
 Bivnio 81, 218  
 Bor 65, 218  
 Bordi 65, 218  
 Bu-bhanwali 87, 207  
 Bui 143, 208  
 Butti 79  
 Chamghas 55, 212  
 Chamkas 55, 212  
 Chapari 94, 105  
 Chinawari 140, 209  
 Chirio-ro-khet 179  
 Chirya-ro-khet 109, 216  
 Choto-amio 172  
 Dab 175, 213  
 Dabi 41, 209  
 Danda-thor 151, 214  
 Daturu 132, 213  
 Dhaman 171, 172, 210  
 Dhamaso 58, 214  
 Dhankar 110  
 Dhedi-dudheli 153  
 Dholo-lamp 188  
 Dholo-ligru 116, 217  
 Dhudheli 152  
 Dhunnya 135  
 Dodha 120  
 Dudheli 152  
 Furri-bekar 79  
 Gaderia-ri-bel 121  
 Gangan 57, 214  
 Ganthia-ghas 183, 216  
 Garmano 185, 216  
 Ghirdano 185, 216  
 Ghora-dhob 183, 216  
 Goilia 78  
 Gokhru 61, 62, 218  
 Golo 99  
 Goondi 128, 212  
 Gorakh-buti 72  
 Gugario 72, 154, 212, 216  
 Guggal 64, 211, 216, 238  
 Gwar 205, 213, 282  
 Hiran-chaba 37  
 Hukkabel 151  
 Imarati 48  
 Jal-bhangra 46, 95, 208  
 Jal-bhangro 113, 214  
 Jangli-chauli 145, 146, 208  
 Jangli-gobhi 114, 215  
 Jangli-moth 84  
 Jharanio 177  
 Jhino-bivniyo 83  
 Jinjani 92  
 Jiria 177, 214

- Kachri 99, 212  
 Kachro 100, 213  
 Kagnasha 57, 212  
 Kagner 138  
 Kakrio 100  
 Kali-bui 124  
 Kanghi 48, 207  
 Kanghi-buti 49, 207  
 Kanti 62, 218  
 Karelo 102, 216  
 Ker 41, 207, 209  
 Keri 207  
 Kharbuji 46, 208  
 Kharo-jal 118, 217  
 Khato-kachario 100, 213  
 Khejari 93, 217  
 Khilra 156  
 Khimp 119, 215  
 Kulfo 45, 217  
 Kukari 146  
 Kumatiyo 89, 207  
 Lambio-bekario 77, 215  
 Lambio-bhurat 171  
 Lamp 166, 167  
 Lampro 166  
 Lana 148, 215  
 Lapio 181, 215  
 Lolaru 147  
 Luni 45, 62, 217, 219  
 Lunki 103  
 Luno 45, 62, 217, 219  
 Madhio 39, 211  
 Makhni 189, 218  
 Makra 168, 213  
 Matiro 98, 210  
 Meerha-jal 118, 217  
 Morali 133, 207, 216  
 Morang 105  
 Morlo 163  
 Moth 205  
 Motha 160  
 Motho 159, 160, 213  
 Mung 205, 282  
 Murat 168, 209  
 Muratio 186, 216  
 Nawri 122  
 Neelo-bekario 75, 215  
 Neem 64  
 Phog 149, 209, 238  
 Pilu 118, 217  
 Pilwan 35, 211  
 Pipal 155  
 Rambui 123, 208  
 Rati-biyani 81  
 Rohira 137, 218, 239  
 Rohis 176, 214  
 Rookhadi 114, 215  
 Rotabel 129, 131  
 Rudenti 130, 212  
 Safed-bagro 37, 211  
 Sangri 207, 217  
 Sanipat 135  
 Santari 129, 211  
 Santha 140, 209  
 Santhi 105, 218  
 Sares 92  
 Sargu 67, 216  
 Sarui 71, 208  
 Sevan 181, 215  
 Sinia 71, 212  
 Soneli 115  
 Tania-ghas 173, 213  
 Til 207, 218  
 Tindsi 98, 211  
 Tumbo 97, 210, 238  
 Unt-kantela 113  
 Unt-kantelo 111, 208  
 Vajradanti 112, 214  
 Vilayati-bavliyo 89

## INDEX TO THE BOTANICAL NAMES

**Abutilon** Mill. 47, 197

- bidentatum* Hochst. ex A. Rich. 28, 47  
 var. *major* (Blatt. & Halb.) Bhandari 48  
*fruticosum* Guill. & Perr. 28, 47, 48  
 var. *chrysocarpa* Blatt. & Halb. 48  
*glaucum* (Cav.) Sweet 49  
*indicum* (L.) Sweet 28, 47, 48, 207, 219  
 var. *guineese* (Schum.) Borss. 48  
*muticum* (Delile ex DC.) Sweet 49  
*pannosum* (Forst. f.) Schlect. 47, 48, 207, 219  
*tomentosum* (Roxb.) Wight & Arn. 49

**Acacia** Mill. 85, 197

- arabica* auct. non (Lam.) Willd. 87  
*arabica* (Lam.) Willd. var. *indica* Benth. 87  
*jacquemontii* Benth. 28, 87, 89, 201, 207, 219, 220, 281  
*merkeri* Harms 89  
*nilotica* (L.) Willd. ex Del. subsp. *indica* (Benth.) Brenan 22, 25, 28, 29, 85, 87, 88, 156, 207, 219, 220, 223, 227, 281  
 var. *indica* (Benth.) A. F. Hill 87  
*nubica* Benth. 28, 87, 89, 90, 200, 229  
*raddiana* Savi 89  
*rupestris* Stock ex Boiss. 89  
*senegal* (L.) Willd. xii, 22, 28, 29, 85, 87, 89, 91, 156, 207, 219, 220, 223, 227  
*tortilis* (Forssk.) Heyne subsp. *raddiana* (Savi) Brenan 20, 85, 89  
*virchowiana* Valke 89

**ACANTHACEAE** 34, 137, 197, 209**Acanthodium** *grossum* Wight 137**Achyranthes** L. 142

- aspera* L. 142  
 var. *arhentea* (Thw.) Hook. f. 143  
 var. *porphyristachya* (Wall. ex Moq.) Hook. f. 143  
*muricata* L. 147

**Adenantha** *aculeata* Roxb. 93**Aerva** Forssk. 142, 143

- javanica* (Burm. f.) Juss. ex Schult. 5, 19, 22, 28, 58, 80, 120, 143, 195, 208, 219, 220  
*persica* (Burm. f.) Merrill 143  
*tomentosa* Forssk. 143  
*velutina* Moq. 147

**Aeschynomene** L. 68

- indica* L. 68, 201  
*kashmiriana* Camb. 68

- Agrostis coromandeliana* Retz. 187
- Ailanthus* Desf. 63
- excelsa* Roxb. 63, 208, 219, 220, 221
- AIZOACEAE** 33, 102, 218
- Albizia* Durazz. 85, 92
- lebbek* (L.) Benth. 92
- Allium cepa* 239
- Alternanthera* Forssk. 142, 143
- sessilis* (L.) R. Br. ex DC. 30, 143, 146
- triandra* Lam. 143
- Alysicarpus* Desv. 68, 69
- cylindricus* (Lam.) Desv. 71
- heterophyllus* (Baker) Jafri & Ali 69, 70, 200
- monilifer* (L.) DC. 28, 29, 69
- rupicola* Edgew. 71
- vaginalis* (L.) DC. 29, 30, 69, 208, 219, 223
- var. *heterophyllus* Baker 69
- AMARANTHACEAE** 34, 35, 142, 196, 197, 208
- Amaranthus* L. 28, 29, 47, 117, 141, 142, 144, 146, 197
- angustifolius* Lam. 144
- blitum* L. 144
- var. *graecizans* (L.) Moq. 144
- var. *sylvestris* 144
- caudatus* 239
- gangeticus* L. 145
- var. *tristis* (L.) Duthie 145
- gracilis* Desf. 146
- graecizans* L. 144, 145, 201
- lividus* L. 144, 201
- mangostanus* L. 145
- oleraceus* L. 144
- palmeri* Wats. 144, 145, 201
- polygamus* L. 145
- var. *angustifolia* (Lam.) Hook. f. 144
- tricolor* L. 144, 145, 201, 239
- tristis* L. 145
- viridis* L. 30, 50, 125, 127, 133, 139, 144, 146, 201, 208, 219, 239
- Amberboa* (Pers.) Less. 111
- ramosa* (Roxb.) Jafri 111, 208, 219, 221
- Ammannia* L. 95
- baccifera* L. 29, 95, 96, 208, 219
- desertorum* Blatt. & Hallb. 29, 95, 198, 237
- Anchusa asperrima* Del. 123

- Andropogon annulatus* Forssk. 175  
*barbatus* L. 172  
*contortus* L. 181  
*foveolatus* Del. 176  
*jwarancusa* Jones 172  
*strictus* Roxb. 176
- Anticharis** Endl. 134  
*glandulosa* Aschers. var. *caerulea* Blatt. & Hallb. ex Sant. 29, 134, 201, 236  
*linearis* (Benth.) Hochst. ex Aschers. 135  
*senegalensis* (Walp.) Bhandari 29, 40, 134, 135, 195, 200
- Antichorus depressus* L. 55
- Antirrhinum glaucum* Stocks ex Wight 135  
*orontium* 201  
*pupilionaceum* L. 135
- APIACEAE** 197
- Arenaria serhyllifolia* 201
- Aristida** L. 5, 23, 25, 28, 29, 40, 83, 166, 167, 169, 188, 197  
*adscenstonis* L. 29, 39, 140, 166, 281, 282  
*depressa* Retz. 166  
*funiculata* Trin. & Rupr. 29, 166, 281  
*hirtigluma* Steud. ex Trin. & Rupr. 188  
*hystriacula* Edgew. 29, 166, 167  
*mutabilis* Trin. & Rupr. 29, 166, 167, 281  
*plumosa* L. 188
- Aristolochia** L. 149  
*bracteata* Retz. 151  
*bracteolata* Lam. 149, 201  
*sempervirens* Forssk. 149
- ARISTOLOCHIACEAE** 34, 149, 198
- Arnobia** Forssk. 123  
*asperrima* (Del.) Hutch. & Dalz. 123  
*hispidissima* (Sieber ex Lehm.) DC. 28, 39, 59, 123, 201, 208, 219, 223
- ASCLEPIADACEAE** 34, 118, 209, 215
- Asclepias daemia* Forssk. 121  
*nivalis* J. F. Gmel. 121  
*procera* Ait. 119  
*spiralis* Forssk. 121
- Aster crispus* Forssk. 116
- ASTERACEAE** 34, 111, 196, 197, 208, 214, 215, 217
- Astragalus tribuloides* 201
- Azadirachta** A. Juss. 64  
*indica* A. Juss. 64, 280
- Balsamodendron nikul* Hook. ex Stocks 64



- wightii* Arn. 64
- Bergia** L. 46
- ammannioides* Roxb. ex Roth 29, 46, 47, 198
- var. *pentandra* Wight 46
- odorata* Edgew. 46
- suffruticosa* (Delile) Fenzl. 29, 46, 107, 139, 208, 219
- BIGNONIACEAE** 34, 137, 198, 218
- Bignonia undulata* Sm. 137
- Bistella digyna* (Retz.) Bullock 94
- Blepharis** Juss. 137
- linariaefolia* Pers. 59, 113, 123, 137, 209, 219
- sindica* T. Anders. 137
- Blumea** DC. 111, 112
- lacera* (Burm. f.) DC. 112, 201
- Boerhavia** L. 29, 55, 139, 197
- coccinea sensu* Stewart 140
- diffusa* L. 29, 79, 98, 112, 140, 198, 201, 209, 219
- diffusa sensu* Duthie 141
- elegans* Choisy 141
- erecta* L. 139, 140, 201
- procumbens* Banks ex Roxb. 140, 201
- punarnava* Saha & Murthy 140
- repens* L. 140, 141
- var. *diffusa* (L.) Hook. f. 140, 141
- var. *procumbens* (Banks ex Roxb.) Hook. f. 140, 141
- rubicunda* Steud. 139, 141
- stellata* Wight 141
- verticillata* Poir. 141
- Bonamia latifolia* (Hochst. & Steud.) Sant. 132
- BORAGINACEAE** 34, 122, 196, 197, 208
- Borago indica* 127
- Borreria** G. F. W. Meyer 110
- articularis* (L. f.) F. N. Will. 29, 110, 192, 201
- hispida* (L.) K. Schum. 110
- Bouchea marrubifolia* (Fenzl. ex Walp.) Schauer 139
- Brachiaria** Griseb. 165, 168
- kurzii* (Hook. f.) A. Camus 168, 201, 237
- ramosa* (L.) Stapf.
- var. *pubescens* Basappa & Muniyamma 168
- var. *ramosa* 168, 201, 209, 219, 281, 282
- BRASSICACEAE** 32, 35, 197, 198
- Bremontiera ammoxylon* DC. 78
- var. *hurmanni* DC. 78

- Breweria latifolia* (Hochst. & Steud.) Benth. 132  
*Briza bipinnata* L. 175  
*Bryonia callosa* Rottl. 99  
     *grandis* L. 99  
     *scabrella* L. f. 101  
*Buchnera angustifolia* D. Don 136  
     *euphrasioides* auct. non Vahl 136  
     *euphrasioides* Vahl 136  
*Bulbostylis* Kunth 157  
      *barbata* (Rottb.) Clarke 30, 157, 201  
**BURSERACEAE** 33, 64, 198, 211  
*Cadaba* Forssk. 40, 41  
     *fruticosa* (L.) Druce 29, 41, 201, 209, 219  
     *indica* Lam. 41  
**CAESALPINIACEAE** 33, 85, 198  
*Calligonum* L. 148, 149  
     *polygonoides* L. 5, 19, 22, 28, 136, 149, 150, 199, 209, 219, 220, 224, 238, 281  
*Calotropis* R. Br. 119  
     *hamiltonii* Wight 119  
     *procera* (Ait.) R. Br. xi, 19, 20, 28, 29, 30, 41, 65, 67, 68, 93, 118, 119, 136, 199, 209, 219, 220, 227, 281  
         subsp. *hamiltonii* (Wight) Ali 119  
**CAPPARACEAE** 32, 40, 209, 216  
*Capparis* L. 40, 41  
     *aphylla* Roth 47  
     *decidua* (Forssk.) Edgew. xiii, 20, 22, 23, 28, 29, 35, 41, 42, 51, 52, 65, 67, 68, 80, 87, 93, 99, 101, 118, 119, 121, 129, 131, 133, 199, 207, 209, 219, 220, 224, 227, 280, 281  
     *oblongifolia* Forssk. 43  
*Carduus ramosus* Roxb. 111  
*Caroxylan salicornicum* Moq. 148  
*Cassia italica* (Mill.) Lam. ex Andrews 85  
     *italica* (Mill.) Spreng. 85  
     *obovata* Collad. 85  
     *obtusata* Roxb. 85  
     *senna* Burm. f. 85  
     *senna* L. 85  
         var.  $\beta$  L. 85  
*Celosia* L. 142, 146  
     *argentea* L. 30, 146  
*Cenchrus* L. 5, 23, 28, 44, 72, 83, 110, 164, 169, 173, 197  
     *biflorus* auct. non Roxb. 171  
     *biflorus* Roxb. 25, 28, 29, 37, 40, 75, 78, 127, 140, 166, 167, 169, 170, 171, 172, 201, 210, 219, 227, 282  
     *catharticus* Delile 169  
     *ciliaris* L. 19, 78, 29, 167, 169, 210, 219, 281, 282

- prieurii* (Kunth) Maire 28, 29, 169, **171**  
*setigerus* Vahl 29, 146, 169, **171**, 210, 219  
*Cephalandra indica* (Wight & Arn.) Naud. 99  
*Chudara tenax* Forssk. 57  
*Chascanum* E. Mey. **139**  
     *marrubifolium* Fenzl. ex Walp. 29, **139**, 200  
**CHENOPODIACEAE** 34, **147**, 210, 215  
*Chenopodium* L. 11, **147**, **148**  
     *album* L. 30, **148**, 210, 219  
*Chloris* Sw. 165, **172**  
     *barbata* Sw. 29, **172**, 201  
     *pallida* (Edgew.) Hook. f. 187  
     *tenella* Roxb. 188  
*Chondrilla naudicaulis* L. 114  
*Cistanche* Hoffm. & Link **136**  
     *tubulosa* (Schrenk) Wight 30, **136**, 195, 198, 201  
*Citrullus* Schrad. ex Eckl. & Zeyh. 28, **97**  
     *colocynthis* (L.) Schrad. 28, 37, 69, **97**, 197, 210, 219, 220, 224, 238, 239  
     *fistulosus* Stocks 98  
     *lanatus* (Thunb.) Matsumura & Nakai  
         var. *fistulosus* (Stocks) Chakravarty 97, **98**, 211, 219, 221  
         var. *lanatus* 97, **98**, 198, 210, 211, 219, 239  
     *vulgaris* Schrad. 98  
**CLEOMACEAE** 32, **37**, 211  
*Cleome* L. **37**  
     *brachycarpa* Vahl ex DC. 39, 40  
         var. *glauca* Blatt. & Hallb. 39  
         var. *longipetiolata* Sabnis 39  
     *fruticosa* L. 41  
     *gracilis* Edgew. 39  
     *gynandra* L. 29, 36, **37**, 44, 61, 79, 107, 109, 111, 114, 116, 146, 198, 211, 219  
     *papillosa* Steud. 39  
     *pentaphyllu* L. 37  
     *scaposa* DC. 28, 29, 37, 38, **39**, 48, 50, 112, 125, 130, 132, 145, 147, 198  
     *vahliana* Fresen. 28, 29, 37, **39**, 40, 211, 219, 221  
     *viscosa* L. 28, 29, 30, 37, **40**, 43, 49, 62, 72, 77, 85, 112, 122, 127, 133, 135, 139, 143, 144, 146, 190, 198,  
         211, 219  
*Coccinia* Wight & Arn. 97, **99**  
     *grandis* (L.) J. O. Voigt **99**  
     *indica* Wight & Arn. 99  
*Cocculus* DC. **35**  
     *laeaba* (Delile) DC. 35  
     *pendulus* (J. R. & G. Forst.) Diels 29, **35**, 211, 219

- Colocynthis citrullus* (L.) O. Kuntze 98  
 var. *fistulosus* (Stocks) Chakravarty 98
- Commicarpus* Standl. 139, 141**  
*verticillatus* (Poir.) Standl. 141, 200
- Commiphora* N. Jacquin 64**  
*mukul* (Hook. ex Stocks) Engl. 64  
*wightii* (Arn.) Bhandari 29, 64, 201, 211, 219, 224, 238
- CONVOLVULACEAE 34, 128, 197, 211, 212**
- Convolvulus* L. 28, 128**  
*auricomus* (A. Rich.) Bhandari var. *volubilis* (Clarke) Bhandari 128, 237  
*deserti* Hochst. & Steud. ex Baker & Rendle 129  
*glomeratus* Choisy var. *volubilis* Clarke 128  
*lastospermus* Vis. 131  
*microphyllus sensu* Choisy 129  
*microphyllus* Sieb. ex Spreng. 129  
 var. *boissieri* Clarke 129  
*parviflorus* Spreng. 129  
*pluricaulis* Choisy 129  
 var. *macra* Clarke 129  
*prostratus* Forssk.  
 var. *deserti* (Hochst. & Steud. ex Baker & Rendle) Parmar 128, 129  
 var. *prostratus* 75, 78, 128, 129, 198, 201, 211, 219, 225  
*scindicus* Boiss. 129
- Conyza lacera* Burn. f. 112
- Corchorus* L. 53**  
*antichorus* Raeusch. 55  
*burmanni* DC. 55  
*capsularis* 239  
*decemangularis* Roxb. 55  
*depressus* (L.) Vicary 28, 29, 53, 55, 57, 77, 141, 153, 198, 212, 219  
*olitorius* L. 29, 53, 55, 201, 212, 219, 239  
*tridens* L. 28, 53, 55, 198, 201, 212, 219, 221  
*trilocularis auct non* L. 55
- Cordia* L. 128**  
*gharaf* (Forssk.) Ehrenb. ex Asch. 28, 128, 201, 212, 219  
*rothii* Roem. & Schult. 128
- Cornus gharaf* Forssk. 128
- Crucca purpurea* L. 81  
*villosa* L. 84
- Crossa* L. 128, 130**  
*cretica* L. 30, 130, 212, 219  
*indica* Retz. 150  
*latifolia* (Hochst. & Steud.) T. Anders. 132

**Crotalaria** L. 68, 71*burhia* Buch.-Ham. ex Benth. 20, 28, 71, 84, 120, 127, 199, 201, 212, 219, 227*hebecarpa* (DC.) Rudd. 29, 71, 72, 109, 191*hirta* Willd. 72*leiocarpa* Vog. 72*luxurians* Benth. 72*medicaginea* Lam. 29, 71, 72, 212, 219var. *luxurians* (Benth.) Baker 72var. *neglecta* (Wight & Arn.) Baker 72*neglecta* Wight & Arn. 72*uniflora* Koen. ex Roxb. 72**Cucumis** L. 28, 97, 99*callosus* (Rottl.) Cogn. 99, 212, 219, 220, 239*colocynthis* L. 97*maderaspatana* L. 101*melo* L.var. *melo sensu* Chakravarty 100var. *momordica* Duthie & Fuller 29, 45, 99, 100, 198, 213, 219, 239*prophetarum* L. 99, 100, 192, 213, 219, 220, 239*sativus* 239*trigonus* Roxb. 99**CUCURBITACEAE** 33, 97, 196, 197, 210, 211, 212, 213, 216**Cullen** Medik. 68, 73*plicata* (Delile) Stirton 73**Cymbopogon** Spreng. 164, 172*jwarancusa* (Jones) Schult. 172*Cymopsis tetragonoloba* (L.) Taub. 201, 213, 219*Cynanchum extensum* Jacq. 121*pyrotechnicum* Forssk. 119*Cynosurus aegyptius* L. 173**CYPERACEAE** 35, 156, 196, 197, 213**Cyperus** L. 156, 157, 197*arenarius* Retz. 28, 157, 158, 159*aristatus* Rottb. 163*atkinsonii* Clarke 5, 28, 157, 159, 199*conglomeratus* Rottb. 28, 157, 159, 199*iria* L. 30, 157, 160*rotundus* L. 30, 46, 47, 107, 116, 157, 160, 161, 162, 163, 164, 199, 213, 219*squarrosus* L. 163*Dactyliandra* (Hook. f.) Hook. f. 97, 101*webwitschii* Hook. f. 28, 101, 200, 229**Dactyloctenium** Willd. 165, 173*aegyptium* (L.) Willd. 173, 174, 213, 219, 281, 282

- scindicum* Boiss. 28, **173**, 213, 219, 282  
*Duemia extensa* (Jacq.) R. Br. 121  
*Datura* L. 132  
     *innoxia* Mill. 132, 213, 219, 220, 225  
     *metel auct. non L.* 132  
*Desmostachya* Stapf. 165, **175**  
     *bipinnata* (L.) Stapf 175, 213, 219, 220  
*Diandrochloa japonica* (Thunb.) Henry 180  
     *diarrhena* (Schult.) Henry 180  
*Dianthera bicalyculata* Retz. 138  
     *paniculata* Forssk. 138  
*Dichanthium* Willemet 164, **175**  
     *annulatum* (Forssk.) Stapf 29, **175**, 201, 227, 282  
     *foveolatum* (Del.) Roberty 175, **176**, 214, 219  
*Dicoma* Cass. 111, **112**  
     *lanuginosa* DC. 112  
     *tomentosa* Cass. 28, 29, **112**, 123, 131, 136, 137, 201, 214, 219  
*Digera* Forssk. 142, **147**  
     *arvensis* Forssk. 147  
     *muricata* (L.) Mart. 30, 122, **147**, 198  
*Digitaria* Haller 164, **176**  
     *adscendens* (H. B. & K.) Hemt. 176  
     var. *fimbriata* (Link) Cuf. 177  
     *ciliaris* (Retz.) Koel. 29, **176**, 282  
     *fimbriata* Link 176  
*Dipcadi* Medik. **156**  
     *erythraeum* Webb. & Berth. **156**, 199, 238, 239  
     *unicolor* (Stocks) Baker 156  
*Diplochonium sesuvioides* Fenzl. 102  
*Dipterygium* DCene. 40, **43**  
     *glaucum* DCene. 28, 37, **43**, 129, 130, 200, 201  
*Dolichos minimus* L. 80  
     *trilobatus* L. 84  
*Doratanthera linearis* Benth. 135  
     *senegalensis* Walp. 135  
*Echinochloa* P. Beauv. 165, **177**  
     *colona* (L.) Link 30, **177**, 187, 214, 219, 221, 227  
*Echinops* L. 111, **113**  
     *echinatus* Roxb. 29, **113**, 193, 201  
*Eclipta* L. 111, **113**  
     *alba* (L.) Hassk. 113  
     *erecta* L. 113, 114  
     *prostrata* (L.) L. **113**, 114, 201, 214, 219

**EHRETIACEAE** 34, 128, 198, 212

**ELATINACEAE** 33, 46, 208

*Flatine ammannioides* (Roxb. ex Roth) Wight & Arn. 46

*Eleocharis* R. Br. 157, 162

*atropurpurea* (Retz.) Presl 30, 162, 163

*Eleusine aegyptia* (L.) Desf. 173

*aristata* Ehrenb. ex Boiss. 173

*compressa* (Forssk.) Asch. & Schweinf. ex C. Christ. 183

*corucana* 239

*flagellifera* Nees 183

*scindica* (Boiss.) Duthie 173

*Elyonurus* Humb. & Bonpl. ex Willd. 154, 177

*hirsutus* Munro ex Benth. 181

*royleanus* Nees ex A. Rich. 177

*Enicostema* Blume 122

*axillare* (Lam.) Raynal 29, 122, 201

*hyssopifolium* (Willd.) Verdoorn 122

*littorale* auct. non Blume 122

*verticillatum* (L.) Engl. 122

*Enneapogon* Desv. ex P. Beauv. 165, 178

*brachystachyus* (Jaub. & Spach) Stapf 178

*desvauxii* P. Beauv. 29, 178, 201

**EPHEDRACEAE** 32, 155

*Ephedra* L. 155

*ciliata* Fisch. & Meyer ex C. A. Meyer 155, 195, 196, 199, 239

*foliata* Boiss. & Kotschy ex Boiss. 155

var. *ciliata* (Fisch. & Meyer ex Meyer) Stapf 155

*peduncularis* Boiss. 155

*Epibaterium pendulum* J. R. & G. Forst. 35

*Eragrostis* M. N. Wolf 165, 178, 197

*amabilis* (L.) Wight & Arn. 30, 179

*ciliaris* (L.) R. Br. 28, 135, 171, 178, 179, 201, 281

var. *brachystachya* Boiss. 179

*cynosuroides* (Retz.) P. Beauv. 175

*diarrhena* (Schult.) Steud. 180

*interrupta* auct. plur. non (R. Br.) P. Beauv. 180

var. *diarrhena* (Schult.) Stapf 180

var. *koenigii* Stapf. 180

*japonica* (Thunb.) Trin. 178, 179

*minor* Host 30, 40, 124, 179, 180, 181, 201

*pilosa* (L.) P. Beauv. 30, 179, 180

*poaeoides* P. Beauv. 180

*tenella* (L.) P. Beauv. ex Roem. & Schult. 179

- var. *plumosa* (Retz.) Stapf 179  
*Eremopogon foveolatus* (Del.) Stapf 176  
   *strictus* (Roxb.) A. Camus 176  
*Erodium chumbulense* Munro 63  
*Euphorbia* L. 28, 125, **151**, 197  
   *aegyptiaca* Boiss. var. *indica* Boiss. 152  
   *caducifolia* Haines xii, 29, 50, 63, **151**, 201, 214, 219, 281  
   *clarkeana* Hook. f. 29, 77, 151, **152**  
   *granulata* Forssk.  
     var. *glabra* Blatt. & Hallb. 153  
     var. *glabrata* Boiss. 151, **153**  
     var. *granulata* 29, 44, 111, 123, 129, 130, 151, **152**, 185  
   *heyneana* Boiss. 152  
   *hirta* L. 30, 151, **153**  
   *neriifolia* auct. plur. non L. 151  
   *pilulifera* auct. plur. non L. 153  
**EUPHORBIACEAE** 35, **151**, 197, 214, 216  
*Eutriana abyssinica* R. Br. ex Fresen. 182  
*Exacum hyssopifolium* Willd. 122  
**FABACEAE** 33, **68**, 196, 197, 208, 212, 215, 218  
*Fagonia* Tourn. ex L. 11, 48, 57, **58**, 147, 167  
   *bruguieri* DC. 48, **58**, 190, 201  
     var. *rechingeri* Hadidi 58  
   *echinella* Boiss. 58  
   *indica* Burm. f. var. *schweinfurthii* Hadidi 58  
   *schweinfurthii* (Hadidi) Hadidi ex Ghaffoor 28, 29, **58**, 124, 132, 178, 201, 214, 219  
*Farsctia* Turra 35  
   *hamiltonii* Royle 28, **35**, 85, 127  
*Ficus* L. 155  
   *religiosa* L. 155  
*Flmbristylis* Vahl 157, **162**  
   *barbata* (Roth.) Benth. 157  
   *mitiacea* (L.) Vahl 163  
   *quinquangularis* (Vahl) Kunth 30, **162**  
*Galega diffusa* Roxb. 81  
   *hirta* Buch.-Ham. 84  
   *incana* Roxb. 84  
   *lanceaefolia* Roxb. 81  
   *purpurea* (L.) L. 81  
   *villosa* (L.) L. 84  
*Galenia asiatica* Burm. f. 118  
*Gastrocotyle hispida* 201  
*Gentiana axillaris* Lam. 122



- verticillata* L. 122
- GENTIANACEAE** 34, 122, 198
- GERANIACEAE** 33, 63, 198
- Gisekia** L. 105
- pharnaceoides* L. 55, 69, 105, 106, 149, 198
- Glinus** L. 105, 107
- lotoides* L. 46, 47, 95, 107, 134, 139, 201, 214, 219
- Glossonema** DCne. 121
- varians* (Stocks) Benth. ex Hook. f. 120
- Glycine capitata** Heyne ex Roth 79
- schimperii* Hochst. & Steud. ex Steud. 80
- Gomphrena sessilis** L. 143
- Goniogyna hebecarpa** DC. 72
- hirta* (Willd.) Ali 72
- leiocarpa* DC. 72
- Gracilea royleana** (Nees ex Steud.) Hook. f. 183
- var. *plumosa* Hook. f. 182
- Grewia** L. 53, 57
- betulaefolia* Juss. 57
- populifolia* Vahl 57
- tenax* (Forssk.) Fiori 28, 29, 56, 57, 93, 190, 214, 219, 220
- Gynandropsis brachycarpa** (Vahl) DC. 39, 40
- pentaphylla* (L.) DC. 37
- Hallia hirta** Willd. 72
- Haloxylon** Bunge 11, 147, 148
- salicornicum* (Moq.) Bunge 19, 28, 30, 148, 215, 219
- Hedyotis aspera** Heyne ex Roth 110
- Hedysarum cylindricum** Lam. 71
- linifolium* L. f. 77
- moniliferum* L. 69
- neli-tali* Roxb. 68
- nummularifolium auct non L.* 71
- prostratum* L. 77
- vaginale* L. 71
- Heleocharis atropurpurea** (Retz.) Kunth 162
- Heliotropium** L. 28, 47, 49, 69, 123, 125, 141, 143, 144, 145, 146, 197
- bacciferum* Forssk. 29, 40, 123, 124, 201
- eichwaldii* auct. non Steud. ex DC. 124
- eichwaldii* Steud. ex DC. var. *lasiocarpum* (Fish. & Mey.) Clarke 124
- ellipticum auct. plur. non Ledeb.* 124
- europaeum* L. var. *lasiocarpum* (Fish. & Mey.) Kazmi 30, 123, 124, 194, 201
- lasiocarpum* Fish. & Mey. 124
- marifolium* Koen ex Retz.

- subsp. *wallichii* (Clarke) Kazmi 125  
 var. *marifolium* 123, 125, 201  
 var. *wallichii* Clarke 123, 125  
*rariflorum* Stocks 29, 123, 125  
*scabrum* Retz. var. *wallichii* (Clarke) Gamble 125  
*strigosum* Willd. 48, 50, 116, 124, 126, 201  
*subulatum* (Hochst. ex DC.) Vatke 75, 78, 112, 113, 123, 126, 194, 201  
*undulatum* Vahl 124  
*zeylanicum* auct. plur. non Lam. 126  
**Heteropogon** Pers. 164, 181  
*contortus* (L.) P. Beauv. ex Roem. & Schult. 29, 181, 201, 215, 219  
**Heylandia** *hebecarpa* DC. 72  
*latebrosa* DC. 72  
*leiocarpa* DC. 72  
**Hibiscus** L. 47, 49  
*amblyocarpus* Hochst. ex Webb. 49, 200  
*lobatus* (Murr.) O. Ktze. 29, 49, 50, 201  
*micranthus* L. f. 49, 50, 201, 215, 219, 222  
*obtusilobus* non Garcke 49  
*ovalifolius* sensu Boisser 50  
*punctatus* Dalz. 49  
*solandra* L'Herit. 50  
*zeylanicus* L. 50  
**Hypocoum** *procumbens* 201  
**Illecebrum** *sessile* (L.) L. 143  
**Indigofera** L. 28, 68, 73, 83, 197  
*anabaptista* Steud. ex Baker 75  
*argentea* auct. non Burm. f. 78  
*argentea* Burm. f. 28, 73, 215, 219  
*cordifolia* Heyne ex Roth 28, 29, 73, 74, 75, 77, 78, 80, 83, 109, 131, 136, 166, 169, 171, 172, 175, 198, 215, 219, 225, 281  
*enneaphylla* auct. plur. non L. 78  
*hochstetteri* Baker 29, 73, 75, 201  
*linifolia* (L. f.) Retz. 28, 29, 55, 73, 76, 77, 185, 187, 215, 219, 225  
*linnaei* Ali 28, 29, 73, 77, 79, 198  
*oblongifolia* Forssk. 73, 78  
*paucifolia* Delile 78  
*prostrata* Willd. 78  
*roxburghii* Tausch 77  
*semitrijuga* auct. non Forssk. 73  
*semitrijuga* Forssk. var. *tetrasperma* DC. 73  
*sessiliflora* DC. 29, 73, 78, 200  
*tribuloides* Boiss. 78

- trigonelloides* auct. non Jaub. & Spach 78
- Ipomoea* L. 128, 130**
- capitellata* Choisy 130
- hepaticaeifolia* L. 130
- pes-tigridis* L. 28, 29, 130**
- var. *capitellata* (Choisy) Clarke 131
- var. *hepaticaeifolia* (L.) Clarke 131
- runicifolia* Choisy 131
- sindica* Stapf 29, 130, 131**
- verticillata* Forssk. 130, 131, 200
- Iresine javanica* Burm. f. 143
- persica* Burm. f. 143
- Isolepis roylei* Nees 163
- Justicia* L. 137, 138**
- bicalyculata* (Retz.) Vahl 138
- procumbens* L. 138, 201**
- Kochia indica* 201
- Kohautia* Cham. & Schldl. 110**
- aspera* (Heyne ex Roth) Brem. 110, 201
- LAMIACEAE 197
- Lancretia suffruticosa* Delile 46
- Lappago biflora sensu* Roxb. 189
- Lasiurus* Boiss. 164, 181**
- ecaudatus* Satyan. & Shankar 181
- hirsutus* (Vahl) Boiss. 181
- scindicus* Henr. xiii, 23, 24, 25, 28, 29, 71, 75, 166, 171, 173, 181, 187, 215, 219, 227, 282
- Latipes senegalensis* Kunth 182
- Launaea* Cass. 111, 114**
- chondrilloides* (DC.) Hook. f. 115
- nudicaulis* (L.) Hook. f. 114
- procumbens* (Roxb.) Ramayya & Rajagopal 29, 114, 215, 219
- resedifolia* (L.) Kuntze 115
- Leptadenia* R. Br. 119**
- pyrotechnica* (Forssk.) Decne. xii, 20, 22, 28, 71, 119, 215, 219, 227, 281
- spartium* Wight 119
- Leptothrium* Kunth 165, 182**
- senegalense* (Kunth) W. D. Clayton 182
- LILIACEAE 35, 156, 198
- Lineum* L. 105, 107**
- indicum* Stocks ex T. Anders. 30, 107, 201
- Linaria sphaerocarpa* Benth. 135
- Lithospermum hispidissimum* Sieber ex Lehm. 123
- Lophochloa pumila* 201

- Lycium* L. 132, 133  
*barbarum* L. 28, 80, 133, 207, 216, 219
- LYTHRACEAE** 33, 34, 95, 208
- Macronyx strigosus* Dalz. 83
- Maerua* Forssk. 40, 43  
*arenaria* (DC.) Hook. f. & Thoms. 43  
 var. *glabra* Hook. f. & Thoms. 43  
 var. *scabra* Hook. f. & Thoms. 43  
*oblongifolia* (Forssk.) A. Rich. 29, 43, 216, 222
- Malconia africana* 201
- MALVACEAE** 32, 47, 196, 197, 207, 215, 217, 218
- Malva sylvestris* 201
- Mangifera indica* 207
- Mariscus* Vahl 156, 163  
*squarrosus* (L.) Clarke 30, 163, 201
- Mastostigma varians* Stocks 120
- Melanocenchris* Nees 165, 182  
*abyssinica* (R. Br. ex Fresen.) Hochst. 29, 182  
*jacquemontii* Jaub. & Spach 29, 182, 183  
*royleana* Nees ex Steud. 183
- Melhania* Forssk. 53  
*denhamii* R. Br. 29, 53
- Melia azadirachta* L. 64
- MELIACEAE** 33, 64, 198
- Melochia cordata* Burm. f. 51
- Melothria* L. 97, 101  
*maderaspatana* (L.) Cogn. 28, 101, 151
- MENISPERMACEAE** 32, 35, 198, 211
- Menispermum laeaba* Delile 35
- Microlonchus divaricatus* DC. 111
- Mimosa* L. 85, 92  
*armata* Rottl. ex Spreng. 92  
*cineraria* L. 93  
*hamata* Willd. 29, 92, 192, 201  
*juliflora* Swartz 93  
*lebbeck* L. 92  
*senegal* L. 89
- MIMOSACEAE** 33, 85, 196, 197, 207, 217
- MOLLUGINACEAE** 33, 105, 214, 216
- Mollugo* L. 105, 109  
*cerviana* (L.) Seringe 28, 44, 108, 109, 114, 126, 198, 216, 219  
*hirta* Thunb. 107  
*nudicaulis* Lam. 109, 198, 201

*Momordica* L. 97, 102

*charantia* L. 102, 216, 219

*lanata* Thunb. 98

*Monsonia* L. 63

*chumbelensis* (Munro) Wight 63

*lawiana* Stocks 63

*senegalensis* Guill. & Perr. 28, 29, 63, 200

**MORACEAE** 35, 155, 198

*Moringa* Adans. 67

*concanensis* Nimmo ex Dalz. & Gibs. 21, 67, 201, 216, 219, 220, 232, 238, 239

*oleifera* 239

**MORINGACEAE** 33, 67, 198, 216

*Mukia maderaspatana* (L.) M. Roem. 101

*scabrella* Arn. 101

*Myriophyllum spicatum* 201

*Nardus thomaea* L. f. 185

*Neurada* L. 94

*procumbens* L. 29, 94

*Niebuhria arenaria* DC. 43

**NYCTAGINACEAE** 34, 139, 209

*Ochthachloa* Edgew. 165, 183

*compressa* (Forssk.) Hilu 29, 183, 216, 219, 239

*Odontanthera* Wight 119, 120, 121

*varians* (Stocks) Mabberley 120, 193, 200, 238

*Oenanthe javanica* 201

*Oldenlandia aspera* (Heyne ex Roth) DC. 110

*digyna* Retz. 94

*Oligochaeta ramosa* (Roxb.) Wagenitz 111

**ORCHIDACEAE** 197

**OROBANCHACEAE** 34, 136, 198

*Oropetium* Trin. 165, 185

*thomaeum* (L. f.) Trin. 29, 185, 201

*Panicum* L. 164, 185

*adscendens* H. B. & K. 176

*antidotale* Retz. 28, 110, 121, 184, 185, 216, 219, 220, 227, 282

*ciliare* Retz. 176

*colonum* L. 177

*compressum* Forssk. 183

*kurzii* Hook. f. 168

*ramosum* L. 168

*turgidum* Forssk. 28, 185, 186, 216, 219, 227, 281, 282

*Pappophorum brachystachyum* Jaub. & Spach 178

*Pavonia* Cav. 47, 50

- zeylanica* (L.) Cav. 29, **50**
- Pennisetum americanum* 205, 210
- cenchrroides* Rich. 169
- ciliare* (L.) Link 171
- priferii* Kunth 171
- Pentatropis* Wight & Arn. 119, **121**
- cynanchoides* R. Br. 121
- nivalis* (J. F.Gmel.) Field & Wood 29, **121**
- spiralis* (Forssk.) Decne. 121
- spiralis sensu* Decne. 121
- Pergularia* L. 119, **121**
- daemia* (Forssk.) Chiov. **121**, 194, 201
- Peristrophe* Nees 137, **138**
- bicalyculata* (Retz.) Nees 138
- paniculata* (Forssk.) Brummitt 51, 113, **138**
- Perotis* Ait. 165, **186**
- hordeiformis* Nees 29, **186**, 201
- latifolia* Hook. f. 186
- Phalaris minor* 201
- Pharnaceum cerviana* L. 109
- Phaseolus radiatus* 205
- trilobus auct. plur. non* (L.) Ait. 84
- Phelipaea tubulosa* Schrenk 136
- Phyllanthus* L. 151, **153**
- amarus* Schum. & Thonn. 153, **154**, 201
- asperulatus auct. plur. non* Hutch. 154
- fraternus* Webster **154**, 198, 201, 216, 219, 220
- maderaspatensis* L. 154, **155**
- niruri auct. plur. non* L. 154
- Plantago amplexicaulis* 201
- Pleurostigma subrotundum* Hochst. 139
- Poa amabilis* L. 179
- ciliaris* L. 179
- cynosuroides* Retz. 175
- diarrhena* Schult. 180
- eragrostis* L. 180
- japonica* Thunb. 179
- pilosa* L. 180
- plumosa* Retz. 179
- tenella* L. 179
- POACEAE** 35, **164**, 196, 197, 209, 210, 213, 214, 215, 216, 218
- Polygala* L. **44**
- erioptera* DC. 28, **44**, 190, 198

- irregularis* Boiss. 29, 44, 200
- POLYGALACEAE** 32, 44
- POLYGONACEAE** 34, 148, 209
- Polygonum* L. 148, 149
- indicum* Heyne ex Roth 149
- lanigerum* 201
- plebeium* R. Br. var. *indica* (Heyne ex Roth) Hook. f. 29, 149
- Pongelion wightii* Tieghem 63
- PORTULACACEAE** 32, 33, 45, 198, 217
- Portulaca* L. 45
- oleracea* L. 30, 45, 62, 217, 219, 220
- Prenanthes procumbens* Roxb. 114
- Prosopis* L. 85, 93
- chilensis sensu* Bhandari 93
- cineraria* (L.) Druce xi, 22, 25, 28, 29, 35, 41, 51, 52, 89, 93, 156, 207, 217, 219, 220, 227, 281
- juliflora* (Swartz) DC. xiii, 28, 29, 93, 201, 217, 219, 220, 282
- spicigera* L. 93
- Psammogeton canescens* 201
- Psoralea odorata* Blatt. & Hallb. 73
- plicata* Delile 73
- Pulicaria* Gaertn. 111, 115, 146
- angustifolia* DC. 28, 30, 115, 193, 201
- crispa* (Forssk.) Benth. & Hook. f. 28, 30, 115, 116, 198, 217, 220
- Pupalia* Juss. 142, 147
- lappacea auct. plur. non* (L.) Juss. 147
- lappacea* (L.) Juss. var. *velutina* (Moq.) Hook. f. 147, 198, 200, 237
- RHAMNACEAE** 33, 65, 218
- Rhamnus jujuba* L. 65
- nannularia* Burm. f. 65
- Rhynchosia* Lour. 28, 68, 79
- arenaria* Blatt. & Hallb. 80
- aurea sensu* Baker 79
- capitata* (Heyne ex Roth) DC. 79, 201
- laxiflora* Camb. 80
- medicaginea* DC. 80
- minima* (L.) DC. 29, 79, 80, 191, 201
- var. *laxiflora* (Camb.) Baker 80
- schimperi* (Hochst. & Steud. ex Steud.) Boiss. 79, 80
- ROSACEAE** 33, 94, 198
- Rostellaria procumbens* (L.) Nees 138
- Rostellularia procumbens* (L.) Nees 138
- Rottboellia hirsuta* Vahl 181
- RUBIACEAE** 34, 110, 197, 198

- Saccharum hirsutum* Forssk. 181  
*Satvadora* L. 117  
     *indica* Wight 118  
     *oleoides* Decne. 28, 29, 30, 117, 217, 219, 220, 280, 282  
     *persica* L. 28, 29, 117, 118, 136, 217, 220, 282  
     *stocksii* Wight 118  
**SALVADORACEAE** 34, 117, 217  
*Schoenefeldia* Kunth 165, 186  
     *gracilis* Kunth 186  
     *pallida* Edgew. 187  
*Schoenoplectus* (Reichb.) Palla 157, 163  
     *roylei* (Nees) Ovczinn. & Czukav. 30, 163  
*Schweinfurthia* A. Br. 134, 135  
     *papilionacea* (L.) Boiss. 135  
     *sphaerocarpa* (Benth.) A. Braun. 135  
*Scirpus atropurpureus* Retz. 162  
     *barbatus* Roth. 157  
     *quinguangularis* Vahl 162  
     *quinquefarius* Buch.-Ham. ex Boeck. 163  
     *roylei* (Nees) Parker 163  
*Scorzonera resedifolia* L. 115  
**SUKOPHULARIACEAE** 34, 134, 197  
*Seddera* Hochst. 128, 132  
     *latifolia* Hochst. & Steud. 132, 200  
*Seetzenia* R. Br. 57, 59  
     *africana* R. Br. 59  
     *lanata* (Willd.) Bullock 29, 59, 113  
     *orientalis* Decne. 59  
     *prostratum* (Thunb.) Eckl. & Zeyth. 59  
*Senna* Mill. 85  
     *italica* Mill. 29, 79, 85, 86, 192, 281  
*Sericostoma* Stocks ex Wight 123, 127  
     *pauciflorum* Stocks ex Wight 127  
*Sesamum indicum* 207, 218  
*Sesuvium* L. 102  
     *sesuvioides* (Fenzl.) Verde. 30, 102, 201  
*Sida* L. 47, 51, 197  
     *cordata* (Burm. f.) Borssum 29, 51, 201, 217, 219, 220  
     *cordifolia* L. 28, 51, 52, 201  
     *glauca* Cav. 49  
     *grewioides* Guill. & Perr. 52  
     *humilis* Cav. 51  
     *indica* L. 48



- mutica* Delile ex DC. 49  
*ovata* Forssk. 29, 51, **52**, 201, 218, 219, 220  
*pakistanica* Abedin 52  
*pannosa* Forst. f. 49  
*tiagii* Bhandari 29, 51, **52**, 54, 201, 237  
*tomentosa* Roxb. 49  
*veronicifolia* Lam. 51  
**SIMAROUBACEAE** 33, **63**, 198, 208  
*Smithia aspera* Roxb. 68  
*Sodada decidua* Forssk. 41  
**SOLANACEAE** 34, **132**, 213, 216  
*Solandra lobata* Murr. 50  
*Solanum* L. 132, **133**  
   *melongena* 239  
   *surattense* Burm. f. 133  
   *virginianum* L. **133**, 194, 198, 201, 239  
   *xanthocarpum* Schrad. & Wendl. 133  
*Spermacoce articularis* L. f. 110  
   *hispida* L. 110  
*Sphaeridiophorum abyssinicum* Jaub. & Spach 77  
   *linifolium* (L. f.) Desv. 77  
*Sporobolus* R. Br. 166, **187**  
   *coromandelianus* (Retz.) Kunth **187**, 188  
*Stenophyllus barbata* (Rottb.) T. Cooke 157  
**STERCULIACEAE** 32, 33, **53**, 198  
*Stipagrostis* Nees 166, **187**  
   *hirtigluma* (Steud. ex Trin. & Rupr.) De Winter **187**  
   *plumosa* (L.) Munro ex T. Anders. 29, 187, **188**, 200  
*Striga* L. 134, **136**  
   *angustifolia* (D. Don) Saldanha 29, 30, **136**, 201  
   *euphrasioides sensu* Benth. 136  
**TAMARICACEAE** 32, **45**, 198  
*Tamarix* L. 11, **45**  
   *gallica auct. plur. non* L. 45  
   *gallica* L. var. *indica* (Willd.) Ehrenb. 45  
   *indica* Koen. ex Roxb. 45  
   *indica* Willd. 30, **45**, 201  
   *troupii* Hole 45  
*Tecoma undulata* (Sm.) G. Don 137  
*Tecomella* Seem. 137  
   *undulata* (Sm.) Seem. 28, 29, **137**, 218, 220, 226, 239, 281, 282  
*Tephrosia* Pers. 28, 68, **80**, 197  
   *diffusa* (Roxb.) Wight & Arn. 81

- falciformis* Ramaswami 28, 80, **81**, 82, 191, 198, 237  
*hamiltonii* Drumm. ex Gamble 81  
*incana* Sweet 84  
*leptostachya* DC. 81  
*multiflora* Blatt. & Hallb. 83  
*pauciflora* Grah. ex Baker 83  
*purpurea* (L.) Pers. **81**, 84, 198, 218, 220  
     var. *pubescens* Baker 81  
*strigosa* (Dalz.) Sant. & Mahesh. 81, **83**, 191  
*subtriflora* Hochst. ex Baker 29, 81, **83**  
*tenuis* Wall. ex Dalz. & Gibs. 83  
*villosa* (L.) Pers. 81, **84**, 200  
     var. *incana* (Roxb.) Baker 84  
*wallichii* Grah. ex Fawcett & Rendle 81  
**Tetrapogon** Desf. 165, **188**  
     *tenellus* (Koen. ex Roxb.) Chiov. **188**  
**TILIACEAE** 32, 33, **53**, 212, 214  
*Tournefortia subulata* Hochst. ex DC. 126  
*Trachyspermum ammi* 210  
**Tragus** A. Haller 165, **189**  
     *biflorus sensu* Schult. 189  
     *racemosus sensu* Hook. f. 189  
     *roxburghii* Panigrahi 29, 112, 178, **189**, 218, 219, 222, 281, 282  
**Trianthema** L. 102, **103**  
     *crystallina auct. plur. non* Vahl 103  
     *govindia* Buch.-Ham. ex G. Don 103  
     *hydaspica* Edgew. 102  
     *pentandra auct. non* L. 103  
     *triquetra* Rottl. ex Willd. 30, 45, 62, **103**, 105  
**Tribulus** Tourn. ex L. 55, 57, 58, **59**, 141, 197  
     *alatus* Del. 59  
     *longipetalus* Viv. 59  
         subsp. *macropterus* (Boiss.) Maire ex Ozenda & Quezcl 61  
     *macropterus* Boiss. 61  
     *pentandrus* Forssk.  
         var. *macropterus* (Boiss.) Singh & Singh 59, **61**, 200, 229  
         var. *pentandrus* **59**, 61, 107  
     *rajasthanensis* Bhandari & Sharma 28, 59, 60, **61**, 62, 198, 201, 237  
     *terrestris* L. 28, 29, 43, 57, 59, 61, **62**, 72, 78, 79, 83, 98, 109, 110, 112, 122, 135, 140, 153, 167, 172, 173, 175, 181, 198, 218, 219, 220, 226, 281  
**Trichodesma** R. Br. 122, **127**  
     *indica* (L.) R. Br. **127**  
*Tricholepis procumbens* Wight 111

- Tridax* L. 111, 116  
*procumbens* L. 29, 30, 116, 193, 201  
*Uropetalum unicolor* Stocks 156  
*Urostigma religiosum* (L.) Gasp. 155  
**VAHLIACEAE** 33, 94, 198  
*Vahlia* Thunb. 94  
*digyna* (Retz.) Kuntze 29, 94  
*viscosa* Roxb. 94  
**VERBENACEAE** 34, 139, 198  
*Verbesina alba* L. 113, 114  
*prostrata* L. 113, 114  
*Vernonia* Schreb. 111, 116  
*cinerascens* Sch.-Bip. 28, 116  
*Vigna* Savi 68, 84  
*aconitifolia* 205  
*radiata* 239  
*trilobata* (L.) Verdc. 29, 30, 84, 239  
*Vilfa coromandeliana* (Retz.) P. Beauv. 187  
*Volutarella divaricata* Benth. 111  
*ramosa* (Roxb.) Sant. 111  
*Xanthium* L. 111, 117  
*indicum* Koen. ex Roxb. 29, 117, 201  
*strumarium* L. 117  
*Zaleya* Burm. f. 102, 103  
*govindia* (Buch.-Ham. ex G. Don) Nair 30, 103, 104, 109, 200, 218, 220  
*Ziziphus* Mill. 65  
*jujuba* (L.) Lam. 65  
*mauritiana* Lam. 65, 218, 219, 220, 226, 282  
*nummularia* (Burm. f.) Wight & Arn. 28, 29, 41, 65, 67, 87, 119, 129, 133, 198, 218, 219, 220, 227, 282  
*rotundifolia* Lam. 65  
*truncata* Blatt. & Hallb. 28, 65, 66, 67, 201, 236  
*Zollikoferia chondrilloides* DC. 115  
**ZYGOPHYLLACEAE** 33, 57, 196, 197, 214, 218, 219  
*Zygophyllum* L. 57, 62  
*lanatum* Willd. 59  
*portulacoides* Forssk. 62  
*prostratum* Thunb. 59  
*simplex* L. 30, 45, 62, 219, 220, 226

---

**INDEX TO THE LOCAL NAMES – FAUNA**

- Chakchundri 263  
Chhoti Ratod 265  
Chhuchhundar 263  
Chinkara 229, 265, 274, 279, 280  
Chua 267  
Godawan 276  
Goh 257  
Jhau 263  
Jhau Chua 263  
Jhawla 263  
Khargosh 267  
Khirga 267  
Lomri 264  
Lonkdi 264  
Lonki 264  
Mushak 267  
Nevla 264  
Nilgai 265  
Noyla 264  
Ratod 266  
Safed Chuha 266  
Sanda 256, 279  
Sassa 267  
Seh 267  
Sehi 267  
Sehla 263  
Undra 267  
Anderson's Toad 255  
Ashy-crowned Sparrow-Lark 260  
Asiatic Jackal 263

## INDEX TO THE ENGLISH NAMES - FAUNA

- Baluchistan's Gerbil 266  
 Bank Myna 262  
 Bay-backed Shrike 261  
 Black-crowned Sparrow-Lark 260  
 Black Drongo 262  
 Black Kite 258  
 Black Redstart 261  
 Black-shouldered Kite 258  
 Blue Bull 265, 279, 280  
 Blue-checked Bee-eater 260  
 Blue Rock Pigeon 260  
 Booted Warbler 262  
 Brilliant Agama 256  
 Brown Rock Pipit 261  
 Cattle Egret 258  
 Chestnut-bellied Sandgrouse 260  
 Cinereous Vulture 258, 282  
 Collared Pratincole 259  
 Common Babbler 261, 282  
 Common Buzzard 258  
 Common Chiffchaff 262  
 Common Crane 259  
 Common Crested Lark 261  
 Common Hoopoe 260, 273  
 Common House Rat 267  
 Common Kestrel 259  
 Common Lesser White throat 262  
 Common Mongoose 264, 274  
 Common Myna 262  
 Common Quail 259  
 Common Raven 262  
 Common Starling 262  
 Common Stonechat 261  
 Common Swallow 261  
 Cream-coloured Courser 259  
 Creeping Beetle 270  
 Crested Indian Porcupine 267  
 Demoiselle Crane 259  
 Desert Agama 256  
 Desert Cat 229, 264, 274, 279, 280  
 Desert Fox 229, 264, 274, 279, 280  
 Desert Hare 247, 267, 274, 279, 280  
 Desert Hedgehog 263  
 Desert Warbler 262  
 Desert Wheatear 261  
 Eagle 279, 280  
 Eastern Calandra Lark 261  
 Egyptian Vulture 259, 272, 282  
 Eurasian Collared Dove 260  
 Eurasian Wryneck 260  
 European Roller 260  
 Falcon 279, 280  
 Ferruginous Pochard 258  
 Field Rat 266  
 Five-striped Palm Squirrel 265  
 Glossy-bellied Racer 258  
 Graceful Prinia 262  
 Greater Hoopoe Lark 261  
 Greater short-toed Lark 261  
 Great Grey Shrike 261  
 Great Indian Bustard 229, 259, 272, 279  
 Green Munia 262  
 Grey Francolin 259  
 Grey Shrew 263  
 Hairy-footed Gerbil 265  
 Houbara Bustard 259, 279, 280  
 House Mouse 266  
 House Sparrow 262  
 Imperial Sandgrouse 260, 279, 282  
 Indian Courser 259  
 Indian Desert Gerbil 266  
 Indian Desert Monitor 257  
 Indian Fox 264, 279, 280  
 Indian fringe-toed Sand Lizard 257  
 Indian Garden Lizard 256, 271  
 Indian Gazella 265  
 Indian Gerbil 266  
 Indian Gray Mongoose 264  
 Indian Long-eared Hedgehog 263  
 Indian Monitor 257, 271  
 Indian Peafowl 259, 273  
 Indian Roller 260, 272

- Indian Sand Boa 257, 271  
 Indian Sand-swimmer 276  
 Indian spiny-tailed Lizard 256, 271  
 Indian white-backed Vulture 258, 282  
 Indus Toad 255  
 Isabelline Wheatear 261  
 Jackal 263  
 Jaisalmer Toad Agama 256, 271  
 Keeled Rock Gecko 255  
 Kentish Plover 259  
 King Crow 262  
 Kite 279, 280  
 Laggar Falcon 259  
 Large Grey Babbler 261  
 Lesser Bustard 229  
 Lesser Sand Plover 259  
 Lesser Spotted Eagle 258  
 Little Brown Dove 260  
 Little Egret 258  
 Little Ringed Plover 259  
 Little Stint 259  
 Long-billed Vulture 258, 272, 282  
 Long-legged Buzzard 258, 273  
 Mongoose 263, 280  
 Monitor Lizard 279, 280  
 Montagu's Harrier 259  
 Northern Bluethroat 261  
 Orphean Warbler 262  
 Pale Hedgehog 263, 274, 279, 280  
 Pallid Harrier 259  
 Partridge 279  
 Peacock 279  
 Pied Bushchat 261  
 Pied-crested Cuckoo 260  
 Plain Prinia 262  
 Punjab Snake-eyed Lacerta 257  
 Purple Sunbird 262  
 Quail 279  
 Rain Quail 259  
 Red Fox 264  
 Red-headed Falcon 259  
 Red-headed Vulture 258, 272, 282  
 Red-vented Bulbul 261  
 Red-wattled Lapwing 259, 273  
 Red-winged Bush Lark 261  
 Rosy Starling 262, 282  
 Rufous-tailed Finch-Lark 261  
 Rufous-tailed Scrub Robin 261  
 Rufous Wheatear 261  
 Sand Fish 256, 271  
 Sandgrouse 279  
 Saw-scaled Viper 257  
 Scorpion 270  
 Shikra 258  
 Short-eared Owl 260  
 Short-toed Snake Eagle 259  
 Sind or Rajasthan Sand Gecko 256  
 Skittering Frog 255  
 Small Green Bee-eater 260, 273  
 Small Indian Mongoose 264, 279  
 Spider 270  
 Spiny-tailed Lizard 279, 280  
 Spotted Owlet 260  
 Spotted Sandgrouse 260, 282  
 Steppe Eagle 258  
 Stoliczka's Bushchat 261  
 Stone-Curlew 259, 273  
 Streaked Fantail Warbler 262  
 Tawny Eagle 258, 272  
 Tawny Pipit 261  
 Temminck's Stint 259  
 Tufted Pochard 258  
 Variable Wheatear 261  
 Vultures 279  
 Western Marsh Harrier 259  
 White-checked Bulbul 261  
 White-eyed Buzzard 258  
 White-throated Munia 262, 282  
 Yellow-bellied House Gecko 255  
 Yellow-fronted Pied Woodpecker 260  
 Yellow-throated Sparrow 262  
 Yellow Wagtail 261

## INDEX TO THE ZOOLOGICAL NAMES

- Acanthodactylus contoris contoris* Gunther 257, 281  
*Acantholepis frauenfeldi* subsp. *bipartita* Forel 252  
 Acarina 269  
*Accipiter badius* (Gmelin) 258  
 Accipitridae 258  
*Acheta domesticus* Linn. 251  
*Acisoma panorpoides panorpoides* Rambur 250  
 Acrididae 250  
 Acridoidea 250  
*Acridotheres ginginianus* (Latham) 262  
     *tristis* (Linn.) 262  
*Acrotelsa collaris* (Fabricius) 250, 275  
*Acrotylus humbertianus* Saussure 250  
 Aculeata 268, 269  
*Aegyptius monachus* (Linn.) 258, 277, 282  
 Aeshnidae 250  
 Aeshnoidea 250  
*Aetius species* 255  
*Agama agilis* Oliver 256, 281  
 Agamidae 256  
*Agriocnemis pygmaea* (Rambur) 250  
*Alaemon alaudipes* (Desf.) 261  
 Alaudidae 260  
*Amandava formosa* (Latham) 262  
*Amitermes belli* (Desneux) 251  
*Ammomanes phoenicurus phoenicurus* (Franklin) 261  
 AMPHIBIA 247, 255, 268, 269  
*Anacanthotermes macrocephalus* (Desneux) 251, 275  
*Anacridium rubrispinum* (Bei-Bienko) 251  
 Anatidae 258  
*Anax guttatus* (Burmeister) 250  
*Androctonus australis finitimus* (Pocock) 254  
 Anisoptera 250  
 Annelida 268, 269  
 Anoplura 269  
 Anseriformes 258  
*Anthus campestris* (Linn.) 261  
     *similis* Jerdon 261  
 Anura 255  
 Aphelenchida 248  
 Aphelenchidae 248  
 Aphelenchina 248

- Aphelenchoidea* 248  
*Aphelenchus avenae* Bastian 248  
*Apidae* 253  
*Apis (Megapis) dorsta* Fabricius 253  
*(Micrapis) florea* Fabricius 253  
*Apoclea rajasthanensis* Joseph & Parui 246, 252, 276  
*Apterogyna mutilloides* Smith 253  
*Aquila nipalensis* Hodgson 258  
*pomarina* Brehm 258  
*rapax vindhiana* (Franklin) 258, 272  
*Arachnida* 246, 253, 268, 269, 276, 278  
*Araneida* 254  
*Araneidae* 254, 255  
*Ardeidae* 258  
*Ardeotis nigriceps* (Vigors) 259, 272, 276  
*Argyrogena ventromaculatus* (Gray & Hardwicke) 258, 281  
**ARTHROPODA** 245, 248, 249, 267, 268, 269, 270, 278  
*Artiodactyla* 265  
*Asilidae* 252  
*Asilinae* 252  
*Asio flammeus flammeus* (Pontoppidan) 260  
*Athene brama* (Temminck) 260  
**AVES** 247, 258, 268, 269, 276, 278  
*Aythya fuligula* (Linn.) 258  
*nyroca* (Guldenstadt) 258  
*Basommatophora* 249  
*Bellamya dissimilis* (Mueller) 249  
*Bithyniidae* 249  
*Boidae* 257  
*Boselaphus tragocamelus* (Pallas) 265  
*Bovidae* 265  
*Bradinopyga geminata* (Rambur) 250  
*Bubulcus ibis* (Linn.) 258  
*Bufo* 255  
*Bufo stomaticus* Lutken 255  
*Burhinidae* 259  
*Burhinus oedicnemus* (Linn.) 259, 273  
*Butastur teesa* (Franklin) 258  
*Buteo buteo vulpinus* (Gloger) 258  
*Buteo rufinus* (Cretzschmar) 258, 273  
*Buthidae* 254, 255  
*Calandrella brachydactyla* (Leisler) 261  
*Calidris minuta* (Leisler) 259  
*temminckii* (Leisler) 259  
*Calotes versicolor* (Daudin) 256, 271



- Camponotus (Dinomyrmex) angusticollis* Jerdon 252  
     (*Tanaemyrmex) compressus* Fabricius 252  
     (*Tanaemyrmex) irritans* Fr. Smith 252  
*Canidae* 263, 264  
*Canis aureus* Linnaeus 263, 281  
 Carnivora 263, 264, 278  
*Castianeira species* 255  
*Cataglyphis bicolor setipes* Emery 252  
*Cercotrichas galactotes* (Temminck) 261  
*Charadriidae* 259  
 Charadriiformes 259  
*Charadrius alexandrinus* Linn. 259  
     *dubius* Scopoli 259  
     *mongolus* Pallas 259  
*Cheiracanthium species* 255  
 Chilopoda 268, 269  
*Chlamydotis undulata* (Jacquin) 259, 276  
*Chlorion regale* Smith 253  
*Chrotogonus (Chrotogonus) trachypterus* (Blanchard) 250  
 Ciconiiformes 258  
*Circaetus gallicus* (Gmelin) 259  
*Circus aeruginosus* (Linn.) 259  
     *macrourus* (Gmelin) 259  
     *pygargus* (Linn.) 259  
*Cisticola juncidis* (Rafinesque) 262  
*Clamator jacobinus* (Boddaert) 260  
*Cludionidae* 255  
*Coenagrionidae* 250  
*Coenagrionoidea* 250  
 Coleoptera 246, 252, 268, 269  
*Colotis phisadia protractus* (Buttler) 252  
*Colubridae* 258  
*Columba livia* Gmelin 260  
*Columbidae* 260  
 Columbiformes 259  
*Compsobuthus acutecarinatus rugosus* (Pocock) 254  
*Coptotermes heimi* (Wasmann) 251  
*Coptotermitinae* 251  
*Coracias benghalensis* (Linn.) 260, 272  
     *garrulus semenowi* (Loudon & Tschudi) 260  
*Coraciidae* 260  
 Coraciiformes 260  
*Corvidae* 262  
*Corvus corax* Linn. 262  
*Coturnix coromandelica* (Gmelin) 259

- coturnix* (Linn.) 259  
*Crematogaster (Acrocoelia) brunnea* var. *contemta* Mayr 252  
*Crocothemis servilia servilia* (Drury) 250  
 Crustacea 268, 269  
*Ctenolepisma ciliata* Dufour 250, 275  
     *longicaudata* Escherich 250, 275  
 Cuculidae 260  
 Cuculiformes 260  
*Cursorius coromandelicus* (Gmelin) 259  
     *cursor* (Latham) 259  
 Cyrtacanthacridinae 251  
*Cyrtodactylus scaber* Heyden 255  
 Danainae 252  
*Danaus (Anodia) chrysippus* (Linn.) 252  
 Dedipodinae 250  
*Dendrocopos mahrattensis* (Latham) 260  
 Dermaptera 246, 251, 268, 269  
 Dicruridae 262  
*Dicrurus leucophaeus* Vieillot 262  
 Dictyoptera 246, 251, 253, 268, 269  
*Digonostoma pulchella* (Benson) 249  
*Dioscolaimoides bulbiferus* (Cobb) Heyns 248  
 Diplopoda 268, 269  
 Diptera 246, 252, 268, 269, 276, 278  
*Discolaimium mukhtarपुरiense* Baqri & Jairajpuri 248, 271  
*Discolaimus major* Thorne 248, 275  
 Dorylaimida 248  
 Dorylaimina 248  
*Dorylaimoidea* 248  
 Dorylinae 252  
*Dorylus (Alaapone) orientalis* Westwood 252  
     (*Typhlopone*) *labiatus* Shuckrd 252  
*Drassodes luridus* (Cambridge) 254  
     *parvidens* Caporiacco 254  
*Echis carinatus* Schneider 257, 281  
*Egretta garzetta* (Linn.) 258  
*Elanus caeruleus* (Desf.) 258  
*Eremiaphila sacra* (Thunb.) 251  
 Eremiaphilidae 251  
*Eremopterix grisea* (Scopoli) 260  
     *nigriceps* (Gould) 260  
*Eremotermes neoparadoxalis* Ahmad 251  
     *paradoxalis* Holmgren 251, 256  
 Erinaceidae 263  
 Erisidae 254

- Eryx johni* Russell 257, 271  
*Estrildidae* 262  
*Eumenes dimidiatipennis* Saussure 253  
*Eumenidae* 253  
*Euphlyctis cyanophlyctis* Schneider 255  
*Eyprepocnemidinae* 251  
*Falco chicquera* Daudin 259  
     *jugger* J. E. Gray 259  
     *tinnunculus* Linn. 259  
*Falconidae* 259  
 Falconiformes 258, 278  
*Felidae* 264  
*Felis silvestris ornata* Schreber 264, 274, 277, 281  
*Formicidae* 252  
*Formicinae* 252  
*Francolinus pondicerianus* (Gmelin) 259  
*Funambulus pennantii* Wroughton 265  
*Galeodis agilis* Pocock 254, 270, 276  
*Galerida cristata* (Linn.) 261  
 Galliformes 259  
 Gastropoda 249  
*Gazella bennettii bennettii* (Sykes) 265, 274  
*Gekkonidae* 255, 256  
*Gerbillinae* 265, 266  
*Gerbillus gleadowi* Murray 265  
     *nanus* Blanford 266, 278  
*Glareola pratincola* (Linn.) 259  
*Glareolidae* 259  
*Gnaphosa species* 255  
*Gnaphosidae* 254, 255  
*Gomphocerinae* 250  
*Gruidae* 259  
 Gruiformes 259, 278  
*Grus grus* (Linn.) 259  
     *virgo* (Linn.) 259  
*Gryllidae* 251  
*Grylloidea* 251  
*Gyps bengalensis* (Gmelin) 258, 282  
     *indicus* (Scopoli) 258, 272, 282  
*Hemidactylus flaviviridis* Ruppell 255  
*Hemitechinus collaris* (Gray) 263, 281  
     *micropus micropus* (Blyth) 263, 274, 278, 281  
 Hemiptera 269  
*Herennia ornatissima* (Dol.) 254  
*Herpestes edwardsii* (E. Geoffery Saint Hilaire) 264, 274, 281

- javanicus auropunctatus* Hodgson 264, 278, 281  
*Herpestidae* 264  
*Heteracris littoralis* (Rambur) 251  
*Heteropoda fabrei* Simon 254  
*Heteropoididae* 254  
*Heterotermes indicola* (Wasmann) 251  
*Heterotermitinae* 251  
*Hippasa species* 254  
*Hippolais caligata* (Lichtenstein) 262  
*Hirundinidae* 261  
*Hirundo rustica* Linn. 261  
*Hodotemitidae* 251  
*Hoplolaimidae* 248  
**Hoplolaimoidea** 248  
*Hoplolaimus indicus* Sher 248  
*Humbertiella species* 253  
*Hyalomma annatolicum annatolicum* Koch 254  
*dromedarii* Kocopoda 254  
*Hyalomma* Koch 247  
Hymenoptera 246, 252, 253, 267, 269, 276, 278  
*Hysiricidae* 267  
*Hystrix indica* Kerr 267  
*Indoplanorbis exustus* (Deshayes) 249  
**Insecta** 245, 249, 268, 269, 275, 276, 278  
Insectivora 263, 278  
**Invertebrata** 245, 248, 267, 268, 269, 278  
*Ischnura aurora aurora* (Brauer) 250  
*senegalensis* (Rambur) 250  
Isoptera 246, 251, 253, 268, 269, 275, 278  
*Ixodidae* 254  
*Jynx torquilla* (Linn.) 260  
*Kochinema farodai* Baqri & Bohra 248  
*Labiduridae* 251  
*Labronema virgo* Monteiro 248, 275  
*Lacertidae* 257  
Lagomorpha 267, 278  
*Laniidae* 261  
*Lanius excubitor* (Linn.) 261  
*vittatus* Valenciennes 261  
Lepidoptera 246, 252, 268, 269  
*Lepisma gyriniformis* 245  
*indica* 245  
*Lepismatidae* 250  
*Lepismatoidea* 250  
*Leporidae* 267

- Lepus nigricollis-dayanus* Blanford 267, 274, 277  
*Libellulidae* 250  
*Libellulidea* 250  
*Lonchura malabarica* (Linn.) 262, 282  
*Luscinia svecica* (Linn.) 261  
*Lycosa madani* Pocock 254  
*Lycosa species* 255  
*Lycosidae* 254, 255  
*Macrotermitinae* 251  
 Mallophaga 269  
**MAMMALIA** 247, 263, 268, 269, 277, 278  
*Mantidae* 253  
*Mantoidea* 246, 251, 268  
*Marpissa species* 255  
*Melanocorypha bimaculata torquata* Blyth 261  
*Meriones hurrianae* Jerdon 266  
*Meropidae* 260  
*Merops orientalis* Latham 260, 273  
   *persicus* Pallas 260  
*Mesobuthus tamulus indicus* (Pocock) 254, 270  
 Mesogastropoda 249  
*Messor barbarus himalayanum* Forel 253  
 Metastigmata 247  
*Microcerotermes laxmi* Roonwal and Bose 251, 275  
   *raja* Roonwal & Bose 251, 256, 275  
   *species* 253  
   *tenuignathus* Holmgren 251  
*Microtermes mycophagus* (Desneux) 252  
   *obesi* Holmgren 252  
   *unicolor* Snyder 252  
*Millardia gleadowi* Murray 266  
*Milvus migrans govinda* (Sykes) 258  
*Mirafra erythroptera* Blyth 261  
**MOLLUSCA** 245, 249, 267, 268, 269  
*Monomorium (Holcomyrmex) glabrum* Em. Andre 253  
   (*Holcomyrmex*) *scabriceps* Mayr. 253  
   (*Parholcomyrmex*) *destructor* Jerdon 253, 276  
   (*Parholcomyrmex*) *gracillimum* var. *mayri* Forel 253  
   (*Xeromyrmex*) *salomonis indica* Forel 253  
*Motacilla flava* Linn. 261  
*Motucillidae* 261  
*Muridae* 265, 266, 267  
*Murinae* 266, 267  
*Muscicapidae* 261  
*Mus musculus* Linnaeus 266

- Mutilla species* 253  
*Mutillidae* 253  
*Myrmicinae* 252  
*Nala lividipes* (Dufour) 246, **251**  
*Nectarinia asiatica* (Latham) **262**  
*Nectariniidae* 262  
**NEMATODA** 245, **248**, 267, 268, 269, 275, 278  
*Neophron percnopterus* (Linn.) **259**, 272, 282  
*Neoscona species* 255  
 Neuroptera 269  
*Noridiidae* 248  
*Nymphalidae* 252  
*Ochrilidia gemiculata* (Bolivar) **250**  
 Odonata 245, 246, 250, 268, 269, 275, 278  
*Odontotermes obesus* Rambur **251**, 256  
     *species* 253  
*Oedaleus senegalensis* (Krauss) **250**  
*Oenanthe deserti* (Temminck) **261**  
     *isabellina* (Temminck) **261**  
     *picata* (Blyth) **261**  
     *xanthopyrma kingi* (Hume) **261**  
*Ophiomorpha raithmai* Anderson & Leviton **256**, 271, 276  
     *tridactylus* Blyth 256, 276  
*Ophisops jerdoni* Blyth **257**  
*Orthetrum sabina sabina* (Drury) **250**  
*Orthochirus krishnai* Tikader & Bastawade **254**, 276  
     *pallidus* (Pocock) **254**  
 Orthoptera 246, 250, 268, 269  
*Oiididae* 259  
*Oxyopidae* 255  
*Oxyptila chandosienis* Tikedar **254**  
*Pantala flavescens* (Fabricius) **250**  
*Papilionidae* 252  
*Papilioninae* 252  
*Pardosa heterophthalmus* (Simm) **254**  
     *pusiola* (Thorell) **254**  
     *species* 255  
     *sumatrana* (Thorell) **254**  
*Passer domesticus* (Linn.) **262**  
*Passeridae* 262  
 Passeriformes 260, 278  
*Pavo cristatus* Linn. **259**, 273  
*Petronia xanthocollis* (Burton) **262**  
*Peucea species* 255  
*Phasianidae* 259

- Pheidole (Pheidole) sulcaticeps* Roger 253  
*(Pheidole) wroughtoni* Forel 253  
*Phoenicurus ochruros* (Gmelin) 261  
*Phrynocephalus laungwalansis* Sharma 256, 271, 276  
*Phylloscopus collybita* (Vieillot) 262  
 Picidae 260  
 Piciformes 260  
 Pieridae 252  
 Pierinae 252  
*Pimelia indica* Sen 246, 252, 270  
 Pisces 269  
 Planorbidae 249  
 Platyhelminthes 268, 269  
*Poecilochroa sedula* (Simon) 254  
   *species* 255  
 Porifera 268, 269  
*Princeps (Menelaides) polytes romulus* (Cramer) 252  
*Prinia gracilis* (Lichtenstein) 262  
   *inornata* Sypes 262  
 Protozoa 268, 269  
*Psammotermes rajasthanicus* Roonwal & Bose 251  
 Psammotermitinae 251  
*Pterocles exustus* Temminck 260  
   *orientalis orientalis* (Linn.) 260, 282  
   *senegallus* (Linn.) 260, 282  
 Pteroclididae 259  
 Pycnonotidae 261  
*Pycnonotus cafer* (Linn.) 261  
   *leucotis* (Gould) 261  
 Pyrgomorphidae 250  
 Qudsianematidae 248  
*Rattus rattus* (Linnaeus) 267, 281  
**REPTILIA** 247, 255, 268, 269, 276, 271, 278  
 Rhinotermitidae 251  
*Rhodischnura nursei* (Morton) 250  
 Rodentia 265, 266, 267, 278  
 Salticidae 255, 256  
*Sarcogyps calvus* (Scopoli) 258, 272, 277, 282  
 Sauria 255, 256, 257  
*Saxicola caprata* (Linn.) 261  
   *macrorhyncha* (Stoliczka) 261, 277  
   *torquata* (Linn.) 261  
*Schistocerca gregaria* (Forsk.) 251  
 Scincidae 256  
*Scinthisarista notabilis pallipes* Uvarov 250

- Sciuridae* 265  
*Sciurinae* 265  
*Scolopacidae* 259  
 Scorpionida 255, 278  
*Setystothemis nigra* (Van der Linden) 250, 275  
 Serpentes 257, 258  
 Siphonaptera 269  
*Solifugae* 254  
 Solifugida 278  
*Soricidae* 263  
*Sparassidae* 255  
*Sparassus species* 255  
*Sphecidae* 253  
*Sphingonotus longipennis* Saussure 250  
 Squamata 255, 256, 257, 258, 278  
*Stegodyphus sarasinorum* Karch 254  
*Stenodactylus orientalis* Blanford 256  
*Streptopelia decaocto* (Frivaldszky) 260  
     *senegalensis combayensis* (Gmelin) 260  
 Strigidae 260  
 Strigiformes 260  
*Sturnidae* 262  
*Sturnus roseus* (Linn.) 262, 282  
     *vulgaris* Linn. 262  
 Stylommatophora 249  
*Subulinidae* 249  
*Suncus murinus* Linnaeus 263, 281  
*Sylvia curruca minula* Hume 262  
     *hortensis jerdoni* (Blyth) 262  
     *nana* (Hemprich & Ehrenberg) 262  
*Sylviinae* 262  
*Synaema species* 255  
*Tatera indica* Hardwicke 266  
*Tenebrionidae* 252  
*Termitidae* 251, 253  
*Termitinae* 251  
*Tetramorium salvatum* Forel 253, 276  
*Thiara (Melanoides) tuberculata* (Mueller) 249  
*Thiaridae* 249  
*Thomisidae* 254, 255  
 Thysanoptera 269  
 Thysanura 245, 250, 268, 269, 275, 278  
*Tibellus species* 255



- Timaliinae* 261  
*Truxalinae* 250  
*Truxelis eximia eximia* Eichwald 250  
*Turdinae* 261  
*Turdoides caudatus* (Dumont) 261, 282  
     *malcolmi* (Sykes) 261  
 Tylenchida 248  
 Tylenchina 248  
*Tylencholaimidae* 248  
*Tylencholaimoidea* 248  
*Tylencholaimus suryawanshi* Ali & Chisty 248, 275  
*Upupa epops* (Linn.) 260, 273  
*Upupidae* 260  
*Uroctea indica* Pocock 254  
*Uroctidae* 254  
*Uromastix hardwicki* Gray 256, 271, 276, 281  
*Vachonus astrostriatus* (Pocock) 254  
     *rajasthanicus* Tikader & Bastawade 254  
     *species* 255  
*Vanellus indicus* (Boddaert) 259, 273  
*Varaniidae* 257  
*Varanus bengalensis* (Linnaeus) 257, 271, 276  
     *griseus* Daudin 257  
 Vertebrata 247, 255, 267, 268, 269, 278  
*Viperidae* 257  
*Viviparidae* 249  
*Vulpes bengalensis* Shaw 264, 277, 281  
     *vulpes pusilla* Blyth 264, 274, 277, 281  
*Xylocopa (Ctenoxylocopa) fenestrata* (Fabricius) 253  
*Xylocopidae* 253  
*Zelotes desioi* Caporiacco 254  
     *nasikensis* Tikader & Gajbe 254  
*Zootecus estellus* (Benson) 249  
     *insularis* (Ehrenberg) 249  
 Zygentoma 250  
 Zygoptera 250

## INDEX TO THE PHOTOGRAPHS

<i>Name of species/photographs</i>	<i>Plate No.</i>	<i>Photo No.</i>	<i>Page No.</i>
<i>Acacia nilotica</i> (L.) Willd. ex Del.			
subsp. <i>indica</i> (Benth.) Brenan	18	1	223
<i>senegal</i> (L.) Willd.	18	2	223
<i>Aerva javanica</i> (Burm. f.) Juss. ex Schult.	17	3	195
<i>Alysicarpus vaginalis</i> (L.) DC.	18	3	223
<i>Anticharis senegalensis</i> (Walp.) Bhandari	17	1	195
<i>Aquila rapax vindhiana</i> (Franklin)	30	1	272
<i>Ardeotis nigriceps</i> (Vigors)	30	6	272
<i>Arnebia hispidissima</i> (Sieber ex Lehm.) DC.	18	4	223
<i>Borreria articularis</i> (L. f.) F. N. Will.	14	4	192
<i>Burhinus oedicephalus</i> (Linn.)	31	2	273
<i>Buteo rufinus</i> (Cretzschmar)	31	5	273
<i>Calligonum polygonoides</i> L.	19	1	224
<i>Calotes versicolor</i> (Daudin)	29	1	271
<i>Capparis decidua</i> (Forssk.) Edgew.	19	2	224
<i>Cistanche tubulosa</i> (Schrenk) Wight	17	2	195
<i>Citrullus colocynthis</i> (L.) Schrad.	19	3	224
<i>Cleome viscosa</i> L.	12	1	190
<i>Commiphora wightii</i> (Arn.) Bhandari	19	4	224
<i>Convolvulus prostratus</i> Forssk. var. <i>prostratus</i>	20	1	225
<i>Coracias benghalensis</i> (Linn.)	30	5	272
<i>Crotalaria hebecarpa</i> (DC.) Rudd.	13	1	191
<i>Cucumis prophetarum</i> L.	14	3	192
<i>Datura innoxia</i> Mill.	20	2	225
<i>Echinops echinatus</i> Roxb.	15	1	193
<i>Ephedra ciliata</i> Fisch. & Meyer ex C. A. Meyer	17	4	195
<i>Eryx johnii</i> Russell	29	6	271
<i>Fagonia bruguieri</i> DC.	12	4	190
<i>Felis silvestris ornata</i> Schreber	32	4	274
<i>Galeodis agilis</i> Pocock	28	3	270
<i>Gazella bennetti bennettii</i> (Sykes)	32	5	274
Grazing	24, 25	2, 1-2	232, 233
<i>Grewia tenax</i> (Forssk.) Fiori	12	3	190
<i>Gyps indicus</i> (Scopoli)	30	3	272
<i>Heliotropium europaeum</i> L.			
var. <i>lasiocarpum</i> (Fisch. & Mey.) Kazmi	16	2	194
<i>subulatum</i> (Hochst. ex DC.) Vatke	16	3	194
<i>Hemiechinus micropus micropus</i> (Blyth)	32	1	274
<i>Herpestes edwardsii</i> (E. Geoffrey Saint Hilaire)	32	3	274
<i>Indigofera cordifolia</i> Heyne ex Roth	20	3	225
<i>linifolia</i> (L. L.) Retz.	20	4	225

Name of species/photographs	Plate No.	Photo No.	Page No.
<i>Lepus nigricollis dayanus</i> Blanford	32	6	274
<i>Merops orientalis</i> Latham	31	3	273
<i>Mesobuthus tamulus indicus</i> (Pocock)	28	2	270
<i>Mimosa hamata</i> Willd.	14	2	192
<i>Neophron percnopterus</i> (Linn.)	30	4	272
<i>Odontanthera varians</i> (Stocks) Mabberley	15	4	193
<i>Ophiomorus raithmai</i> Anderson & Leviton	29	4	271
<i>Pavo cristatus</i> Linn.	31	1	273
<i>Pergularia daemia</i> (Forssk.) Chiov.	16	1	194
<i>Phrynocephalus taungwalansis</i> Sharma	29	2	271
<i>Pimelia indica</i> Sen	28	1	270
<i>Polygala erioptera</i> DC.	12	2	190
<i>Pulicaria angustifolia</i> DC.	15	2	193
<i>Rhynchosia minima</i> (L.) DC.	13	2	191
<i>Sarcogyps calvus</i> (Scopoli)	30	2	272
<i>Senna italica</i> Mill.	14	1	192
Settlement pattern and development	23	1-2	231
Settlement pattern and population	22	1-2	230
<i>Solanum virginianum</i> L.	16	4	194
<i>Tecomella undulata</i> (Sm.) Scem.	21	1	226
<i>Tephrosia falciformia</i> Ramas.	13	3	191
<i>strigosa</i> (Dalz.) Sant. & Mahesh.	13	4	191
Topography Gravelly and rocky areas	5	1-2	xiii
Barren Sand-dunes	1	1-2	ix
Sandy plains	3	1-2	xi
Sandy plains and rock outcrops	4	1-2	xii
Stablized Sand-dunes	2	1-2	x
Tourism	26, 27	1-2	234, 235
<i>Tribulus terrestris</i> L.	21	2	226
<i>Tridax procumbens</i> L.	15	3	193
<i>Upupa epops</i> (Linn.)	31	6	273
<i>Uromastix hardwicki</i> Gray	29	3	271
<i>Vanellus indicus</i> (Boddaert)	31	4	273
<i>Varanus bengalensis</i> (Linnaeus)	29	5	271
Vegetation types – Grassland	10B	1	24
Grasslands in sandy and gravelly plains	11	1-2	25
Sand-dunes and inter-dunal areas	6, 7	1-2	19, 20
Sandy and hummocky plains	9	1-2	22
Scrub forest and grassland	10A	1-2	23
Scrub vegetation on dunes	8	1-2	21
<i>Vulpes vulpes pusilla</i> Blyth	32	2	274
Wind erosion	24	1	232
<i>Ziziphus mauritiana</i> Lam.	21	3	226
<i>Zygophyllum simplex</i> L.	21	4	226

## INDEX TO THE FIGURES

	<i>Figure No.</i>	<i>Page No.</i>
<i>Acacia nilotica</i> (L.) Willd. ex Del.		
subsp. <i>indica</i> (Benth.) Brenan	13	88
<i>nubica</i> Benth.	14	90
<i>senegal</i> (L.) Willd.	15	91
<i>Alysicarpus heterophyllus</i> (Baker) Jafri & Ali	8	70
<i>Ammannia baccifera</i> L.	16	96
<i>Calligonum polygonoides</i> L.	20	150
<i>Capparis decidua</i> (Forssk.) Edgew.	3	42
<i>Cenchrus biflorus</i> Roxb.	23	170
<i>Cleome gynandra</i> L.	1	36
<i>scaposa</i> DC.	2	38
<i>Cyperus arenarius</i> Retz.	21	158
<i>rotundus</i> L.	22	161
<i>Dactyloctenium aegyptium</i> (L.) P. Beauv.	24	174
<i>Gisekia pharnaceoides</i> L.	18	106
<i>Grewia tenax</i> (Forssk.) Fiori	5	56
<i>Indigofera cordifolia</i> Heyne ex Roth	9	74
<i>linifolia</i> (L.f.) Retz.	10	76
<i>Mollugo cerviana</i> (L.) Seringe	19	108
<i>Panicum antidotale</i> Retz.	25	184
<i>Senna italica</i> Mill.	12	86
<i>Sida tiagii</i> Bhandari	4	54
<i>Tephrosia falciformis</i> Ramaswami	11	82
<i>Tribulus rajasthanensis</i> Bhandari & Sharma	6	60
<i>Zaleya govindia</i> (Buch.-Ham. ex G. Don) Nair	17	104
<i>Ziziphus truncata</i> Blatt. & Hallb.	7	66

### About the Authors

Dr. V. Singh, born on August 15<sup>th</sup>, 1947 obtained his M. Sc. and Ph. D. degrees in Botany from the University of Meerut (U. P.) during the year 1967 and 1974 respectively, with specialization in Taxonomy. He is devoted to the study of Indian biodiversity right from the date of completion of post graduation and in thirty seven years of his research career he has published books like : 3-volumed Flora of Rajasthan, Flora of Banswara district, Ethnobotany of Rajasthan, Asteraceae of Sikkim and Ethnobotany and Medicinal Plants of India and Nepal (edited) which have got World wide recognition. He is also recognized for the monographs on Indian *Zygophyllaceae*, *Lamiaceae* (the genus *Leucas* R. Br.), *Diospyros* L. and *Caesalpiniaceae* (subtribe *Cassiinae*). He has worked on different aspects of Indian flora viz. taxonomy, ecology, phytosociology, ethnobotany, medicinal botany, conservation, etc. and has more than 100 research papers in his credit.

Monika Singh, born on January 1<sup>st</sup>, 1978, obtained her M. Sc. degree in Environmental Science from the University of Rajasthan, Jaipur (Rajasthan) during the year 1998, with specialization in Environmental Impact Assessment. She has been awarded Ph. D. degree in Botany by Jai Narain Vyas University, Jodhpur (Rajasthan) during 2005. She has 3 research papers in her credit.

### About the Book

The present book on the Biodiversity of Desert National Park deals with 245 species of higher plants and 270 species of animals. Besides geographical position and topography, the abiotic components viz. geology, soils, water, climatic conditions, which determine the composition of biota in an ecosystem, have been discussed in details. Correct and valid names have been adopted for the floral and faunal elements along with local and English names. The keys have been provided for plant species from infra-specific to family level for easy identification. The short diagnostic description, phenology, ecology and distributional aspects have been provided under each plant species. Besides statistical synopsis of floral composition and comparison of Biodiversity of Desert National Park with rest part of Thar desert, the phytogeographical and biological spectra have also been worked out to determine the routes of migration and phytoclimate respectively. Bioperspective value of the Park has been assessed to determine the economic potentiality and sustainable utilization of bioresources.

The faunal diversity includes both invertebrate and vertebrate fauna, arranged in a classified manner, along with localities of occurrence. The shelter and feeding habits of vertebrates and their dependency on vegetation have been provided to determine plant-animal relationship and flow of energy. Details about the endemic and threatened species of plants and animals, along with causes of threats, have been given for proper management of the Park.

About 93 colour photographs of habitats and plants and animals, along with 25 illustrations of plant species, have been provided. The data has not only been provided in tabular form, but histograms, graphs, figures, etc are used to illustrate the findings. It is hoped that the book will prove a milestone in the management of the Park.

**Front Cover :** Scrub vegetation and *Ardeotis nigriceps* (Vigors), Great Indian Bustard, an endemic, threatened and flagship species of desert, particularly of sand-dunes.



भारतीय वनस्पति सर्वेक्षण  
BOTANICAL SURVEY OF INDIA

### Botanical Survey of India

3<sup>rd</sup> MSO Building [Block F, 5<sup>th</sup> & 6<sup>th</sup> Floor],  
CGO Complex, DF Block, Sector I, Salt Lake City, Kolkata 700064