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Biodiversity Assessment Report

Wakal River Basin, Rajasthan, India

World Vision

FIU
Florida International University
Miami's public research university

Integrated Management of Coastal and Freshwater Systems Program

Biodiversity Assessment Report
Wakal River Basin, Rajasthan, India

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Cover Photographs: Monsoon landscape in the Wakal River Basin, Rajasthan, India. (John M. Steifel).

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ACKNOWLEDGEMENTS

Wakal is very important river of southern Rajasthan. Its catchement is rich in biotic wealth. State's many rare and threatened species are confined to this zone. Besides providing home to a variety of wild species, Wakal catchment sustains livelihood of thousands of human beings of Jhadol, Kotra, Girwa, Gogunda and Khedbramha tehsils.

To understand biotic features of Wakal basin, presnet study was conducted with the support of World Vision India, Udaipur and many other organizations and individuls. I overwhelmingly very greatful to all of them. More specifically, I would like express my deep sense of indebtedness and reverence to Mr. Pratyush Das, Program Manager, World Vision India, ADP, Navbharat, Udaipur; Dr. Anjana Purkayestha, Dr. Elizabeth Anderson, Mr. John Stiefel, Mr. P.K. Dutta, Unit Manager, AFPRO, Udaipur; Prof. P.K. Singh, Dr. N.K. Chauhan, Ms. Mamta Sahoo and Mr. Anil Mehta for discussions, suppport, guidence and help.

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Dr. S.K. Sharma

ACRONYMNS

E	=	East
F	=	Figure
m	=	Meter
MBC	=	Mewar Bhil Core
MSL	=	Mean sea level
Mt.	=	Mount
N	=	North
NGOs	=	Non- Government Organisations
NTFPs	=	Non-timber forest produces
per.com.	=	Personal communication
S	=	South
VFPMC	=	Village forest protection & Management Committee

VOCABULARY OF VERNACULAR TERMS

Jhar / Jher / Jer	=	Spring
Bid	=	Area set apart for grass production
Nal	=	Narrow valley
Magra Bavsi	=	Good of Hill & Forest
Magra Pooja	=	Worship of Hill & Forest

CHAPTER -1: BIODIVERSITY AND HABITAT STATUS IN WAKAL RIVER BASIN

Southern Aravalli is very rich in rivers than central and nothern Aravallis. The Sei, Som, Wakal, Mansi, Western Banas, Eastern Banas, Karmoi, Jhakham, Mahi, Annas, Vagan, Vatrak, Khari, Bedach, Menali, etc. are important rivers of this zone. There are two mega-drainage system exist in the area–one carrys the run off to Bay of Bengal and another to Arabian Sea. The dividing line of two mega-watersheds passes through Paba, Alsigarh, Ubheshwar and Kumbhalgarh. Rivers, arising east of Aravallis, from Alsigarh to Kumbhalgarh drain their water in Bay of Bengal while those originate west of Alsigarh-Kumbhalgarh, drain their runoff in Arabian Sea. The Eastern Banas, Ayad etc. carry water to Bay of Bengal while Mahi, Wakal, Mansi, Sei, Western Banas etc. carry rain water to Arabian sea. Among rivers which flow towards west, Mahi and Wakal are important in many ways.

Wakal River:

Catchment of Wakal River in spreaded in four tehsils of Udaipur district viz., Jhodol, Gogunda, Kotra and Girwa and one tehsil of Gujarat State namely Khedbramha. Wakal river originates in the hills near Ghora village in Gogunda tehsil and thereafter flowing southward near Ogna, Birothi and Manpur it reaches Panarwa and takes sharp turn towards West and enters Phulwari Sanctuary (Fig.1). It flows furthern towards West, bisecting Phulwari Sanctuary in two unequal halves and reaches close to Kotra. After flowing for about 112 km in the Udaipur district, it leaves the boundary of State near village Gau Pipla and enters Gujarat State.

Various geomorphological features of Wakal are intersting. Many fixed and shifting outcrops can be seen at various places in the bed of Wakal. The biggest fixed outcrops is present near Khanchan forest *Chowki* which is popularly known as *"Langotia Bhata"*. This is a common belief among tribals that Lord Hanuman while bringing *Sanjeevani Buti* for revival of Laxman, he flown over this river. While flying, his under garment, the *langot*, slip off here. People are of openion that this stone is nothing but *"langot"* of Lord Hanuman, hence the name *"Langotiya Bhata"*.

Wakal joins Sabarmati river down to Kotra and ultimately meet the Gulf of Cambay. Harnav river, originating from forests of Mahadi Naka and sorrounding forest area, traverse middle of Khedbramha town, also join Sabarmati in Gujarat state. River Sei, which originates between Pindwara and Deola join Sabarmati in trans-border zone.

***Darrahs* of Wakal:**

However, Wakal flow becomes cease during summers but water remains available at many depressions, locally called *"Khadra"* or *"Darrah"* or *"Dara"*. These

PROTECTED AND WILDLIFE RICH AREAS IN & AROUND WAKAL CATCHMENT

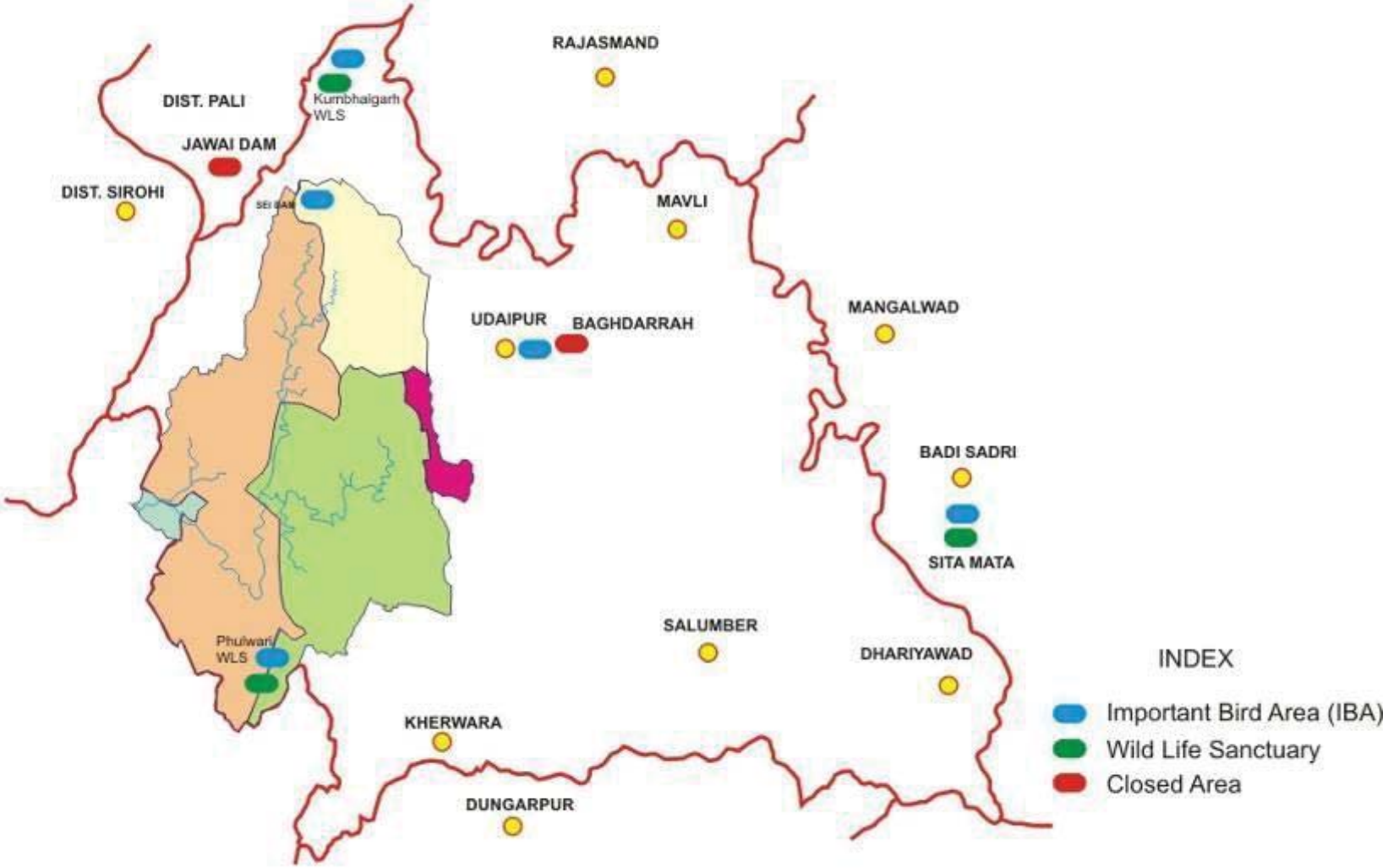


Fig. : 1

perennial **riverbed pools** prove very useful water sources to folk and domestic as well as wild animals. Few important *"darrahs"* of Wakal River (Fig 2) from Kotra to Birothi are as following:

1. Dhola Khadra
2. Vaniya Khadra
3. Kunti Khadra
4. Valdara
5. Paledara
6. Kalladi Dara
7. Thadi Makhni Dara
8. Rakho Dara
9. Veerapan
10. Paniyara or Paniyara Dara
11. Vaghdara/Vaghdar*
12. Umreta Dara
13. Adamera Dara
14. Mesaniya Dara
15. Paniya Dara
16. Kaldara
17. Langotiya /Langotiya Bhata
18. Satt Suvariya
19. Kukrimata Dara
20. Suli Dara
21. Gordara
22. Sheetlamata Dara
23. Himbalvat Data
24. Jangi Dara
25. Piplamata Dara
26. Nan Dara
27. Pati Dara
28. Koodiya Dara
29. Velai Dara
30. Navnara Dara
31. Athwaliya Dara
32. Birothi Dara
33. Guma Dara
34. Bhawra Dara
35. Simaliya Dara
36. Sagarwa

Many *darrahs* are present between Birothi and Ogna. In Nal Mokhi zone, the origin area of stream, river flows through very narrow hilly path and typical *darrahs* are absent there. Where path of river is straight or free from obstacles, path remains *darrah* free but where path is full of curves and obstacles of rock and outcrops, many *darrahs* appear in the riverbed.

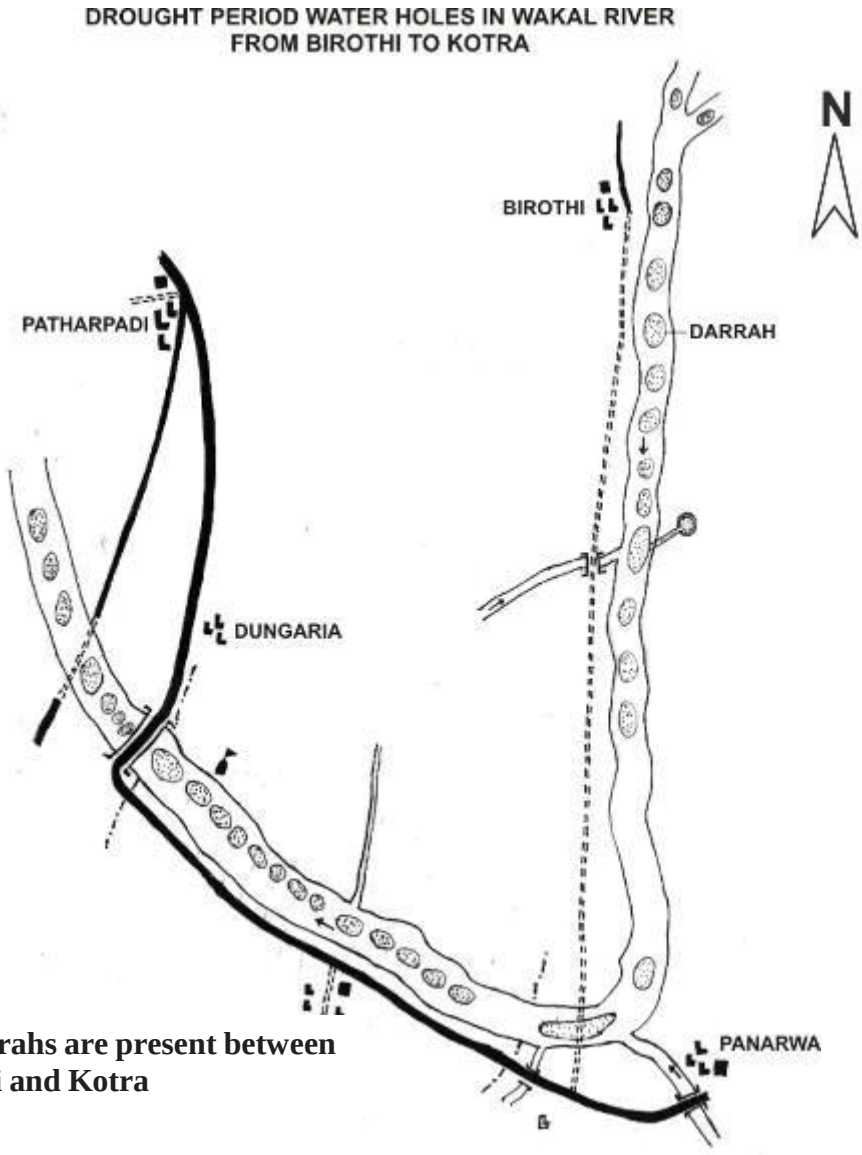
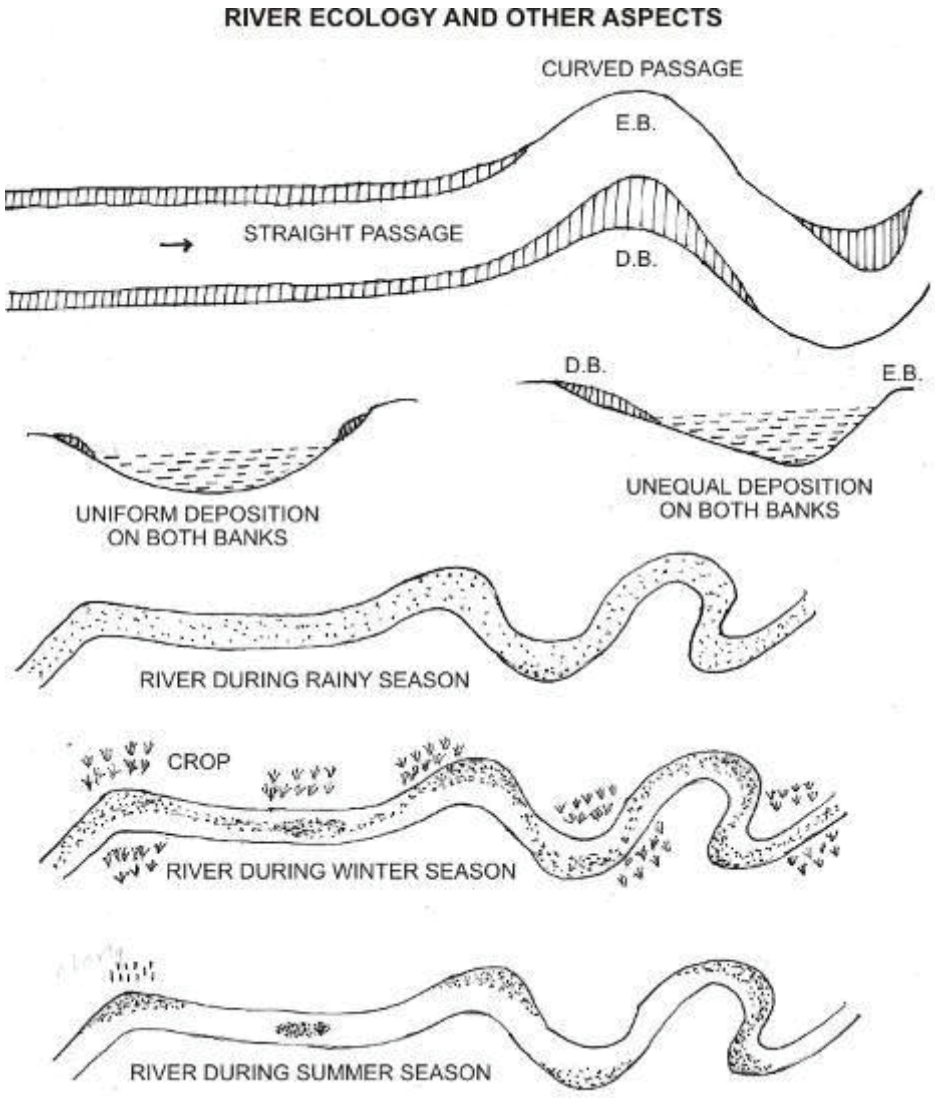

DROUGHT PERIOD WATER HOLES IN WAKAL RIVER
FROM BIROTHI TO KOTRA
N
BIROTHI
PATHARPADI
DARRAH
DUNGARIA
PANARWA
36 Darrahs are present between
Birothi and Kotra

Fig. 2

Importance of *Darrahs*:

Darrahs are important water source for local agricultural. Drinking needs of many villages, wild and domestic animals is also fulfilled by the *darrahs*. *Darrahs* are also used for fishing by the local tribles. These water pools are much used to irrigate the crops during winters. *Chhena* (*Panicum miliaceum*) one of local lesser millets is also cultivated near darrahs during summers by the tribles (Fig.3).



EB = Erosion Bank
DB = Deposition Bank

Fig. 3

Threats to *Darrahs*:

Once Wakal was perennial but now it is gradually becoming semi-perennial and importance of *darrahs* is increasing. It is experience of many past years that ecology of *darrahs* is changing very fast. There are certain threats for existence of these water sources as enumerated below:

- Siltation
- Extensive irrigation from *darrahs* is responsible their untimely drying.
- Use of fish poison by tribals for fishing
- Destruction of riperain strips
- Sand mining
- Blocking of path of upstream network by construction of dams and anicuts.

River bank vegetation of Wakal and its tributaries:

Since water regime of banks is high and deposition or erosion remains continue hence different seral stages of vegetation are seen on the banks. Vegetation strips along banks have entirely different vegetational composition than surroundings.

Since ecological condition remains different along river banks hence species present there are of different type than surrounding area. Mesic to hydrophilic and hydrophytic species grow on banks. Composition of species is directly linked with perenniality of stream. Since Wakal and its tributaries are semi-perennial to perennial hence semi-evergreen strips of vegetation ($1S_1$ forest) occur at places. If streams are perennial and narrow like Bhildi Mata stream in Phulwari forst block, two narrow strip of riparian forest come into existence– one strip on each bank. Both strips are so narrow that their crown touch each other over stream. Crown overlapping is also seen at places (Fig.4). Thus whole stream bed remains under shade round the year. Such shaded banks and bed harbour shade loving species (sciophytes) like *Ampelopterus prolifera, Dalbergia volubilis, Colocasia esculenta, Sauromaticum pedatum, Centella asiatica, Carvia callosa, Impatiens balsamina, Girardinia zeylanica, Cyathocline purpurea, Leea edgeworthii, L. macrophylla, Centratherum phyllolaenum, Ficus hispida, Anagallis arvensis, Bacopa monnieri, Limnophila heterophylla, Eranthemum roseum, Haplanthodes verticillatus, Neurocanthus sphaerostachys, Ruellia tubersosa, Petalidium barleriodes, Polygonum barbatus, Curcuma pseudomontana, Salix tetrasperma, Hpitage benghalensis, Flamingia bracteata* etc. Such streams are present between Mandwa and Panarwa, Khanchan and near Luhari, Nal Mokhi, Nalsandol, Khokhariya-ki-Nal etc.

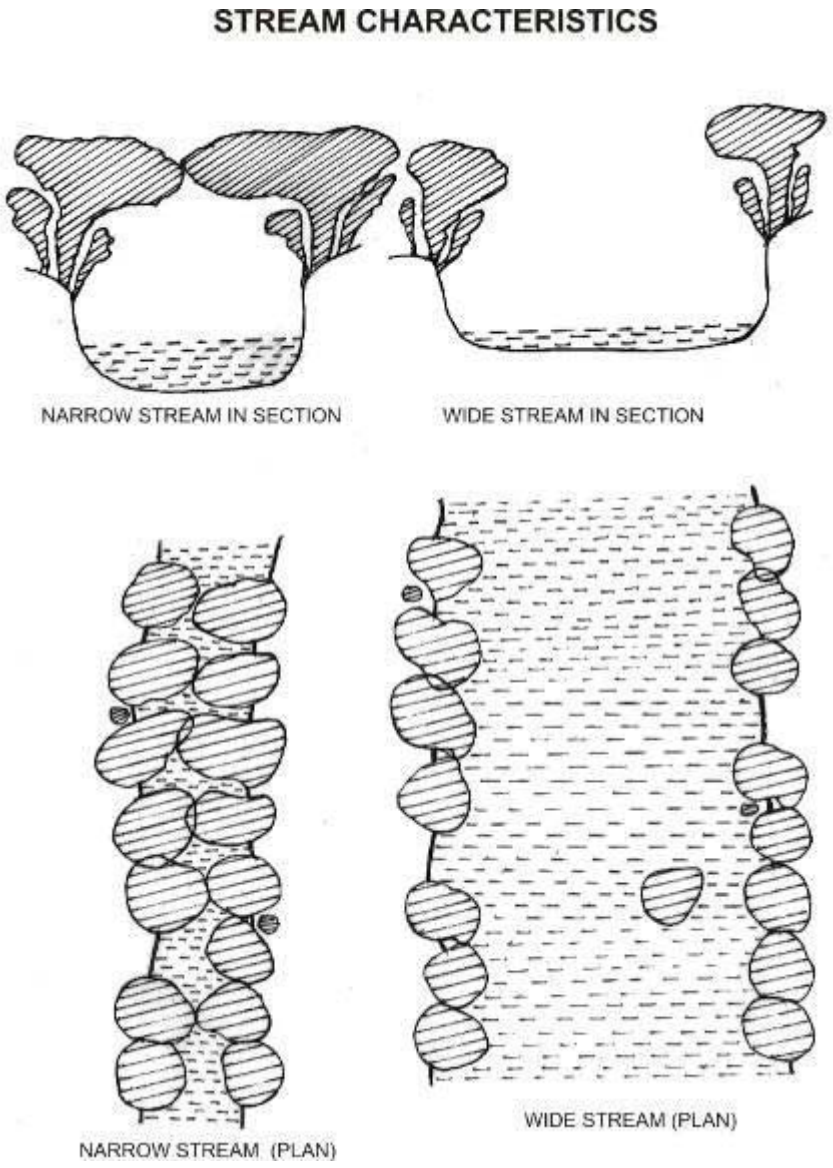


Fig. 4

Big rivers like Wakal has wide bed hence bank vegetation cannot provide shade to whole bed. *Terminalia arjuna, T. tomentosa, Pongamia pinnata, Syzygium heyneanum, Vitex negundo, Phoenix sylvestris etc.* are common **"bank species"** of Wakal. *Syzygium heyneanum, Tamarix ericoides, Vitex negundo* etc. are common **"bed species".**

Ecology of bank and bed trees is quite different. When flow is in peak, rolling stones hit the up stream surface of stems of bed trees. Due to repetate hitting, trees show bending towards down stream side and debarking can be seen towards up stream side of their stem. Epicormic branches arise from wounded area. Trees

standing at bank are more safe and have straight stem. Generally debarking and epicormic branches are not seen in bank trees (Fig. 5).

Protection of bank and bed species is necessary because they provide shelter to Giant Wood Spider, Tickell's Blue Flycatcher, Red Weaver Ant etc. Besides this, bank trees also ensure stability of the banks. Bank and bed species provides suitable ecological conditions to sciophytes.

River Curve Vegetation:

Behaviour of a river is just like a canal. Maximum speed of water flow in a canal is found at 0.4 h* depth from upper surface of water (Ashok Bhardwaj, Asstt. Eng. pers. com.). Due to friction with surface of banks and bottom, speed of water flow is slowed down near bottom and banks. Vegetation and rock outcrops etc. further decrease the speed of flow. Due to friction with air near upper surface, speed of flow slowed down at upper surface too. Due to loss in velocity of flowing water, suspended silt and sand particles are deposited at bottom and banks. Sedimentation pattern in Wakal River is of different type at curves and straight passages. When passage is straight, water flows with uniform pressure and speed and sedimentation are deposited equally on both the banks. At such passage, bed remains nearly flate. However, at curves, behaviour of river is quite different and amazing. At curves, the outer bank becomes more prone for erosion due to heavy scouring while inner bank continuously gets deposition. Thus at curves, outer banks acts like erosion bank and inner like sedimentation bank. Due to prominent sedimentation at inner bank, riverbed becomes slopy and a depression appears near outer bank due to repeated scouring. These depressions generally remain full of water round the year and locally called "darrah". Water regime of eroded bank remain high than sedimented bank. Due to unequal water regime of both the curves, vegetation cover present on both the banks is of different nature. The eroded bank gets more mesic, more hydrophylic, more semi-evergreen/evergreen species while the sedimented bank gets less mesic, less hydrophylic, less semi-evergreen/evergreen vegetation. We can call this phenomenon as species curve lag (Plate 5). Since water regime of both the banks remains equal at straight path, hence, both the banks get cover of similar type of vegetation and if other factors remain same, no difference in vegetation at both the banks exists.

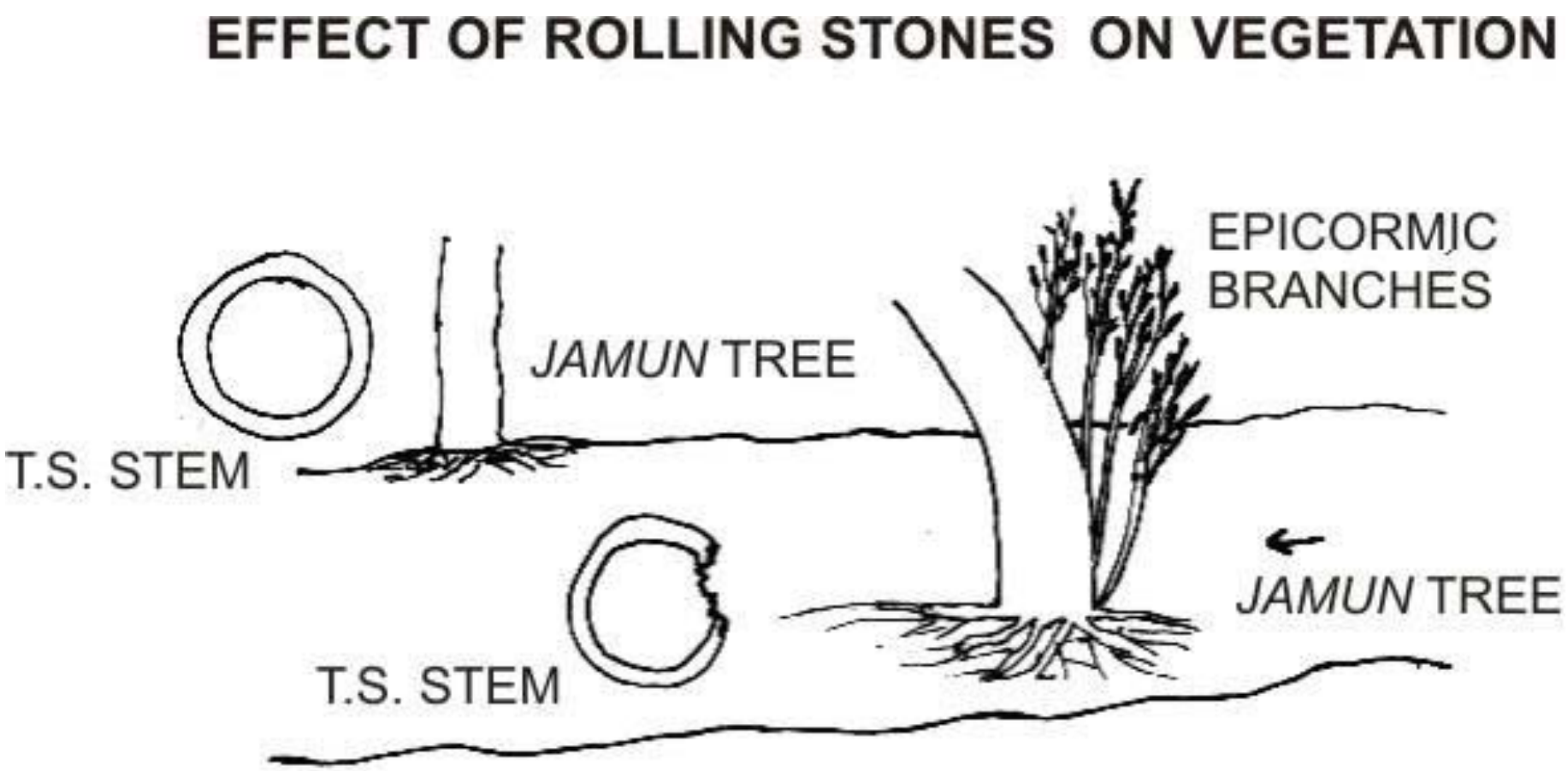

EFFECT OF ROLLING STONES ON VEGETATION
EPICORMIC BRANCHES
JAMUN TREE
T.S. STEM
JAMUN TREE
T.S. STEM

Fig. 5

It is noticed along Wakal and its tributary that there is a relation between water regime of banks and vegetation pattern at curve as depected below:

Water regime decreasing →

Eroded Bank	**Sedimented Bank**
Vitex negundo: Few plants present	*Vitex negundo*: absent
Vitex negundo: Profusly present	*Vitex negundo:* Few plants present
Pangamia pinnata and *Vitex negundo* dominant	*Vitex negundo*: dominant
Pangamia pinnata dominant	*Vitex negundo*: dominant with dotted *P. pinnata*
Pongamia pinnata dominant dotted with *Syzygium heyneanum*	*Pangamia pinnata* alone present or *P. pinnata* present with *Vitex negundo*
Syzygium heyneanum and *Terminalia arjuna* present	*Pangamia pinnata* commonly present
Syzygium heyneanum & *Terminalia arjuna* profusly present	*Pangamia pinnats* commonly present

↓ **Sedimented Bank**

Water regime increasing

↓ **Eroded Bank**

Forest Types of Wakal Basin:

The forests of Wakal Basin fall under "II Dry Tropical Forest" category as per the Champion and Seth's revised (1968) classification of forest types. Many subtypes and groups along with their subsidiary edaphic types are also recognized. Type of forests of Wakal Basin Wildlife Sanctuary are as following:

II - DRY TROPICAL FORESTS

GROUP 5: TROPICAL DRY DECIDUOUS FORESTS

(i) Sub- group 5A: Southern Tropical Dry Deciduous Forests,

C_1 = Dry Teak bearing forest.

C_{1a} = Very dry Teak forest.

(ii) Sub- group 5B: Northern Tropical Dry Deciduous Forests,

C_2 = Nothern Dry mixed deciduous forest

- Degraded stages of dry deciduous forest

  DS_3 = Euphorbia scrub

  DS_4 = Dry grassland

- Edaphic climax types in dry deciduous forest

  E_2 = Boswellia forest

  E_5 = Butea forest

  E_{8a} = Phoenix stands

  E_9 = Dry bamboo brakes

- Seral types of dry deciduous forests

  Primary seral type

  $1S_1$ Riparian forest

  Secondary seral type

  $2S_1$ Secondary dry deciduous forest

Forest types present in Wakal basin area arementioned below

Table 1.1 : Forest types present in various parts of Wakal basin

Type of Forest	Location	Zone of occurrence
$5B/C_2$	Nal Mokhi, Nal Sandol, Phulwari, Khokharia-ki-Nal	Present on slop of hills. *Anogeissus latifola, Boswellia serrata, Dendrocalamus strictus, Carissa spinarum* etc. are impotent species.
$5B/DS_3$	Phulwari	Upper reaches of hill near Bhildi Mata in Hukeri- ki- nal. *Euphoribia* scrub is seen on dry rocks over here.
$5/DS_4$	Gogunda, Pai, Alsigarh	Present in form of grass *bids* in many villages.
$5/2S_1$	Encroached patches	Such patches are seen in foothills and valleys of various blocks. *Sehima nervosum, Heteropogon contortus, Eremopogon foveolatus, Crysopogon fulvus* etc. are common grass in rolling grassland commonly seen during rainy season.
$5/E_{8a}$	Kukawas, Deola, Arjunpura,	Low- laying areas and banks of streams in foot hill zones, valleys and in plains.

	Birothi, Panarwa	Wild date palm is common species over here.
$5/E_2$	Nal Mokhi, Bari, Madri, Nala, Som, phhulwari, Juda.	Present of upper reaches prone to high run off and more rocky in nature. *Salar* is dominant species in such forest types.
$5/E_5$	Jhadol, Gogunda, Deola, Kotra, Panarwa.	Present in foot hill zones and plains. *Palas* is dominant in this zone.
$5/E_9$	Phulwari, Tinsara, Ramkunda, Ladan, Subra-subri.	Soil layer of various depth is present on slops hence bamboo forests can be seen from foothill to upper reaches.
$5/1S_1$	Wakal river from Nal Mokhi to Kotra : Mansi river from Jhadol to Birothi.	Banks of Wakal river and its tributaries
$5A/C_{1a}$	Daiya, Ambasa, Harwa, Surajbara, Ogna, Barakada, Oda, Thobawara. Kakarmala,	Teak is dotted in foothill zones and middle slop. This forest is the western most limit of Teak in India. The northern most limit also exists in Sageti forest block of Sayra range.(Fig.8)

$5/E_6$ *Eagle marmelose* forest can be seen in small patches here and there, specially in Devli, Dhedmariya, Umariya, Ambasa, Daiya, Nalmokhi and Khokhariya -ki-Nal.

Storeyfication and Canopy density of forest

Forest of Wakal basin areas are bi to tri storeyed in most of the area. Bamboo is common in undergrowth in many blocks like Dhedmaria, Devli, Harwa, Asawara, Phulawari, Ramkunda, Tinsara and Ladan. Right from foothills to the crest of hills, bamboo is distributed uniformly. The largest bamboo breaks of state are present in Wakal basin. The canopy density vary from 0.2 to 0.8. The tree height, vary from 5 m to 11m. As one move from foothill to crest, tree height decreases. *Terminalia bellerica, Madhuca indica, Mangifera indica, Haldina cordifolia Terminelia arjuna, Ficus benghalensis, Phoenix sylvestris* etc. are the largest sized tree species of Wakal Basin. The growth and regeneration of different species is excellent in many pockets of the sanctuary.

Along the water courses, due to better availability of moisture, special micro-climate has been formed in pockets. Evergreen species are commonly at such places with dense under growth.

Khajur is a riverine species in this area and sometimes make pure stands. It is found in abundance along streams and in low laying areas. Regeneration of this species is generally profuse and abundant.

Floristics of various major types of forests of Wakal Basin:

Wakal Basin is known for its dense and multistoryed forests. All the life forms of the plants are present in this zone. A birds eye-view of storyfication of the basin's forests is presented below:

5A/C_1A: Very dry Teak forest:

Storey I: *Tectona grandis, Anogeissus latifolia, Emblica officinalis, diospyros melanoxylon, Miliusa, Tomentosa, Cassia fistula, Mitragyna parvifolia, Boswellia serrata, Butea monosperma, Lannea coromandelica, Madhuca indica, Adina cordifolia, Terminalia tomentosa and soymida febrifuga.*

Storey II: *Acacia catechu, Zizyphus xylopyrus, Flacourtia indica, Dandrocalamus strictus, Wrightia tinctoria, Acacia leucophloea.*

Storey III: *Carissa spinarum, Securinega leucopyrus, S. virosa, Woodfordia fruticosa, Nyctanthes arbor-tristis, Helicteres isora, Capparis sepiaria, Lantana camara, Holarrhena antidysenterica, Acacia pennata.*

Storey IVa: *Cossia tora, Tephrosia purpurea, Acanthospermum hispidum.*

Storey IVb: *Apluda mutica, Hetropogon contortus, Themeda quadrivalvis.*

5B/C_2: Nothern dry mixed deciduous forest:

Storey I: *Anogeissus letifolia, Boswellia serrata, terminalia tomentosa, Lannea coromandelica, Sterculisa urens, S. willosa, Firmiana colorata, Ficus benghalensis, Terminalia arjuna, Soymida febrifuga, Albizzia odoratissima, Emblica officinalis, Mitragyna parvifolia, Diospyros melanoxylon, Cassia fistula, Bridelia retusa, Bauhinia variegaa, Butea monosperma, Terminalia bellerica, Madhuca indica, Ficus religiosa, Ficus virens, Bombex ceiba, Miliusa tomantosa, Adina cordifolia.*

Storey II: *Acacia catechu, Zizyphus xylopyrus, Flacourtia indica, Dandrocalamus strictus, Wrightia tinctoria, W. tomentosa, Acacia leucophloea, Bauhinia recemosa.*

Storey III: *Carissa spinarum, Woodfordia fruticosa, Holarrhena antidysenterica, Vitex negundo, Jatropha curcas, Grewia tenax, Ficus hispida.*

Storey IVa: *Cossia tora, Tephrosia purpurea, Acanthospermum hispidum, Achyranthes aspera, Thespesia lanzan, Tridex procombens, Ensete superbum.*

Storey IVb: *Apluda mutica, Hetropogon contortus.*

Anagesisus pendula, Acacia senegal, Commiphora wightii, Rhus mysorensis are totally absent. Capparis decidua, Maytenus emarginata, Balanites oegyptiaca, Tecomella undulate, Zizyphus nummularia, Prosopis cineraria are rare in this sanctuary. *Cuscuta reflexa, C. hylina, Dendrophthoe falcata, Viscum articulatum* are common parasitic plants in the area. Epiphytic orchids are fairly common in few localities.

5/DS$_4$ Dry grassland:

Sehima - dichanthum type grassland are present in private grass *bids* at periphery of sanctuary. Area is hilly and undulating and hillocks get converted into rolling grasslands during rainy season. *Sehima nervosum, Heteropogon contortus, Chrysopogon fulvus, Themeda quadrivalvis, Eremopogon foveolatus, Cymbopogon matini, Sorghum helepense* are common grass on open hills and hill slopes. *Apluda multica* is a grass commonly seen on hill slopes under forest cover. It is definitely a forest grass can grow in partial shade also.

5/E$_2$ Boswellia forest:

Storey I&II: *Boswellia serrata, Lannea coromandelica, Sterculia urens, Ougenia oojeinensis, Anogeissus latifolia. Dendrocalamus strictus* is present cooler zone having good soil.

Storey III: *Nyctanthes arbor-tristis, Holarrhena antidysenterica, Helicteres isora.*

Storey IVa: *Cassia tora, Tridax procumbens, Euphorbia hirta, Acanthospemum hispidum, Borreria hispida.*

Storey IVb: *Apluda mutica, Hetropogon contortus, Sehima nervosum, Chrysopogon fulvus.*

5/E_5 Butea forest:

Storey I&II: *Butea monosperma, Acacia leucophloea, Anogeissus sericea, Phoenix sylvestris, Ficus benghalensis, F. religiosa, Zizyphus mauritiana, Pongamia pinnata.*

Storey III: *Carissa spinarum, Lantana camara, Capparis sepiaria, Vitex negundo.*

Storey IVa: *Cassia tora, Tridax procumbens, Euphorbia hirta, Acanthospemum hispidum, Achyranthes aspera, Tephrosia purpurea.*

Storey IVb: *Apluda mutica, Hetropogon contortus, Themeda quadrivalvis, Cymbopogon martini.*

5/1S_1 Dry tropical Riverain forest

Storey I&II: *Syzygium heyneanum, Terminalia arjuna, Ficus glomerata, Pongamia pinnata, Phoenix silvestris, Salix tetrasperma, Dalbergia volubilis, Hiptage bengalensis.*

Storey III: *Tamarix ericoides, Vitex negundo, Ficus hispida, Kirgenlia reticulate, Typha Angustata, Phragmites austrilis.*

Storey IV: *Phyla nodiflora, Bacopa monnieri, Centella asiatica, Cyathocline purpurea, Eclipta alba, Coix lacryma-jobi, Echinochloa spp., Cyperus spp., Cynodon dactylon.*

Grasslands of Wakal basin:

Two type of grasslands are confined to Rajasthan. *Sehima-Dicanthium* type of grassland is present on Aravallis and east of Aravallis where rainfall is more than 500mm per annum. While area situated west of Aravallis support *Dicanthium-Lesuirus-Cenchrus* type of grassland. This type of grassland develops in the area having light soils and receiving less then 500mm rainfall annully.

Thus Wakal basin area is predominatly possessing *Sehima-Dicanthium* type of grassland. Grass succession in Wakal basin generally starts with *Melanocenchrus jacqumonti* and terminates at *Sehima-Dicanthium* stage in open protected areas but it terminates at *Apluda mutica* stage in forest area where tree density is more. *Apluda mutica* is a typical forest grass which can grow in light shade of upper canopy. But when canopy becomes close, this species disapears from the scene.

Fungi of the Wakal basin:

High rainfall, high relative humidity, high tempeture and presence of enormous quantity of dead organic material provide congenial enviroment to fungi to grow. Many macrofungi becomes quite visible during monsoon season in Wakal basin zone. Following species of fungi have been indetified from the Wakal basin area:

1. *Agaricus sp.*
2. *Polyporus picipus.*
3. *P. sanguineus*
4. *Lenzities betulina*
5. *Micropus xanthopus*
6. *Ganoderma sp.*

Due to high presence of fungal elements, humification is fast in the forest areas. Most of forest areas of Wakal basin like Phulwari, Ram Kunda, Ladan, Tinsara, Nal Mokhi Ubheshwar, Kirat, Kamalnath etc. are rich in humus which is very helpful to support various plant species especially fern and bryophytes.

Semi-evergreen/Evergreen elements of Wakal Basin:

Many semi-evergreen / evergreen elements can be seen in Wakal Basin, which indicate that forests of this zone are not fully dry and deciduous. Presence of specific micro climate is responsible for survival of evergreen species. A glimpes of evergreen elements is depitected below.

Table 1.2: Semi-evergreen/Evergreen elements of Wakal Basin

S. No	Taxa	Presence in Wakal Basin	Forest type where speices grows in other parts of India
1.	Genus *Syzygium*	*S. heyneanum abundant* (Along streams)	**Group 1-** Tropical wet evergreen forests **Sub-group 1B -** Northern Typical wet every green forests **Group 2 -** Tropical semi-evergreen forest **Sub-group 2B –** Northern Tropical semi-evergreen forest
2.	Genus *Mallotus*	*M. philippensis* (Present along nallahs is shady areas)	**Group 2 -** Tropical semi-evergreen forests **Sub group 2A –** Southern Tropical semi-evergreen forests.
3.	Genus *Diospyros*	*D. melanoxylon* (Abundently present	**Group 2 -** Tropical semi-evergreen forests **Sub group 2A –** Southern Tropical semi-evergreen

		on hill slop)	forests.
4.	*Terminalia tomentosa*	Less common, seen in valleys	**Group 2 -** Tropical evergreen forests **Sub group 2A -** Southern Tropical semi-evergreen forests. **Sub type 2A/C_2 -** West coast semi-evergreen forests
5.	*Bombax ceiba*	Fairly common	**Group 2 -** Tropical evergreen forests **Sub group 2A -** Southern Tropical semi-evergreen forests. **Sub type 2A/C_2 -** West coast semi-evergreen forests
6.	*Pterocarpus marsupsium*	Rare	**Group 2 -** Tropical semi-evergreen forests **Sub group 2A -** Southern Tropical semi-evergreen forests. **Sub type 2A/C_2 -** West coast semi-evergreen forests
7.	*Dalbergia latifolia*	Rare	**Group 2 -** Tropical semi-evergreen forests **Sub group 2A -** Southern Tropical semi-evergreen forests. **Sub type 2A/C_3 -** Tirunelveli semi-evergreen forests.
8.	*Toona ciliata*	Rare	**Subtype 2B/C_{1b} -** Eastern Sub-montan semi-evergreen forests
9.	*Adina cordifolia*	Fairly common	**Type 2B/C_2 -** Cachar tropical semi-evergreen forest
10.	*Bridelia tomentosa*	Fairly common	**Type 2B/C_3 -** Orissa tropical semi-evergreen forests
11.	*Mangfera indica*	Common	**Type 2B/C_3 -** Orissa tropical semi-evergreen forests
12.	*Firmiana colorata*	Less common	**Type 2B/C_3 -** Orissa tropical semi-evergreen forests

Besides above, there are many other plants which are of evergreen/ semi-evergreen nature, can be seen in Wakal Basin forests. A list of such plants is given below:

Mangifera indica

Manilkara hexandra (species of tropical dry evergreen forest)

Santalum album

Syzyium cumini

Randia dumetorum (species of sub-tropical hill forest)

Trema orientalis

Woodfordia fruticosa

Ficus hispida

Various type of Ferns

Epiphytic orchids

Above list indicates that forest of Wakal basin has congineal ecological condition which can support the biota of Peninsular and Western Ghats region.

Diversity of Biota in Wakal Basin:

During study, it was found that floral diversity in Wakal basin is remarkable. Since various macro and micro habitats like dense forest, grass land, scrub land, farm land, water bodies, rocky zone, cool and moist pockets, etc. are available in catchment area hence various life forms of plants grow over here. The floral wealth of the zone is as follows:

Table 1.3 : Wild and farmland plant diversity

S.No.	Taxa	Species		
		In Wild	On Farmland	Total
1	Dicot plants	364	89	453
2.	Monocot plants	133	21	34
	Total	497	110	607

The Wakal catchment area in rich in water bodies and avian life. A synopsis of species is as follows:

Total family represented	:	49	
Total Genera	:	153	
Resident Species	:	161	
Winter migrant species	:	61	227 Species
Summer Migrant species	:	1	
Passage Migrant species	:	4	

A brief synopsis of wild species, identified during study period is as follows :

Table 1.4 : Synopsis of wild species

S.No	Taxa	Genera	Species
1.	Thalophyta	18	5 (Rest yet to identified)
2.	Bryophyta	14	19
3.	Pteridophyta	11	13
4.	Spermotophyta	355	497
5.	Non-chordata	84	98 (many species yet to identified)
6.	Ichthyofauna	20	34
7	Batrachofauna	7	8
8.	Herpetofauna	36	41
9.	Avifauna	153	227
10.	Mammalian fauna	37	40

Protected Areas in and around Wakal Basin:

Wakal Basin has the finest forest patches of Rajasthan which sustain large number of wild faunal species. Plentiful waterholes, dense forest cover, multi-storeyed forest crop, presence of caves, concaves, split and crevices in hills provide different types of nichs to wild animals.

Though animals are present every where in Wakal basin, but few localities are reicher than rest area. Such localities are listed below:

Table 1.5 : Animal rich area (i.e. Protected areas) in and around Wakal basin.

S.No.	Name of Area	Location	Importance
1.	Phulwari wildlife Sanctuary & Important Bird Area	Southern part of Wakal Basin	Rich in flying squirrel, four-horned antelope, wild fowls, sloth bear, orchids, lianas, ferns and MFPs
2.	Sei Dam (Important Bird Area)	North-western border of Wakal Basin	Rich in aquatic life forms
3.	Jawai Dam (Former Closed Area)	North-western border of Wakal Basin	Rich in aquatic life forms

4.	Kumbhalgarh WLS & Important Bird Area	Near southern end of Wakal Basin	Rich in sloth bear, wild fowls, wolf, ferns. A MPCA (Medicinal Plant Consevation Area) of *Boswellia serrata* is under progress.
5.	Balal Ram Ambaji WLS	Southern end of Wakal Basin	Rich in sloth bear.
6.	Jassor WLS	Southern end of Wakal Basin	Rich in sloth bear.

Above table indicates that Phulwari is the only protected area situted in Wakal basin. Forest cover is very dense in this sanctuary (Plate1) Five protected area namely Sei Dam, Jawai Dam, Kumbhalgarh, Bala Ram Ambaji and Jassor situated on periphery of Wakal basin. To and fro movement of animals is seen among all these protected areas.

Plants Introduced by British Army officers in Wakal basin

A unit of MBC (Mewar Bhil Core) used to kept posted at Kotra round the year before independence. A small cantonment was established by the Britishers at Kotra. Barracks of soldiers and residences of officers were constructed here. For beautification and shade purpose, many trees were planted in Kotra by the Britishers. Though most of old trees have gone, but a few are still present as shown in following table no. 6:

Table 1.6 : Few planted trees of colonial period in Wakal basin:

S. No.	Present location	Name of species	No. of plants still present	Nature of plant	Present status
1.	Wildlife office campus at Kotra	*Manilkara sapota (Syn. Sapota achras)*	1	Evergreen, provide edible fruits	Healthy, protected by Forest Deptt.
2.	Panchayat Simiti campus at Kotra	*Adansonia digitata*	1	Deciduous sacred tree	Healthy, protected by Panchayat Samity

High peaks of Wakal Basin :

Many high peaks are present in Wakal basin area which support many submontane species like *Toona ciliata, Caesalpinia decapetela,Protium serretum* etc. Few high peaks of Wakal basin area are as follows :

Table 1.7: High hills of Wakal basin area:

S. No.	Location of peak	Tehsil	Forest range	Maximum height (m above MSL)
1.	Pipalmal (S-E of village)	Kotra	Ogna	1064
2.	Virpura (West of village)	Kotra	Ogna	1166
3.	Ranpur (West of village)	Kotra	Ogna	1021
4.	Kamalnath	Jhodol	Jhodol	1005
5.	Nal (East of road)	Gogunda	Gogunda	1062
6.	Shivdiya (N-W village)	Gogunda	Gogunda	1123
7.	Dholia Dungar (West of road near Mokhi)	Gogunda	Gogunda	1183
8.	Jaswantgarh (West of village)	Gogunda	Gogunda	1063
9.	Losing (West of village)	Gogunda	Gogunda	1090
10.	Pai	Girwa	Udaipur	1064
11.	Dodawali	Girwa	Udaipur	1080
12.	Khumbalgarh	Khumbalgarh	Khumbhalgarh	1223

Since height of many peaks is more than 1000 m above MSL which is suitable to support many sub-montane plant species in these zone.

Sacred groves :

Many religious spot *(devra)* are present near tribal habitations. Vegetation around *devras* is generally spared by tribals. Sacred trees or small sacred groves can be seen near each *devra*. But, when a *devra* is present amidst of forest, it is difficult to trace its boundary.

Few important religious spot of Wakal basin are as follows:

Table 1.8: Some religious spots of Wakal basin

S.No.	Name of block	God	Goddes
1.	Devli	Bhande Baba, Tumma Dev, Redwa Bavji, Ratangarh Bavji	-
2.	Ambasa	Bhera Baba	Agasi Mataji
3.	Umariya	Amliwala Bheruji, Mera Bavji, Mahadeoji, Shri Tagraji, Lalagarji,	Barai Mata, Manch Mata, Akhadi Mata, Kotri Mata, Kunda Mata, Gama veda Mata
4.	Dharawan	Kodra Bavji, Mahadeoji, Bheruji, Chhipaliya Bavji, Laniya Bavji, Tarabriya Bavji, Pata Bavji	Dhamka mata, Geru Mata, Jogni Mata

5.	Dhedmariya	Barawala Mahadeoji, Bheru Bavji, Khat Ramarail Dev Bavji, Bhader Bavji, Duja Dhader Bavji, Utariya Bhamiya, Takiawala Mahadeo, Bheruji, Vadlawala Bhader Bavji, Mahadeo Haran, Hamora Khetar, Bala Mahadeoji, Hafiyawal Mahadeoji	Bamni Mata (at two places), Tuti Rawni Mata, Tamal Vad Mata, Richhola Mata, Rana Bhil Mata, Asapuri Mata, Kochra Mata, Peepla Mata Ambavi Mata
6.	Asawara		Jiru Mata
7.	Phulwari	Bagdara Bavji, Bhera Bavji,	Bhildi Mata, Hal Mata, Ban Mata
8.	Mamer	Kilor Bavji	Jodi Mata, Bheri Mata,
9.	Harwa	Bhader Baosi	
10.	Daiya	-	Khanakba Mata
11.	Kamalnath	Kamalnath, Shanideo	-
12.	Nal Mokhi	Dholia baosi	-
13.	Nal Sandol	-	Sandol Mata

Terracota horse, a zoomorphic representative figure is offered to "Baosis". Tribals are of belief that Baosi roam in the forest and villages on the back of offered horse to protect people of the area.

'Bhut Baosi' is another type of god of Bhils. They believe that *Bhut Baosi* protect them from *Bhuts* (bad souls). It is believed that *Bhut Baosi* lives in giant old trees. Bhil offer bows and arrows near the root zone of *'Bhut Baosi tree'* and worship it also. A *Bhut Baosi* tree of *Terminalia arjuna* is present in *Khanchan* on the bank of Wakal river. Terracote horses are not offered to *Bhut Baosi*. *Bhut Baosi* trees are honored and spared by the Bhils.

Man-made Water bodies:

Besides Mansi, Wakal, Sei and Som rivers, there are many man made water sources in and at periphery of Wakal basin area like:

- Buxa-ka-Naka dam, near Mahadi
- Savan Kyara dam, near Mahadi
- Hakarwa (Vasela) dam, near Mamer
- Janiwas dam, near Mahad
- Rao Mamer's pond at Mamer
- Sei Dam near Deola
- Ogna Dam
- Jhadol Dam
- Jada Pipla Dam
- Velania Dam

Natural Water bodies:

Natural springs are also present in basin area of Wakal river. Locally they are called *Jhar or Jher or Jer*. During olden days, *Jhars* were used at hunting places by the tribals.

Many small, but reliable natural water holes are present in basin area which are used by pet and wild animals for drinking. Few of them are listed below :

Table 1.9: Some natural water holes of Wakal Basin

S.No.	Name of water hole	Locality (village / forest block)
1.	Karnihal / Kanihal	Kharawani
2.	Kunda	Bedadhar
3.	Sas-Bahu-ka-kund	Mandwa
4.	Aadam-Uppar Fer	Mandwa
5.	Dehliwala Khadra	Manasi
6.	Pobo-ka-Khadra	Manasi
7.	Dharla Kund	Ada Haldu Block
8.	Putli Biyan Amba	Ada Haldu Block
9.	Baga-ka-Pani	Dotar
10.	Bor-ki-Naal	Asawara Block
11.	Guradara-ki-Naal	Asawara Block
12.	Dhedri-ki-Naal	Asawara Block
13.	Khad Devti-ka-Khadra	Manasi
14.	Memnami	Mamer Block
15.	Nahri Khol	Mamer Block
16.	Mahudi-ka-Khadra	Morchhuchha
17.	Dhowaniya/Bhaderia Kund	Antaliya
18.	Khara Veri	Antaliya
19.	Phuldariya Kund	Antaliya
20.	Khamani Mata	Kadwa Mahuda
21.	Bhader Baosi Kund	Devli Block
22.	Katawali Jer	Between Lathuni and Ambavi in Daiya Block
23.	Bujha Jer	Daiya Block
24.	Kotri Jok	Harwa Block
25.	Tala Jer	Ambasa
26.	Nala	Som I block
27.	Kawel Kund	Daiya Block
28.	Devligarh Kund	Devli Block
29.	Chunapani	Mahad
30.	Kamalnath	Kamalnath
31.	Kaileshwar	Near Undithal
32.	Ramkunda	Ramkunda
33.	Ubheshwar	Ubheshwar

People say that Baga-ka-Pani and Nahri Khol were important water hole in ancient time when tigers used to drink there. Nomenclature of these water holes is itself an evidence of people's claim.

Aquatic lifeforms of Wakal basin:

Various types of aquatic life is seen in waterbodies of Wakal basin. Patches of *Typha angustata* are seen at places. Lotus cultivation is also done in many waterbodies. Migratory water fowl take shelter in these waterbodies during winters. Various types of fishes liek *Notopterus notopterus, Oxygaster clupeoides, O. bacaila, Barilius barana, B. bendelisis, Danio devario, Rasbora daniconius, Ambliy pharyngodon mola, Catla catla, Cirrhina mrigala, C. reba, Garra gotyla, Labeo rohita, L. gonius, L. boggut, L. calbasu, L. fimbriateus, L. bata, Puntius chagunio, P. ticto, P. sarana, Tor khudree, Lepidocyphalus guntea, Nemacheilus botia, Mystus cavasius, M. aor, M. seengala, Wallago attu, Channa marulius, c. punctatus, C. striatus, Mastacembalus armatus, Ambassis nana etc.* are common fish fauna of water bodies which attracts piscivorus birds. A speices of crab *Paratelphusa jaquemanti* is also seen in streams and low lying wet areas. A fresh water prawn *Macrobrachium rosenbergil* is also present in perennial streams (Md. Yasin, pers. com.). This species was seen in streams of Ada Lakad, Manpur and surround villages.

Extensive read areas are absent is waterbodies of Wakal zone. *Typha angustata* is seen in small patches. *Phragmites* species is seen in may hilly fluvial streams.

Hill Pattern :

Hills of Wakal basin are characterised by presence of a layer of soil of varying depth. Presence of soil layer makes a hill very suitable for *Anogeissus latifolia, Dendrocalamus strictus* and their associates. Since thick soil layer is present on hill slopes, which soak good amount of water and hill become unsuitable for edephic climax of *Anageissus pendula* ($E5/E_1$).

There are four hill types seen in Wakal basin area (Fig. 6):

1. Isolated Conical hills

These hills are prone to high runoff and soil erosion. Thin or no soil layer occurs on such hills. More xeric vegetation seen on such hills.

2. Concave hills

Sometimes cupping is seen atop of hills. This situation is helpful to harvest rainwater *insitu.* Besides cupping if soil layer is also present in such hills, they support very rich broad-leaved vegetation. Ubheshwar, Kamalnath, Kumbhalgarh (present at border of Wakal basin), Madri block etc. are examples of this type of hills.

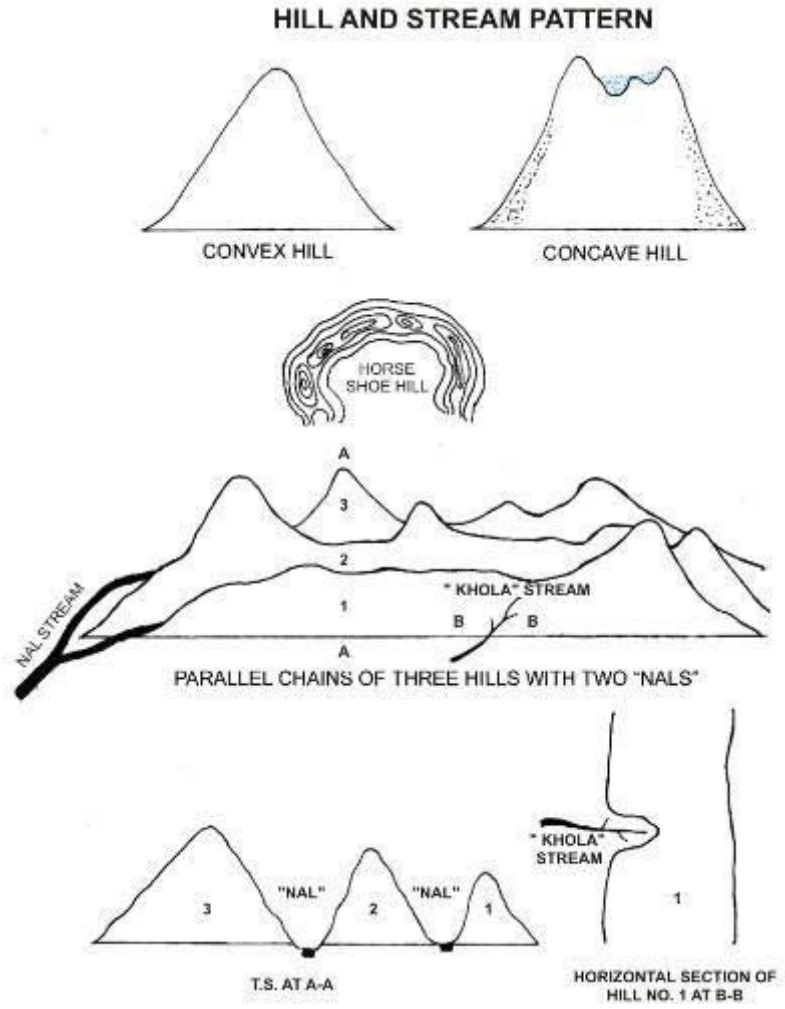


Fig. 6

3. **Horse - shoe hills :**

Shape of such hills is semi-circular. If soil is present on inner slopes, rich biodiveristy is seen in encircled area.

4. Parallel Chains :

The general orientation of hills is south to north. Mountain chains run parralled to each other in few pockets. Water regime found better in such areas hence they support rich vegetation. Diversity occurrs high on inner slopes of parallel chains. Area between two parallel chains either may wide or narrow. If it is relatively narrow, it is locally called "*Nal*". *Nal* is a "street" between two high parallel mountain chains. A stream of varying width and discharge is always present in a *nal*.

Most of wide *nal* or valleys have been occupied by human beings for agricultural and habitations. *Madhuca indica, Termanilaia bellirica, Carissa*

spinarum, Butea monosperma, Acacia nilotica etc. are important vegetation of this zone. Narrow *nals* or vallyes in many pockets are still free from human encroachment, but degradation is going on there. High biotic diversity is present in narrow *nals* and they need protection.

"Nal"

A valley, specially a narrow one, is called "*nal*" in local dialect (Fig.6). The area present between two parallel mountain chains or a deep fold present in a chain itself is a *"nal*". Essentially a nallah or stream or river is always present in the "*nal*". Stream of "nal" may be perennial, seasonal or ephemeral. Water regime in a "*nal*" remain higher than adjacent area. Succession of vegetation keep pace with water regime, hence more water loving species can be seen in "nal" than surrounding. The forest present along the banks of perennial streams and in sheltered valleys is called riparian forest. Many "*nals*" and riparian strips are present in Wakal basin and other parts of southern Rajasthan. Sometimes riparian strips are of semi-evergreen or evergreen status within the surrounding deciduous forest. Thus a sort of 'post-climax' stage is seen in valleys. *Nals* have rich biodiversity. May rare plant species like *Dalbergia volubilis, Costus speciosus, Ensete superbum,* terrestrial orchids etc. are met with in *nals.* Many rare animal species are also confined to *nals* (Plate 2-5). Few important "*nals*" and composition of their riparian elements is as follows:

Table 1.10: Floristic of few *nals:*

S. No.	Name of "*nal*"	Location	Nature of Valley	Main plant species of riparian forest
1.	Phulwari-ki-nal	Near Panarwa	Narrow	*Centella asiatica, Ficus hispida, Dalbergia voulubilis(*Plate 2), *Amplopteris prolifera, Carrisa spinarum, Pogostemon heyneanus, Mangifera indica, Arisaema tortuosum, Colocosia esculenta, Sauromatum pedatum, Pongamia pinnata, Syzygium heyneanum Celastrus paniculata* (Plate 2) *etc.*
2.	Gamdi-ki-nal	Near Gamdi	Narrow	*Enseta superbum*(Plate 5), *Arisaema tortuosum, Centella asiatica, Syzygium heyneanum, Colocosia esculenta, Sauromatum pedatum, Argereia sericea, A. strigosa, Costus speciosus* (Plate 4) *etc.*
3.	Khanchan-ki-nal	Khanchan to Luhari	Narrow	*Salix tetrasperma, Enstete superbum, Centella asiatica, Syzygium heyneanum, Clocasia esculenta, Terminelia arjuna etc.*
4.	Khokharia-ki-Nal	Between Jaswantgarh & Deola	Narrow	*Mangifera indica, Colocosia esculenta, Sauromatum pedatum, Pongamia pinnata, Syzygium heyneanum,* Bryophytes Pteridophytes *etc.*
5.	Nal Mokhi	Mokhi	Narrow	*Ficus racemosa, Pongamia pinnata, Syzygium heyneanum* Bryophytes Pteridophytes *etc.*

It is evident from above table that floristic of the "*nal"* is very close to many South Indian forests of high rainfall zone. There are many other *"nal"* also present in

Wakal basin which possess similar type of floristic. A list of important *"nals"* of Wakal basin is as follows:

1.	Bor-ki-nal	6.	Kewdi-ki-nal
2.	Guradara-ki-nal	7.	Jogiwad-ki-nal
3.	Dhedri-ki-nal	8.	Gujeri-ki-Nal
4.	Sarli-ki-nal	9.	Nal Sandol
5.	Hukeri-ki-nal	10.	Kakan-ki-Nal

Presence of *nal*, thick soil layer on slopes, high perenniality of streams, similar type biotia in a wide area are main a characteristic of Wakal basin area, which makes it a special biotop in Rajasthan.

The Mango-Mahuwa Belt of Wakal basin:

Phulwari area of Wakal basin is rich in Mango and Mahuwa Trees. Villages like Kharavani, Dotar, Dhiya, Mamer, Hasreta, Nakola, Koldhara, Vav Viran, Bhim Talai, Kawel, Ambavi Ambasa, etc. are rich is these two species, specially in Mahuwa. The largest Mahuwa grove of the State is confined to Phulwari Wildlife Sanctuary. Even pure natural Mahuwa patches can be seen here in valleys. Soil depth and water regime is good in valleys. Soil fertility is also good in there which make them much suitable for Mahuwa growth. Mahuwa groves in Wakal basin area are listed below:

Table 1.11 : Mahuwa groves in Wakal basin area

S.No.	Location	Remarks
1.	Ambavi	A beautiful dense grove is present between Katawli jer and Daiya. This is the largest grove of the State. This grove is rich epiphytic orchids.
2.	Kawel	A grove is present near Kawel village under jurisdiction of Daiya nak. The grove harbours lot of epiphytic orchids.
3.	Mahad	A dense Mahuwa grove is present between Mahad and Ambasa. This grove is also rich in epiphytic orchids.
4.	Ambasa	While moving from Ambasa towards Daiya a dense Mahuwa grove is seen near Kathodi hostel.
5.	Nala	This area is present outside sanctuary and situated East of Falasia village near Nala village. It is present top of hills on a plateu. Soil depth is good over here.

Above finding indicate that Wakal basin is really an interesting ecological zone of state which has its own peculiarities and specialities. These areas deserve protection and conservation to sustain biotic wealth for welfare comming generations. For this scientific planning and management is needed. For this, planners and managers should be familier with issues of the area.

BOX -1

Important Findings

1. Wakal basin area is dotted with various types of water holes like rivers, darrah, dams, springs etc. which support a variety of biota.
2. Presence of *"Nals" i.e.* narrow valleys is an important feature of Wakal basin. Riparian forest with evergreen and semi-even green species in characteristic of *nals.*
3. Concaving atop of certain hills is very important feature which helps to increase water regime in the area.
4. Presence of soil of varying depth on hill slope in a peculiar character of Wakal basin which makes the area suitable for broad-leaved, tuberous, and mesic species. Presence of bamboo brakes is characteristic feature of the zone.
5. Area is suitable for many multipurpose trees like Jamun, Mango and Mahuwa.
6. Many species of peninsular India and Western Ghats are confined to Wakal basin area.
7. Forest is multistoried. Sometime four stories are seen in the forests.
8. As many as 35 plant species besides all the terrestrial orchids are dwindling in the forest.
9. Six mammalian species have exterminated from the basin forests.
10. Regeneration of most of plant species is unsatisfactory.
11. Epiphytism is common in the forest which indicates that forest is of better type than central and nothern Aravallis, where this features is not so prominent.
12. Area is fire prone.
13. Nearly 607 + plant species and 448 + animal species are there in Wakal basin area.
14. There is a great potential for development of Eco- tourism in this zone.
15. There are many ecological problems in the basin area like increasing biotic pressure on forest resource, wells without parapect wall, increasing road trampling etc.

CHAPTER – 2: IMPORTANT ISSUES

Wakal basin is an important zone of Rajasthan where bio-diversity is very rich. This part of Rajasthan has dense forest and high population of tribal community. The bio-diversity of area is under anthropogenic pressure because human and bovine population is increasing very rapidly. Network of roads is developing very fast which is taking heavy toll from wild animals. Since area is hilly and undolating and road making is not very easy job in such a difficult terrain. Road and water streams are paralelly running side by side in narrow valleys at many places. Since water streams are wildly used as waterhole by the wild animals hence presence of road in proximity of water streams is responsible for trempling of wild animals.

Few Important issues related with bio-diversity of the area are as following.

Wakal basin as a 'fringe home' of Peninsular and Western Ghats' biotic elements

Peninsular zone is comprises Cental India, the deccan, and the Western and Eastern Ghats. This zone is stituated south of the fertile Indogangetic plains, forming a triangular plateau of wide undulating plains separated by ranges of flat-topped hills (Kehimkar 2000; Sharma 2007). Few Peninsular and Western Ghats faunal and floral elements present in Wakal basin area are listed below:

Table 2.1 : Peninsular & Western Ghats elements of Wakal river basin

S.No	Name of Species	Remark
1	**FLORA** *Acacia ferruginea* (Family Fabaceae)	It is found in the Indian Peninsula (Anonymous 1983). This species is present in Phulwari Sanctuary, Jhadol, Chhatardi etc. areas of Udaipur district.
2	*Commiphora gileadense* (Family Burseraceae)	It is a shrub or undertree, present in Udaipur, Chittorgarh, Banswara and Dungarpur districts (Sharma, 2002).
3	*Ensete suberbum* (wild plantain) (Family Scitaminae)	Small patches of this species are present in four tehsils of Udaipur district namely Girwa, Jhadol, Gogunda and Kotra. Few isolated patches are also present on rocky banks of Chambal River (Sharma, 2001b).
4	*Miliusa tomentosa* (Family Annonaceae)	It is present in Gujarat, Orissa, Central India, Northern Circars and the Western Ghats from the Konkan to Tirunelveli. An isolated tract of distribution is also present in sub-Himalayan

		zone. This species is present in southern Aravallis and Hadoti region of Rajasthan (Anonymous, 1975).
5	*Soymida febrifuga* (Family Meliaceae)	It is common in the dry deciduous forest of Indian Peninsula (Annoymous, 1981). It is commonly present in all the sanctuaries and mixed deciduous forests of southern Aravallis and Hadoti zone.
6	*Tectone grandis* (Teak) (Family Verbenaceae)	Sageti block in Sayra Forest Range is the last northern distribution limit of this tree species.
1	**FAUNA** **MAMMALS** *Moschiola meminna* (Mouse Deer)	This species was first reported by Mr. R. Tehsin (1980) in Dhariyawad and Jhadol forests of southern Rajasthan. Probabely now extinct in wakal basin.
2	*Prionailurus rubiginosus* (Rusty- spotted Cat)	Mainly confined to peninsular India (Menon, 2003). Present in forests of Thur Magra and Sajjangarh Sanctuary in Udaipur district. Also present upto Sariska in northern Aravallis. This species has been reported from J & K also.
3	*Funambulus palmarum* (Three-striped Palm Squirrel)	It is present in Phulwari, Sitamata and Kumbhalgarh Sanctuaries. Also present in all the dense forests of Udaipur district.
4	*Petaurista philippensis* (Indian Giant Flying Squirrel)	It is found in most of peninsular India. It is met with in Phulwari and Sitamata Sanctuaries. All *Madhuca indica* gorve of State possess this species (Tehsin 1980; Chundawat *et al.* 2002).
1	**BIRDS** *Amandava formosa* (Green Avadavat)	Mainly confined to Central India and few parts of South India. It is present in Mt. Abu and Kumbhalgarh area of southern Rajasthan.
2	*Dinopium benghalense puncticolle* (Southern Golden-backed Woodpecker)	Reported from Gujari-ki- Nal area of Jhameri Reserve forest (Jhadol Range) in Udaipur district (Sharma 2002).

3	*Francolinus pictus* (Painted Francolin)	Present in croplands, grasslands, scruslands of Udaipur, Banswara, Dungarpur, Kumbhalgarh and Pratapgarh areas.
4	*Callus sonneratii* (Grey Junglefowl)	This species is present in Mt. Abu, Phulwari, Kumbhalgarh, Sitamata and Todgarh-Rovli Sanctuaries.
5	*Galloperdix spadicea* (Red Spur fowl)	This species is present in Phulwari, Kumbhalgarh, Mt. Abu, Sitamata, Bassi, Sajjangarh and Todgarh-Rovli Sanctuaries. It is also present in other forest areas of sourthern Rajasthan.
6	*Lonchura malacca malacca* (Southern Black-headed Munia)	Seen near Velania dam in Jhadol Tehsil of Udaipur district (Sharma 200l a)
7	*Turdus merula nigropileus* (Black-capped Blackbird)	It is present in Mt. Abu (Ali and Ripley, 1983) and Akyawad Forest Nursery, Deola (Sharma, 2000 b). It is also present in Phulwari Sanctuary, Kamlanath, Ladan and Ramkunda forests.
8	*Myiophonus horsfieldii* (Malabar Whistling Thrus)	Present in Mt. Abu (Ali & Ripley, 1983).
9	*Nectarinia zeylanica* (Purple-rumped Sunbird)	It is spotted in outskirts of Phulwari and Sajjangrah Sanctuaries, Banki and Neemach Mata forests. It is also present in Banswara area.
10	*Parus xanthogenys aplonotus* (Central Indian Yellowcheeked Tit)	It is present in Mt. Abu and Jhalawar zone (Ali & Ripley, 1983). It is also present in southern Aravallis in Phulwari, Sajjangarh and Sitamata Sanctuaries beside Banki, Keora-ki-Nal, Khokhariya-ki-Nal, Deola and Jarga hill.
11	*Zoothera citrina cyanotus* (Whitethroated Ground Thrush)	This species is present in Mt. Abu, Phulwari and Sitamata Sanctuaries.
1	REPTILES Ahaetulla nasuta (Common Green Whip Snake)	Present in Mt. Abu, Phulwari and Sitamata Sanctuaries (Sharma 2005).

2.	*A. nasuta* var. *isabellinus*	Present in Mt. Abu, and Phulwari Sanctuaries (Sharma 2005).
3	*Dendrelaphis tristis* (Common Bronzeback Tree Snake)	Present in forests of Jhadol, Gogunda, Kotra and Khairwara tehsils.
4	*Coluber gracilis* (Slender Racer)	Spotted in Jhadol Tehsil.
5	*Sibynophis subpunctatus* (Dume'ril's Black-headed Snake)	Seen in Kamalnath, Phulwari and Kumbhalgarh Sanctuaries.
6.	*Macropisthodon Plumbicolor* (Green Keelback)	Seen in Kamalnath, Jhadol, Nalsandol, Mt. Abu, Phulwari and Kumbhalgarh Sanctuaries, Undari, Kailwara.

Ecological Boundaries of Wakal Basin Biotope in Rajasthan:

Phulwari sanctuary typically represents Wakal basin biotop. This sanctuary is surrounded by simlar type of forest cover all around beyond its legal boundaries. To the North, forests of the sanctuary merge with the territorial forests of Ramkunda, Torna and Ladan forest blocks and simlar type of forest is in spread up to Khokharia-Ki-Nal, Bokhada, Kumbhalgarh, and Kailwara. In the south, area is in continuity with forests of Vijai Nagar and Antar Sumba Ashram Ranges of Sabarkantha district of Gujarat State. On the East, forest of Adivas, Som I, Garanwas, Bawalwada are in continuity and unchanged habitat is in spread up to Jhameri, Sera, Marwad Alsigrah, Bormal, Dodawali, Ubheshwar and Nalmokhi forest blocks. On the west same type of forest is in distribution in Merpur, Samoli, Lamba Haldu and Subra-Subri Forest Blocks. Within Rajasthan outer boundaries of Wakal Basin biotop passes through east of Nalmokhi, Khokharia-Ki-Nal, Kumbhalgarh, Morus, Mamer, Ambasa, Daiya, Garanwas, Pipalbara, Pai, Kaileshwar and Ubheshwar (Fig.7).

Except western side, ecological boundaries of rest three directions of sanctuary get amalgamated with forests of Deola, Gogunda, Ogna, Kotra and Jhadol forest ranges which have quite similar floral composition as that of Phulwari forests. Towards west, forests of Kotra and Kukawas ranges are in continuity but as one moves further towards far west, dryness increases and vegetation tend to more xerophytic in nature.

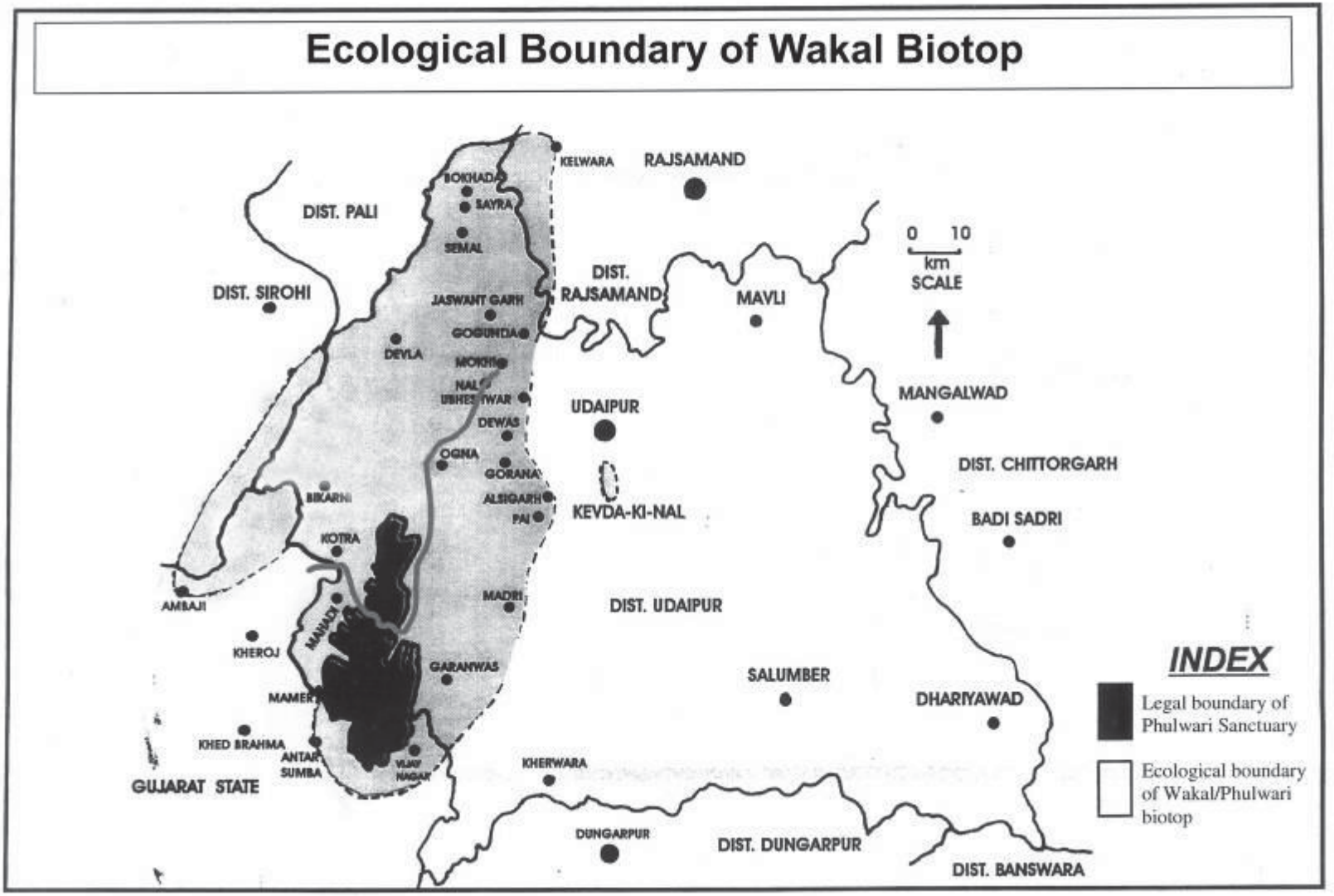

Ecological Boundary of Wakal Biotop
KELWARA
RAJSAMAND
BOKHADA
SAYRA
SEMAL
DIST. PALI
DIST. SIROHI
DIST. RAJSAMAND
MAVLI
0 10
km
SCALE
JASWANT GARH
GOGUNDA
DEVLA
MOKHI
NAL
DEWAS
UDAIPUR
MANGALWAD
OGNA
GORANA
DIST. CHITTORGARH
BIKARNI
ALSIGARH
PAI
KEVDA-KI-NAL
BADI SADRI
KOTRA
AMBAJI
MADRI
DIST. UDAIPUR
KHEROJ
GARANWAS
SALUMBER
DHARIYAWAD
MAMER
KHED BRAHMA
ANTAR SUMBA
GUJARAT STATE
KHERWARA
DUNGARPUR
DIST. DUNGARPUR
DIST. BANSWARA
INDEX
Legal boundary of Phulwari Sanctuary
Ecological boundary of Wakal/Phulwari biotop

Fig. 7

Though Wakal basin is spreading in four tehsils of Udaipur district of Rajasthan State and one tehsil of Gujarat State but its Ecological boundaries are more wide as shown below:

Table 2.2. : Ecological boundaries of Wakal Basin Biotop

Direction	Udaipur district	Rajasmand district	Sirohi district	Bansakantha district	Sabakantha district
North	Bokhada, Sayra	Kelwara, Kumbhagarh	-	-	
South	Memer, Mahad, Daiya, Garanwas	-	-	Ambaji	Antarsumba, Vijai Nagar
East	Gogunda, Ubheshwar, Alsigarh, Madri	Kelwara	-	-	Vijai Nagar
West	Udaipur District border	-	Moras	Ambaji	

An isolated small patch of similar forest type is presented in Keora-ki-Nal on the way to Salumbar.

Bases of Ecological boundaries:

Wakal Basin is the area of Aravallis in Rajasthan where *Anogeissus pendula, Rhus mysorensis, Acacia sengal* and *Commiphora* wightii are absent. The area, devoid of these four species is included in Wakal Basin biotop. Presence of many evergreen plant species and biotic elements of peninsular zone and Western Ghats makes it special in Rajasthan. The northern and western most distribution limits of many plant and animal species terminates in Wakal basin area (Fig. 8). India's teak distribution limit culminates near northern end of Wakal basin. Biogeographically area around 24° 30' N in Wakal basin in very interesting. This zone harbours many Peninsular elements. Even species of Himalayan zone are also seen in Kumbhalgarh (northern end of Wakal basin) and Mt. Abu (western outskirts of Wakal basin). Characteristics of Wakal Basin biotope are as following:

- Presence of dry mixed deciduous forest on hill slopes.
- Presence of evergreen species here and their, specially near springs and along streams.
- Presence of many Peninsular and western Ghats biotic elements.
- Presence of orchids.
- Presence of many arboreal faunal species.
- Presence of dry bamboo brakes.
- Presence of perennial fluvial water sources.

Absence of Anogeissus pendula, Rhus mysorensis, Acacia sengal and Commiphora wightii.

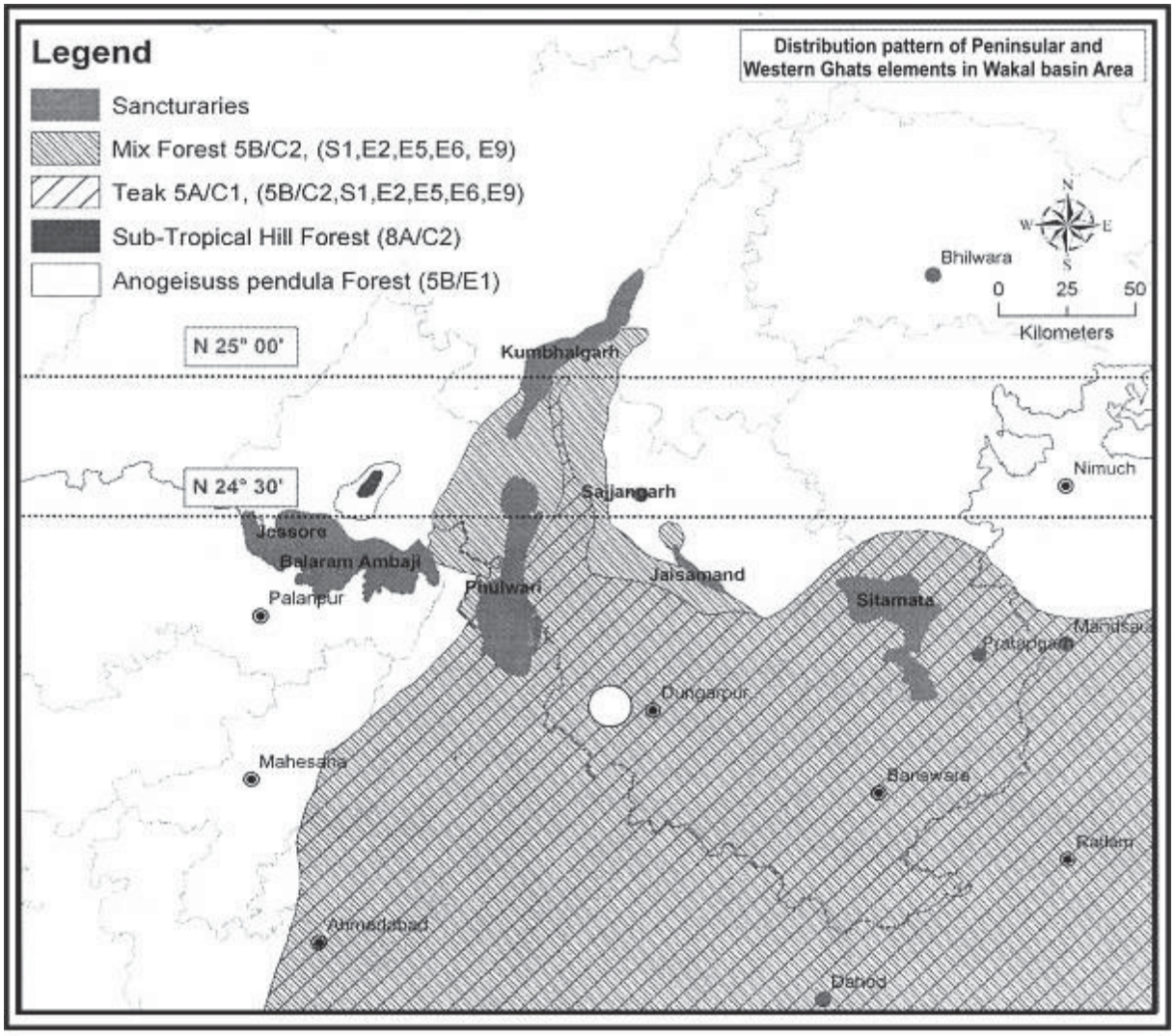


Fig. 8

Potential for Medicinal Plant and Non-timber forest produces:

It is not easy to define a medicinal plant. Every plant is medicinal at one place or other. However, some plants are well known to various medicinal systems and many codified drugs are obtained from them. Many plants are known as source of traditional medicines and NTFPs. Our tribals and rurals procure indigenous medicine and many NTFPs from them.

Conditions of wakal basin are very congineal for growth of many meditional plants like *Gloriosa superba, Abrus precatorius, Urginea indica, Asparagus*

racemosus, Sterculia urens, Annona squmosa, Plumbego zeylanica, Eulophia ochreata, Feronia limonia, Aegle marmelose, Emblica officinalis, Phyllanthus niruri, Hemidesmus indicus, Stereospermum colais, Crateva nurvala, Ensete superbum, Urgenia indica, Bacopa monnrei, Centella asiatica, Carissa congesta, Terminalia bellirica, Puraria tuberosa, Terminalia arjuna, Momordica dioica, Pongamia pinnata, Woodfordia fruticosa, Helicteres isora, Nyctenthes arbortristis, Phoenix sylvestris, Chlorophytum borivilianum, Hymenodictyon excelsum, Tamarindus indicus, Leptedinia reticuluta, Leea macrophylla, etc. These species are naturally present in forest areas of Wakal basin. Most of them can be cultivated in agricultural fields and waste land to uplift the socio-economic condition of local people.

Though area is rich in medicinal plants but there are many threats existing in the State of Rajasthan which are responsible for declining of availability of medicinal plants. Few of them are listed below:

Table 2.3 : Threats to medicinal plants

Threat	**Species suffering**
Over fruit collection	*Anona squamosa, Momordica dioica, Emblica officinalis,, Mangifera indica, Carissa congesta*
Unripe fruit collection	*Anona squamosa, Momordica dioica, Emblica officinalis, Mangifera indica, Jatropha curcas*
Over seed collection	*Sterculia urens*
Fiber extraction (destructive harvesting)	*Sterculia urens, Helicteres isora*
Harvesting of under ground parts (destructive harvesting)	*Chlorophytem borivilianum, C. tuberosum, Puraria tuberosa, Gloriosa superba, Momordica dioica, Corallocarpus epigaeus, Urginea indica, Eulophia ochreata, Plumbego zeylanica, Asparagus racemosus*
Selective extraction	*Bombex ceiba, Pterocarpus marsupium,* plants of foothill zone like *Terminalia arjuna, Pongamia pinnata,* tubrous plants

Poor fruit setting	*Oroxylum indicum, Stereospermum colais, Puraria tuberosa, Sterculia urens*
Low seed germination	*Chlorphytum borivilianum, Oroxylum indicum., Stereospermum colais, Tinospora cordifolia, Asperagus racemosus, Celastms peniculatus*
Habitat destruction	Different stages of degradation are prevailing in the most of parts of the state due to heavy anthropogenic and bovine pressure. Habitat destruction and alteration can be seen even in the protected areas. This is creating problems to most of the species.

Unripe fruits of *Anona squamosa* are massively collected from Deola, Ukhaliayat, Jaswantgarh, Gogunda and Kumbhalgarh, ripened at home by the locals using indigenous techniques and marketed. Unripe fruits of *Momordica dioica* are massively collected and marketed to Ahmedabad, Falana and other cities. Unripe fruits of *Emblica officinalis* are collected and boiled to facilitate de-seeding. The de-seeded fruits obtained so are dried and marketed. Unripe fruits of *Mangifera indica* and *Carissa congesta* are collected from the wild and consumed locally. Sometime surplus is marketed also.

Seeds of *Sterculia urens* are collected for domestic consumption. Seeds of *S. urens* are used as substitute of ground nut and relished by the tribals. Many birds like Rufous Treepie (*Dendrocitta vagabunda*) is also very fond of seeds of *Sterculia* and it devours those seeds which are still present on trees at inaccessible cliff. Missive debarking of *Sterculia urens* and *Helicteres isora* is done to get fibers for domestic use, specially for farm-fence.

Many plants like *Chlorophytum borivilianum, Puraria tuberosa, Gloriosa superba* etc. are harvested by destructive methods. Digging and extraction of their underground parts destroy them for ever. *Chlorophytum boriuilianum* sold as *safed musli* in market. *C. tuberosum* is also extracted for adulteration in the tubers of C. *borivilianum.* Tubers of male plants of *Momordica dioica* are extracted for traditional lice killing medicine. Though bulbs of *Urginea indica* are non-edible, but they are dug out by the Kathodis, sliced, collected in a bamboo baskets and kept under flowing water whole night and then consumed. *Eulophia ochreata,* a terrestrial orchid, collected and sold as aphrodisiac medicine. Tubers of *Corallocarpis epigeous*

are extracted to make country barometers. Tubers *of Pururea tuberosa* are collected by the bhils on *makar - sakranti* festival (January, 14) every year and consumed.

Bombex ceiba is massively extracted by the local tribal from the wild and sold in market or door to door in urban areas to perform the *Holi Dhahan* a famous festival of the Hindus. This practice is in vogue specially in *Mewar* region. Very young plants of *B. ceiba* are also extracted to consume their tuberous roots as delicacy.

Habitat destruction is a major problem in the zone. Free grazing by cattle, trampling, encroachment, specially in the foothill zone and riverine banks destroying many species. Canopy opening in close canopy areas is changing nature of microhabitats Mass scale "Earth Works" done during relief and other similar operations take very heavy toll from propagules and perennating parts of many species. While making approach roads, existing farm fences and hedges and unattended edges of fields are destroyed which badly affects the hedge flora. The relief works affect *Momordica dioica, Abrus precatorius, Urginea indica, Leptedinia reticulata, Ipomoea nile, Jatropha curcas, Baliospennum montanum, Cryptolepis buchananii, Cryptostegia grandiflora* etc.

River and stream banks are encraoah by the tribal and others for agriculture. Since water is available there in pockets for irrigation, hence riverine banks deforested here and there. It takes heavy toll from *Terminelia arjuna, Pongamia, pinnata, Vitex negundo, Syzygium heyneanum, S. jambos, S. cumini* etc. Agriculture in encroached foot hills is responsible for destruction of many mesophytic forest species including large number of tuberous species. Poor fruit setting in many spices is also responsible for poor occurrence of many species like *Oroxylum indicum, Stereospermum colais, Sterculia urens, Puraria tuberosa.* Pods of *Oroxylum indicum* are of huge sized and looks like sword. Pods of this species when still present on trees are collected and used as novelty for house decoration. Low seed germination and low establishment in *Chlorophytum borivilianum, Oroxylum indicum, Stereospermum colais* is responsible for their low occurrence. Pre-mature extraction of tubers of *Chlorophytum borivilianum* by tribals is badly affecting seed production in this species. Collection of tubers as "seed" for agriculturization this species is dwindling its occurrence in wild at a faster pace.

Hill pattern and occurrence of medicinal plants :

Isolated, conical, small hill or single isolated long chain of hill is generally remain more dry in nature due to massive run off. Soil cover on such hills either remains absent or very thin and patchy. The xerophytic vegetation clad such hills. *Commiphora wightii, Euphorbia spp.,* specially *E. caducifolia, Acacia Senegal, Adhatoda zeylanica, Anogeissus pendula, Dichrostachys cinerea* etc. patronize such

hills. Hill with such type of floristics are generally not present in Wakal basin, but they are present at periphery of the same.

But isolated hill or hill chain, having concaving or cupping in their upper reaches, bear less dry vegetation. Water storage in their concave zone, increases moisture regime in whole or part of hill. Similarly , valleys of multiple parallel hill chains have nallahs and chord of different moisture regime. Such moist hill system have mixed broad-leaved species and grasslands in foothills and along the nallahs (Harsvardhan, Pers. com.). Kamal Nath hills, Phulwari Wildlife Sanctuary, etc. are good example of this pattern.

Extensive flat area atop is equally good and allow massive percolation of water inside hills. The water so retained, comes out in the form of hill streams and surface oozing at places. All these things increases water regime of habitat. Such hills sustain mixed broad-leaved species in nature. Presence of spongy rocks also responsible for high water regime in few localities. Similarly, multiple parallel chains of hills are also able to sustain mixed broad-leaved forest. Phulwary is a good example where a network of streams enhancing water regime in valleys to support better kind of forest. The hill stream present between long 'open tunnel' of two parallel hills provide micro-climate to many ever-green and hygrophilic plant species. Presence of soil cover on such hills again is responsible for creating more congenial conditions for better type of forest. Due to soil cover and good water regime these hills can sustain broad-leaved species like *Mangifera indica, Anogeissus latifolia, Mallotus philippensis, Bridelia retusa, Cissus rependa, Ampelodssus latifolia, Pongamia pinnata* along with xerophytic species. Xerophytes like *Anogeissus pendula, Commiphora wightii, Rhus mysurensis* etc. are totally absent at Kamal Nath, Phulwari and other wet and moist area of Wakal basin. The 'moist hills' are very rich in *Centella asiatica Eulophia ochreata, Leea macrophylla, Habenana digitata, H. marginata, H. farcifera, H. longicorniculata, Nervilia aragoana, Baccopa monneri, Puraria tuberosa* etc. We should take utmost care not to change the hydrology and pedology of hills of Wakal basin.

The "Nal" Forests and accurrence of medicinal plants:

The area present between to long narrow hill chains is locally called as "Nal". The forest present in "Nal" area is always more mesic in nature than the rest area. "Nal-Forest" is protected from two or three side by high hills itself. "Nal Forests" of Rajasthan are rich in medicinal plants, especially in tuberous plants, climbers, lianas and broad-leaved tree species. Generally, a seasonal or perennial stream is also associated with a "Nal". According to availability of moisture level, "Nals" are of three types:

(a) Dry (b) Moist and (c) Wet.

"Nals" of northern and central Aravallis are generally of dry type but in Wakal basin area many "Nals" are of moist and wet nature. Sometime all the three main stages viz., dry, moist and wet and their transitions are seen within the same "Nal". "Nal" forests are rich in medicinal plants as well as in other floral diversity including Bryophytes and Pteridophytes.

Wakal basin is very rich in non-timber forest produce like *Ratanjyot*, *Mahuwa* flower and fruit, *karanj* seed, *safad musali*, wild fruits, *kikoda*, Folk midicines, *palash* leaves and flowers, honey, wax etc. People habitually collect these things from wild for their livlihood. But over collection is affecting existance of many species.

Dwindling numbers of certain species:

There are few plant species whose number is decreasing fast in wild due to biotic pressure. A list of decreasing plants in given below :

Table 2.4 : Plants whose number in dwindling fast in Wakal basin area :

S.no.	Latin name of species	Hindi Name	Causes of decrease
1	*Chlorophytum borivilianum*	Safed Musli	Tuber collection
2.	*Anogeissus latifolia*	Dhawda	Gum collection by putting fire in forest. Green leaves collection for fodder. Use of food for agricultural implements. Over grazing.
3.	*A. sericea* (Plate4)	Indok	Prunning for fodder
4.	*Ficus glomerata*	Gular	Collection of leaves enmass for fodder. Throwing glowing coal in hollow trees to kill and burn them for encroachment for making irrigated agricultural field along river and streams.
5.	*Carrissa spinarum*	Karonda	Fruit collection enmass, cutting of the bushes for making the dry fencing of agriculture fields, massive fruit collection.
6.	*Diospyros melanoxylon*	Timru	Repeated cutting of stem for taking new flush of shoots for more production for *Bidi patta*. Massive collection of unripe fruits for local consumption (Fruits are ripened at house).
7.	*Dalbergia latifolia*	Kali shisham	Trees hacked down for making of house implements.
8.	*Dalbergia volubilis*(Plate 1)	Jai Bel	Habitat loss, dourght
9.	*Gmelina arborea*	Sawan, Hawan	Trees cut down for house making

10.	*Pterocarpus marsupium*	Biya	Tree cut for making legs of cot and house making
11.	*Tectona gradis*	Sag	Young crop is destroyed for making encroachment is foothill and valleys. Wood is also use for house making.
12.	*Adina cordifolia*	Haldu	Wood is used for house and utensil making.
13.	*Centella asiatica*	Manduk Parni	Prolonged drought, habitat loss
14.	*Salix tetrasperma*	Vera	Prolonged drought.
15.	*Sterculia urens*	Kadaya	Collection of seed for eating
16.	*S. villosa*		Use of bark as fibre
17.	*Dendrocalamus strictus*	Bans	House making, fense making, *topla* (basket) making, grazing, soil loss, trampling.
18.	*Porana paniculata*		Stem used as rope for house and fens making, habitat loss
19.	*Firmiana colorata*		Use of bark as fibre, use of wood in making musical instrument
20.	*Ensete superbum*(Plate 4)	Magre kel	Habitat less, drought, overgrazing.
21.	*Ougeinia oogeinsis*	Tanas	Use of wood for plough making, collection of flowers for vegetable
22.	*Bombex ceiba*	Semal	Use of wood in making Holi pyre, sale of wood for this purpose in cities.
23.	*Carvia callosa*		Habitat loss, drought
24.	*Eranthemum roseum*		Habitat loss, drought
25.	*Flamingis brateata*		Habitat loss, drought
26.	*Girardinia zeylanica*		Habitat loss, drought
27.	*Habanaria Spp.*		Habitat loss, drought, trampling, overgrazing, soil loss
28.	*Nervilia aragoana*		Habitat loss, drought, trampling, overgrazing, soil loss
29.	*Hymenodictyon excelsum*	Lunia	Timber for domestic use
30.	*Impatiens balsamina*	Timidia	Habitat loss, drought, trampling, overgrazing, soil loss

31.	*Mangifera indica*	Aam	Drought
32.	*Momordica dioca*	Kikoda	Mass scale unripe fruit collection for vegetable and trade. Desctriction of hedges during road makng and road widening in famin relief woks.
33.	*Pogostemon pubescens*		Hebatat loss, decressing water regime.
34.	*Sapindus laurifolius*	Aritha	Seed collection
35.	*Acacia catechu*	Khair	Grazing, trampling
36.	Terrestrial orchids	-	Habitat loss, soil erosion, grazing, trampling

Commiphora wightii is a red data species which is present at eastern fringe of Wakal basin, which is also decreasing in numbers.

Besides above wild plants, cropping of sugarcane has disappeared from the area. Before 1980, sugarcane was common crop in Panarwa area. Many wild animals of Wakal Basin forests used to take shelter in sugarcane fields. But due to dwindling water table, now irrigation facilities have became unsufficient for cropping of sugarcane.

Once all above species were very common. But now they are dwindling fast. Soil erosion, human disturbances, over grazing, trampling and drought are certain limiting factors which took a heavy toll from above species.

Presence of a soil layer of varying depth on hills of catchment of Wakal river is a remarkable ecological factor. This is responsible for growth and distribution of *Dendrocalamus strictus, Anogeissus latifolia,* Terrestrial orchids, and many tuberous plants like *Curcuma pseudomontana, Arisaema tortuosum, Colocasis esculanta, Sauromatum pedatum, Chlorophytum* spp. etc. If soil get washed away, these species will lost from the catchment area. Regeneration of many of these species is not satisfactory at all.

Northern and western most distribution limits of many peninsular and western ghats species end in catchment of Wakal river. Nothern most distribution limit of teak ends in Sagati near nothern end of Wakal basin area. Hence Wakal catchment is a very important habitat from biogeography point of view. It is habitat's quality, which is responsible for their presence over here. Presence of 5B/8a, $5B/E_9$, $5B/1S_1$, $5A/C_1$ types of forest make Wakal catchment very special. Disturbances in this zone will lead shrinkage in distribution limits of such species towards south. Area upto 25^0N latitude is very sensitive and utmost safety from ecological angle is required.

Species extermination:

Before independence, area was richer than what we have today. Forest was better during those days. Anthropogenic disturbances were less. After independence, due to habitat loss, species extermination has taken place in a wide area and many species are still proceeding towards extermination. Following six species have been locally exterminated so far:

1. Dhole *(Cuon alpinus)*
2. Smooth-coated Otter *(Lutra perspicillata)*
3. Bengal Tiger *(Panthera tigris)*
4. Mouse Deer *(Moschiola meminus)*
5. Sambur (*Rusa unicolor)*
6. Chinkara *(Gazella bennettii)*

Species proceeding towards extermination :

Many speices are proceeding towards extermination. A list of them is as follows:

1. Ratel *(Mellivora capensis)*
2. Sarus cran *(Grus antigone)*
3. Grey Junglefowl *(Gullus soneratti)*
4. Mugger *(Crocodyles palustris)*
5. Indian Sawback Turtle *(Kachuga tecta)*
6. Indian Flap-shall Turtle *(Lissemys punctata)*
7. Star Tortoise *(Geochelone elegons)*
8. Indian Softshell *(Aspideretes gangeticu)*

Natural regeneration status of important plant species:

Though seed production of most of species is good but regeneration is not satisfactory. Area is highly grazing prone and this is a big single factor which takes a heavy tall from natural regeneration. Species like *Acacia catechu* is very grazing sansitive. Certain species are suffering from over fruit collection like *Annona squamosa, Emblica officinalis, Carissa spinarum, Phoenix sylvestris, Madhuca indica.* Since most of seeds are extracted by the human beings hence natural regeneration is badly affected. Unfortunately *Dendrocalamus strictus* is not regenerating in forests now naturally. Soil erosion, grazing trempling and opening in canopy are responsible for this.

High occurance of *Ficus* species and forest epiphytes:

Plant epiphyte is a plant growing on, but not nourished by another plant. Wakal Basin is rich in forest epiphytes. *Ficus* spp., orchids and *Tinospora cordifolia* are main epiphytes of Wakal basin. State's major orchid zone is present in Wakal basin. Northern most distribution limit of epiphytic orchids of state culminates in Wakal basin. (Fig. 9)

Some important epiphytic plants of Wakal Basin are giving below:

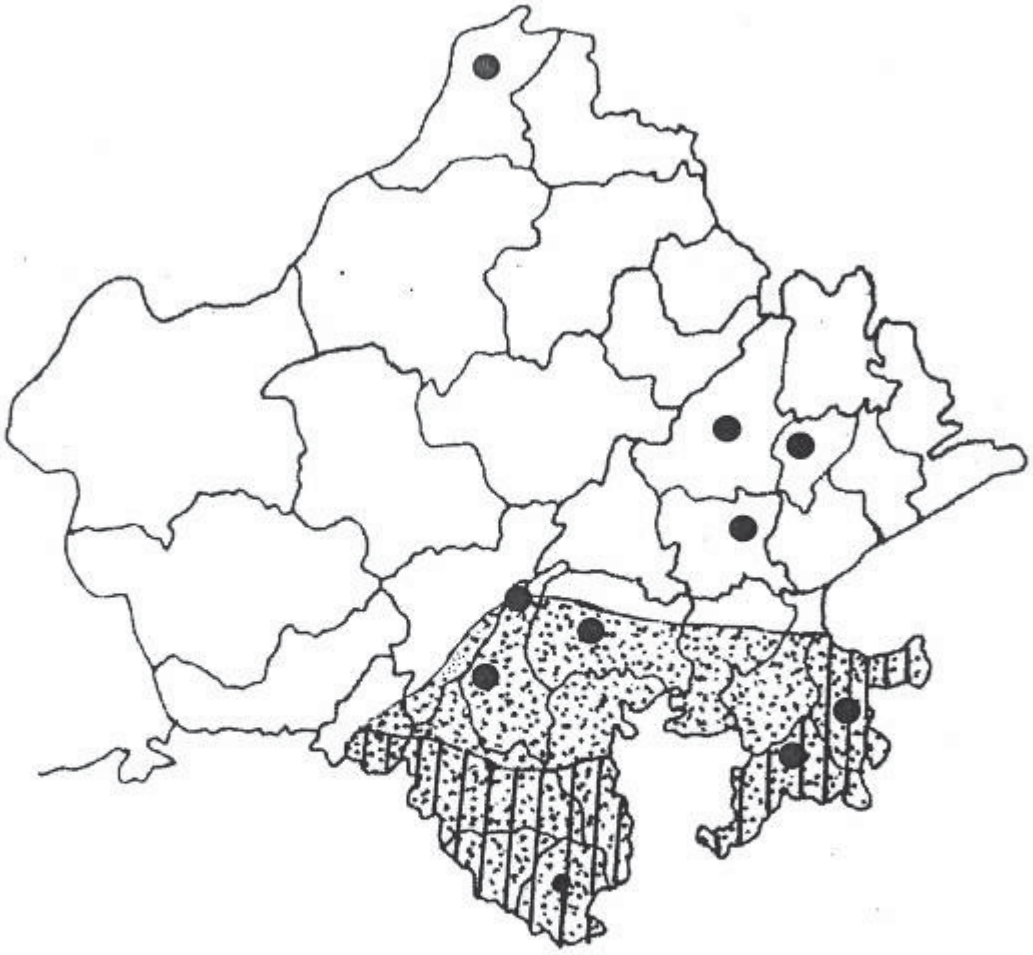
Table 2.5 : Ephiphytes of Wakal Basin

S. no	Name of Species	Habit	Family	Main hosts
1.	*Ficus benghalensis*	Tree	Moraceae	*Phoenix sylvestris, Butea monosperma*
2.	*F. religiosa*	Tree	Moraceae	*Phoenix sylvestris, Butea monosperma*
3.	*F. virens*	Tree	Moraceae	*Phoenix sylvestris, Butea monosperma*
4.	*F. amplisima*	Tree	Moraceae	*Phoenix sylvestris, Butea monosperma*
5.	*Vanda tessellata*	Herb	Orchidaceae	*Madhuca indica*
6.	*Aerides crispum*	Herb	Orchidaceae	*Madhuca indica*
7.	*Acampe praemosa*	Herb	Orchidaceae	*Madhuca indica*
8.	*Tinospora cordifolia*	Climber	Menispermaceae	*Hedges* and various trees

Ficus benghalensis and *F. religiosa* sometimes attain such huge sizes that the trees on which they grow, are completely covered and ultimately killed.

Many grasses show epiphytic nature at Mt. Abu Wildlife Sanctuary a area very close to Wakal basin. Grasses grow on thick horizontal and semi-horizontal branches of many trees there. They also grow on rough trunk of *Phoenix sylvestris*. This phenomenon is absent in Wakal Basin area.

DISTRIBUTION OF ORCHIDS IN RAJASTHAN



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●	***Zeuxine strateumatica*** **recorded**
|||	**Zone where epiphytic orchids are present**
⁘	**Zone where terrestrial orchids are present** (except *Zeuxine strateumatica*)

Fig. 9

To know the status of epiphytism in Wakal basin an area of approximately 5.65 ha was surveyed as follows:

* From Ambasa to Daiya: 10 km x 50 m = 0.5 sqkm
* From Kotra to Som Ghata: 37 km x 50 m = 1.85 sqkm
* From Panarwa to Birothi: 15 km x 50 m = 0.75 sqkm
* From Dhedmariya Naka to Dhovaniya Kund: 5 km x 50 m = 0.25 sqkm
* From Panarwa to Daiya: 20 km x 50 m = 1.0 sqkm
* From Kotra to Mamer: 26 km x 50 m = 1.3 sqkm

The trends of epiphytism in Wakal basin are given below.

Table 2.6: Trends of epiphytism in Wakal basin

S. no.	Host	Epiphyte	Number of cases observed
1.	*Mangifera indica*	*Ficus benghalensis*	1
2.	*Ficus benghalensis*	*Capparis sepiaria*	1
3.	*Ficus benghalensis*	*Ficus virens*	1
4.	*Ficus benghalensis*	*Lannea coromandelica*	1
5.	*Zizyphus mauritiana*	*F. benghalensis*	3
6.	*Zizyphus mauritiana*	*F. religiosa*	2
7.	*Zizyphus mauritiana*	*F. carica*	2
8.	*Butea monosperma*	*F. religiosa*	28
9.	*Butea monosperma*	*F. benghalensis*	21
10.	*Butea monosperma*	*Adhatoda zeylanica*	1
11.	*Butia mmrspena*	*F. virens*	4
12.	*Butea monosperma*	*Holoptelia integrifolia*	1
13.	*Butea monosperma*	*H. intquifolia and Ficus virens*	1
14.	*Butea monosperma*	*F. hispida*	1
15.	*Butea monosperma*	*F. carica*	3
16.	*Butea monosperma*	*Girandinia zeylanica*	1
17.	*Butea monosperma*	*Casearia elliptica*	1
18.	*Butea monosperma*	*Lannea coromandelica*	1
19.	*Butea monosperma*	*F. glomerata racemosa*	1
20.	*Adina cordifolia*	*Ficus benghalensis*	7
21.	*Adina cordifolia*	*Ficus religiosa*	1
22.	*Adina cordifolia*	*Adhatoda zeylanica*	1

23.	*Adina cordifolia*	*Phoenix sylvestis*	1
24.	*Madhuca indica*	*F. benghalensis*	20
25.	*Madhuca indica*	*F. religiosa*	4
26.	*Terminalia bellerica*	*F. benghalensis*	1
27.	*Pongamia pinnata*	*F. religiosa*	5
28.	*Pongamia pinnata*	*F. benghalensis*	2
29.	*Pongamia pinnata*	*F. carica*	1
30.	*Ficus religiosa*	*F. religiosa*	1
31.	*Anogeissus latifolia*	*F. benghalensis*	1
32.	*Wrightia tinctoria*	*Ficus religiosa*	4
33.	*Wrightia tinctoria*	*F. benghalensis*	1
34.	*Wrightia tinctoria*	*F. virens*	1
35.	*Holoptelia integrifolia*	*F. religiosa*	1
36.	*Mitragyna parviflora*	*F. benghalensis*	1
37.	*Mitragyna parviflora*	*F. virens*	1
38.	*Albizia procera*	*F. benghalensis*	1
39.	*Ficus racemosa*	*Capparis sepiaria*	1
40.	*Syzygium heyneanum*	*F. benghalensis*	10
41.	*Phoenix sylvestris*	*F. religiosa*	21
42	*Phoenix sylvestris*	*F. benghalensis*	10
43.	*Phoenix sylvestris*	*F. hispida*	1
44.	*Phoenix sylvestris*	*F. carica*	1
45.	*Phoenix sylvestris*	*Kirganalia reticulata*	2
46.	*Emblica officinalis*	*Sauromatum pedatum*	1

A synoptical overview of epiphytism in Wakal Basin is presented below

Table 2.7: Synoptical overview of epiphytism in Wakal basin

S. no.	Name of host	Number of species of epiphytes grow on host	Total no of infested hosts
1.	*Butea monosperma*	12	64
2.	*Phoenix sylvestris*	5	35
3.	*Adina cordifolia*	4	10
4.	*Ficus benghalensis*	3	3
5.	*Zizyphus mauritiana*	3	7
6.	*Pongamia pinnata*	3	8

7.	*Wrightia tinctoria*	3	6
8.	*Madhuca indica*	2	24
9.	*Mitragyna parviflora*	2	2
10.	*Mangifera indica*	1	1
11.	*Terminalia bellerica*	1	1
12.	*Ficus religiosa*	1	1
13.	*Anogeissus latifolia*	1	1
14.	*Holoptelia integrifolia*	1	1
15.	*Albigia procera*	1	1
16.	*Ficus recemosa*	1	1
17.	*Syzygium heyneanum*	1	10
18.	*Emblica officinalis*	1	1
	Total 18	15 (See table below)	177

Table 2.8: Synoptical overview of epiphytism in Wakal basin

S. no.	Genus	Species having epiphytic nature
1.	*Ficus*	6
2.	*Adhatoda*	1
3.	*Cappris*	1
4.	*Caseria*	1
5.	*Girardiania*	1
6.	*Holoptelia*	1
7.	*Kirganalia*	1
8.	*Lannea*	1
9.	*Phoenix*	1
10.	*Sauromatum*	1
	Total	15

Butea monosperma and *Phoenix sylvestris*, are important host species to harbour the non-orchid epiphytes(Plate-2). Notches, made for gum extraction on trunk of *Butea monosperma* provide easy entry to rain water, which lead decay. Sometimes this portion develop a hollowness during old age of the tree. Epiphytes grows in these hollows snugly. Hollowness in dicot trees appear due to disintigration of pith zone which is utilized by the epiphytes to grow. Monocot trees like *Phoenix sylvestris* harbour epiphytes in its basal stilt root zone and on trunk among ramnants of leafbases. Only those monocot trees like *Pheonix silvestris* harbour epiphytes on trunks which have rough surface. Smooth trunked monocot trees like coconut, bottle palm etc (which are grown as ornamental plants). does not harbour epiphytes on surface of trunk as they provide poor enchoring facility to the epiphytes.

Ficus epiphytes send their roots downward to make contact with soil. Root travers either through hollowness of branches and stem of the host or on sten surface. Hollowness in stem generally does not occur in monocot trees hence root travelling occurs on surface of trunk only.

Epiphyte grows on body of host in various ways like:

* By encircling (Plate 2)
* By spiralling
* By netting
* By penentration through hollows or weak portions
* By surface travelling

Stilt root in butt zone of *Phoenix sylvestris* provides suitable site to *Ficus benghalensis* and *F. religiosa*. Forks of old trees like *Albizia procera* and *Madhuca indica* provide wantage points to epiphytes. Craks on rough bark of *Madhuca indica, Zizyphus mauritiana* etc. provide suitable substratum to epiphytes. Vertical folds present on stem of *Wrightia tinctoria* prove good to epiphytes. Hollows of old trees like *Butea monosperma, Adina cordifolia, Madhuca indica* etc. provide suitable space for epiphytes. Many cuts and wounds are generally seen on stem of *Butea monosperma* in wild. This hardy tree has great capacity to bear these mechanical injuries. In old age, many cuts and wounds take shape of hollows. Cuts, notches, wounds and hollows of stem of *Butea monosperma* are the best site for epiphytes. When, transverse section of stem of old fallen trees of *Ficus benghalensis* and *F. religiosa* are studied, stem of their host can be seen embaded inside stem of epiphyte.

Maximum epiphytes seen on *Butea monosperma* and *Phoenix sylvestris* in Wakal basin area. As far as *P. sylvestris* is concerned, besides butt zone, persistant leaf bases and fibrous covering near growing tip provide good sites to *Ficus benghalensis* and *F. religiosa.* In Wakal basin area, conservation of *Butea monosperma* and *Phoenix sylvestris* is must because existance of *Ficus beghalensis* and *F. religiosa* is depend on them.

Epiphytes generally remains absent on upper half of tall *Phoenix sylvestris* trees because they have less roughness owing to absence of permanent leaf bases while they remains present on lower half of stem for long time.

Sometime multiple epiphytism is seen in Wakal basin zone. More than one species of epiphytes can be seen growing on single host. Hyper-epiphytism is also seen in Wakal basin. An epiphytes can grow on body of another epiphyte also.

Ficus racemosa, F. carica and *F. hispida* are "poor" epiphytes then *F. benhalensis, F. religiousa* and *F. virens* in Wakal Basin Wildlife Sanctuary.

Importance of epiphytes in Wakal basin

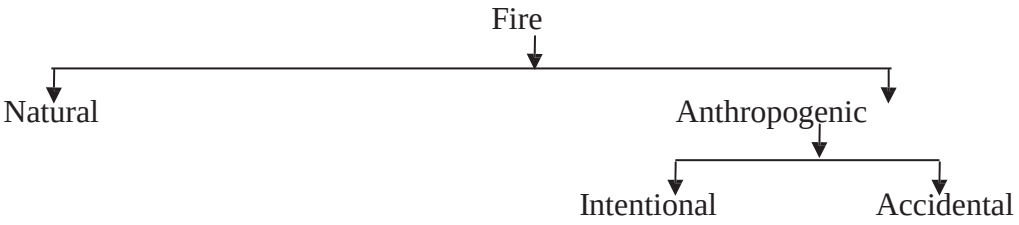
Epiphytes are very important from Wildlife point of view. Many frugivorous and folivorous animals and birds, like Barbets, Green pegions, Hornbills, Sloth bears, Hanuman langurs, Squirrels, Flying Foxes etc. use fruit of *Ficus* spp. as food. Flying Foxes eat leaves of *Ficus* spp. Five-striped Palm Squirels lightly gnaw the basal portion of mid-rib towards lower side of leaf and lick latex for food.

Forest Fire:

Being deciduous nature, forests of Wakal Basin are prone to fire (Plate 5). From mid winter to early summer i.e. December to March, leaf fall occurs in the area, which is more prominant towards upper reaches and hill slopes. Fire season starts from April and goes on till June upto pre-monsoon showers. In Wakal basin, fire is of 'ground fire' type. Besides fallen leaves and other slash, dried forest grasses, specially the *Apluda mutica* catches fire.

Type of Fire in Wakal Basin:

Fires in Wakal Basin are of following types:



Causes of different type of fire:

Following are the sources of fire in Wakal Basin from where fire can be crept in the forest:

Natural fire

- Rolling Stones (very rare)

Intentional fire

- Bolma (sort of worship)
- Clearing of ground to encroach the forest land for agriculture purpose
- Fumigation befor honey collection to ward of the bees
- To detection the presence of honey bees in hollows of trees, fire in thrown in hollows
- Sometime forest is burnt intentionally to have new growth of grasses to graze the domestic animals

- To take revenge form enemy, tribals use fire as weapon to burn house or husk dump or barn or gathered fuel wood of enemy
- If a snake is present in the pile of grass or slash, fire is ignited to kill the serpent.
- After harvesting Rabi crop, residue is bernt in the fields.
- During summers tile for roof making are burnt

Accidental fire

- Fallen leaves below crown of Mahua are burnt by the tribles to clear ground below Mahuwa tree for collection of Mahuwa flower. Unattended fire may cause hazard.
- Burnt cigarettes and *biris* are thrown along the road side by the passengers passing through the sanctuary. Often thrown cigarettes and *biris* fall on the dry leaves and catch fire.
- While passing throw the forest during night period, camp fire is made by the triblas to keep off the wild animals. During winters, to get rid of coldness, the camp fire is also made. Someting unattended camp fire spreads in the forest
- The fires are caused due to negligence of right holder living inside the forests.

During festivities of *bolma*, a red *odhni*, is offered to the *magra ba*vsi (god of hill and forests). The red *odhni* is nothing but "fire" -a symbol of odhni, which is set in the surrounding forest of *magra bavsi*. Most of trees are quite fire hardy in local forest but *magara pooja* takes toll from insects, nestlings, reptiles and new regeneration of certain species. Nests and eggs, especially which are present on ground and low bushes are destroyed. Dried grass also burnt to ash and herbivorous face food scarcity.

Obonxious Weeds:

Most important weeds of Wakal Basin is *Lantana camara*. It is colonizing forest areas near Ubheshwar, Ogna, Khokhariya-ki-Nal, Deola, Panarwa and Birothi. Its another related species *L. wighitana* in totally absent from Wakal basin area, while it is commonly present in many forest areas of Southern Rajasthan.

Important weeds of Wakal Basin area as following :

Table 2.9: Important weeds of Wakal basin area

S.No.	Name of Weeds	Family	Areas highly infested
1.	*Lantana camara*	Verbenaceae	Panarwa, Birothi, Ubheshwar, Gogunda, Kokhariya-ki-Nal, Gotmeshwar
2.	*Parthenium hysterophorus*	Esteraceae	Road sides, Kotra, Panarwa, Mamer, Jhadol
3.	*Acanthospermum hispidum*	Esteraceae	Common in all forest blocks and grassland
4.	*Prosopis juliflora*	Fabaceae	Only few specimens seen here and there.

P. juliflora is relatevily absent from the Wakal basin. Continuous vigil is necessary to monitor this species to check its entry and spread in the sanctuary.

Box-2 Some more issues

1. Wakal Basin is dominated by the tribal. Their houses are *kachcha* with mud wall and tile roofing. Now concept of *pucca* house is emerging with stonewall and concreat roof. This change is enhenceing stone and sand mining in the area.
2. Massive fishing is done by the tribals in the waterbodies durring summers and may fish poisons are used for this activty. Many non-targeted aquatic animals are also killed during fishing.
3. Zone is prone for snake bites. Majority of human population is ophidiophobic. Besides brown-coloured snakes like rat snakes and fresh water snakes, no other snake is spared.
4. Brown coloured snakes have totemic status and spared by Bhuria Clan of Bhils and Kothodis.
5. Different Bhil Clans have their totemic plants, which are generally spared by them.
6. To perform *Bolma*, fire is set in the forest by the tribals during summers. This is a regular features of forest burning in the area.
7. Saffron sprinkling is a common practice in the area to save the forest. Saffron or *Keshar* is brought from Keshariya ji, (a famous pilgrim spot of southern Rajasthan), crushed in water the then sprinkled over the forest. This is the method of puting social bane against anthropogenic damages to the forest.
8. Grasslands are facing degradation in the area.
9. Canopy density in decreasing in the forest.
10. Heavy casualty of amphibians is seen on the roads during rainy season. Breeding of amphibians is not satisfactory. Population of amphibians is decreasing fast. This is affecting may food chains of Wakal basin ecosystem.
11. Many natural heritage like endemic species, *tornas* (natural opening in the hills), giant trees and lianas of the state, gorges, springs, waterfalls etc. are present here and there in this zone. Maintenance of most of them is very poor and they are facing severe degradation.
12. Three endamic centres are there in Rajasthan, namely, Thar, Mt. Abu & South-eastern Rajasthan. Wakal basin is a pro-runner of Mt. Abu endamic centres hence it need protection.

CHAPTER- 3: RECOMMENDATIONS

Ecological Problems of Wakal Basin

Study reveals that degredation is going on in Wakal basin area. Forests of catchment are highly under pressure. Over grazing is a major problem in the area. During summer season, fires are commonly seen in many pockets of basin. Tribles living inside forset areas are also responsible for many negative activites. For example Kathodi habitually kills langurs for flesh and hide (Plate-7). They use iron snare to capture the langurs. Snares are placed on trees and langurs are forcefully directed towards "equiped trees". Killing of langurs is affecting population of leopards.

Various types of fish poison are used by the tribles for fishing in stagnated water of *darrahs*. Tree cover is day by day diwindling in the catchment. Slowly chemicals are entering in the agircultural practicies of the area. Poision treated grains are used for sowing, which sometime kills the wild birds. Overgrazing is a big problem for regeneration of forest in the catchment zone. Fragmentation of forest cover is going on which is enhencing inbreeding in wild animals. Over collection of seeds/fruit of certain species is affecting regeneration of many species. In nutshell there are certain problems which are listed below (Plate 6-7):

Problems being faced by the flora:

- Decreasing in forest cover
- Over collection of fruits (which left little seeds for natural regeneration)
- Enormous domestic use of wood
- Mssive seed/fruit collection of certain speacies
- Poor natural regeneration
- Decreasing water regine

Problems being faced by the fauna:

- Use of pesticides increasing
- Wells without perapet wall
- Animal trampling and hunting
- Disturbed basking zone of crocodiles
- Destruction of reeds by domestic cattle
- Electrocution
- Waterholes sharing both by domestic and wild animals

- Road trampling
- Fragmentation of forest cover
- Use of fish poison for wanton fishing.

Problems being faced both by fauna & flora:

- Increasing human and bovine population
- Encrochment in wide valleys
- Extension of agricutural
- Overgrazing and trampling
- Soil erosion
- Fire hazard
- Habitat loss
- Unemployment, lack of education and awareness
- Loss of riverine strips
- Degradation of grassland
- Practice of *Neera* collection though decreasing in the area but this practice is affecting population of *Phoenix sylvestris*.

Recommendation for welfare and restoration of Biota:

Though there are problems in the area but after adopting certain prophyletic and curative measure, we can restore the ecological condition of Wakal river basin. Reforestration, soil and moisture conservation and *insitu* forest and grassland conservation can be some reliable measures. Periodic monitoring of the situation is also necessory. Public awareness is the need of the hours. There are certain measures, which can be applied in the basin area for ecorestoration:

1. Catchment forest cover of Wakal River should be protected. Sufficient soil and moisture conservation works are needed in catchments without damaging and disturbing the drainage system.

   Gap planting/sowing of indigenous species is recommended. Proper species selection, timely planting and sowing, effective after care, public participation

are few tools for the success of afforestation/reforestation activties. Three tier planting (plating of trees, shrubs and herbs) in necessary in Wakal basin to save biodiversity of the area. Advance closure technique is good for Wakal basin becouse root stock is still in better condition in most of the basin area.

Protection of grasslands is required in whole basin area. Check on over fruit collection is necessary to promote natural regeneration in the basin zone. rotection of *Butea monosperma* and *Phoenix sylvestris* is nacessary to ensure survival of *Ficus* spp. Wakal basin has state's maximum number of *Ficus* spp. qualitatively and quantitatively. Ficus are considered as umbrella tree, which supports survival of wide range of wild animals.

2. Protection of wet and moist streams is necessary because they act as natural fire lines. If dryness decreases these natural fire lines will collapse and fire hazards will increase.
3. Human and bovine population growth is depleting the biotic resource of the basin area. It leads habitat alteration and habitat loss, which ultimately leads species loss. Hence, a check on anthropogenic disturbances in needed.
4. Roads are generally manufactured parallel to streams. This may spoil water hole quality of the streams. Roads, parallel to streams are much prone for trampling and poaching.
5. A breeding centre of Hare, Grey partridge, Quails should be started. Farm breed animals should be released in the basin area to increase food supply quickly and easily. This will help to restore the brocken food chains.
6. Fire control measure should be enhanced.
7. Corridor between Phulwari and Balaram Ambaji and Jossore basin area should be developed and protected. Similarly, corridor between Phulwari and Kumbhalgarh need protection. If we fail doing so, incidence of inbreeding will increase.
8. Electric lines should be under ground in animal rich areas to minimize danger of electrocution.
9. Forest around springs, stream curves, waterfalls should be fully protected.
10. Narrow valley are very rich is plant diversity. They need intensive protection

11. Bank vegetation of Wakal river and other streams need protection.

12. *Carissa spinarum* bushes are ruthlessly cut down and used as fencing matrial in agricultural fields. This bush need full protection becouse survival of many wild animal speices depand on it. New bushes should be developed in foothill areas.

13. Tube well and traditional well digging be discouraged. Extraction of underground water will change the moisture regime of the upper strata of soil and hydrophilic and mesophytic species will suffer from physical scarcity of the water. This will affect phenology and composition of forests, especially in valleys and along streams.

14. Kathodis are very keen of eating langurs. Langur is a food of Panthers. Langur protection means leopard protection, hence awareness among Kathodis is necessary to protect the panthers.

15. A continuous vigil is necessary on spread of weeds like *Lantana camara, Prosopis juliflora, Acanthospermum hispidum, Xanthium indicum and Parthenium hysterophorus*.

16. Dams and anicuts are newer in the area, which are free from aquatic weeds. Atmost care should be taken to keep them away.

17. Parpet wall are needed on all the wells and tanks to impose a check on stumbling of wild animals

18. Around 99 percent tribal huts are *kachcha* type at present. In future, modern *puckka* housing is likely to be introduced. In such situation, a heavy demand for masonry stone will arise, which will probably initiate illegal mining and quarrying in the sanctuary area. At the same time, illegal sand mining will be also started.

19. Employment, education and awareness enmass is very nacessary.

Recommendation for welfare of tribals :

1. Life of tribals depend on biotic resource of basin area hence awareness in tribal folk is necessary to conserve the biotic resources.

2. Tribals collect immature fruits of *Jatropha curcas* and *Annona squamosa.* This practice is very harmful for tribal economy. By collecting mature fruits of

these species, production can be enhanced from same number of plants. High yielding *Annona* (Sitaphal) can be introduced in the area.

3. Tribals sale their product at low price in raw form. By value addition process, their products can be made profitable. But this needs serious research and efforts.

4. Tribals grow maize, wheat etc. in their holdings. The area is much suitable for fruit and vegetables. Fruit and vegetable cultivation is more profitable for them.

5. Kikoda *(Momordica dioica)* fruits are collected from wild. Its cultivation is very easy. Agriculture of *M. dioica* and *Coccinia grandis* should be promoted to uplift the economic condition of the cultivaters.

6. Cucurbitacious vegetable can be grown in rainy season near farm hedges as well as near wild bushes without involving much cost and labour.

7. Backyard poultry is more profitable then goatry in and Wakal basin area in terms of ecology. Hence, backyard poultry should be promoted to meet out the protein and 'Shikar' demand of the tribals vis-a-vis to minimize the brousing damage which is caused by goatry.

8. Big anicuts and dams can be utilized for growing of *Trapa nutans* and *Nelumbo nucifera*. Both species can yield salable product to the tribals.

9. Grass resource should be properly utilized. Area is famous for *Heteropogon contortus* and *Apluda mutica* production. Since fodder is easily available from forest, hence fodder value of grasses is least respected. Grass is not extracted in most of the forests and plantations, which becomes a cause of fire hazard. Proper planning for grass resource may prove beneficial to tribals. Instead of open grazing, cut and carry system should be adopted for grass harvesting. This should be done around villages only. It will help to reduce fire hazards. Grass of inner zone should be left for wild animals.

10. Area is very suitable for cultivation of tuberous crops. Scientific cultivation of *Suran*, Turmeric, Zinger, *Arvi*, *Ratalu* etc. can change economy of area. Instead going for maize cultivation, tuberous crop cultivation prove more economical. Area is good for rain fed chili cultivation. By developing proper

storing facility and value addition process more benefit can be given to the tribals.

11. Area is good for pulse cultivation like *Mung*, *Chawla*, *Toor* and *Urd*. Generally insecticide and chemical manure are not utilized in many pockets of the basin. Thus agricultural product is quite close to highly priced organic product in such localities. Proper certification, packaging and publicity can give more prices to tribals.

12. Area has potential for Eco-tourism and farm - tourism. Serious efforts can open this avenue. A package tour of Mt. Abu, Ambaji, Phulwari and Udaipur can attract tourist inflow. However, before starting this, attention should be given on development of basic facilities.

13. Cattle are status symbol in tribal community. However, large numbers of cattle are unproductive and they take heavy toll of forest resource. Productive cattle in less number are more economical for tribals. Animal husbandry should be eco-friendly in this zone.

14. Broom making raw material like *Khajur* leaves and *Eremopogon foveolatus* are available in bulk. This raw material is sold to neighboring states on cheaper rates. This resource should be fully utilized. But plastic brooms are hard competitor now.

15. Area is high drainage density zone. Streams are much suitable for Jamun and Karanj *(Pongamia pinnata)* cultivation. Both species can be grown on banks of streams for betterment of tribals.

16. Mahuwa regeneration in agriculture field is poor. Whole seed is extracted to sale. Planting of Mahuwa should be promoted in private land so that second and third generation of mahuwa get ready for production in coming years.

17. Marketing of certain wild fruits like *Carissa spinarum*, *Phoenix sylvestris*, *Diospyros melanoxylon*, *Ziziphus mauritiana*, *Syzygium heyneanum* can open new avenus of income regeneration.

18. Gas connection can decrease dependence of tribals on forest for fuel wood. Saving of fuel wood means saving of forest. Since purchasing capacity of tribals is poor hence supply should be subsidized.

Threats are there for existence of Wakal and its tributaries. Anthropogenic disturbances, including increasing network of roads, fire hazard, electrification activities, soil erosion, damage to catchment vegetation cover, road construction, and antipathy against wild animals are important negative factor which are damaging biotic resource of Wakal basin. Periodic studies are a must to judge the trends of breeding of wild animals, food availability, and eco-health of habitats, hydrology of area and role of people living inside and at the periphery of the basin area.

Conservation measures for medicinal plants

1. Little knowledge is available about status, local extraction and trade trends of medicinal plants. Hence emphasis hould be given on these aspects to bridge the gaps. A base live survey about status of different species is must for periodic evaluation and monitoring of the situation in future.
2. Many individuals and institute, NGOs are working in isolation. Continuous networking in necessary among different agencies.
3. Continuous intensive and extensive insitu habitat conservation measures are needed in medicinal species rich forests.
4. Medicinal plant garden should be established an at places for *ex-situ* conservation and to promote the extension activities.
5. A public awareness campaign in necessary to protect the medicinal plants in wild. Village Forest Protection and Management Committees (VFPMCs) can prove good in this work.
6. Agricultrization of certain species should be promoted to minimize pressure on forests. There is a great scope in this field. Scientific agriculture of certain medicinal species can uplift the socio-economic status of many families of rural areas.
7. Negative factors, responsible for decrease and destruction of medicinal plants in nature should be identified, analyzed and suitable measures should be adopted to minimize them. Our target should be forests, fallow lands, grasslands and all other known habitats.
8. Massive destructive harvesting should be discouraged.

Restoration of *darrahs* : Since *darrahs* are important ecological sites hence they need protection for welfare of public, pets and wild animals. There are certain recommendations for restoration as following:

- Catchment protection by intenstive and extensive soil and moisture conservation works and *insitu* conservation of vegetation cover.
- Regulation of irrigation activites along banks
- Check on use of fish poisons
- Awareness in public

BOX 3

FEW TRENDS IN WAKAL BASIN AREA

1. Forest cover is shrinking.
2. Canopy density is decreasing.
3. Grasslands are disappearing.
4. Water regime is decreasing.
5. Stage-horning is appearing in mesophytic plants like mangos.
6. Perennaility of streams is decreasing
7. Water spread in darrahs is shrinking.
8. Ecology of springs, curves, valleys, waterfalls, outskirts of fores and grasslands is changing.
9. Envassive weeds are penetrating in fresh areas.
10. Human – wild animal conflict is increasing.
11. Reeds are disappearing.

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PLATE 1 :FOREST COVER TYPES IN PHULWARI Kl NAL WLS

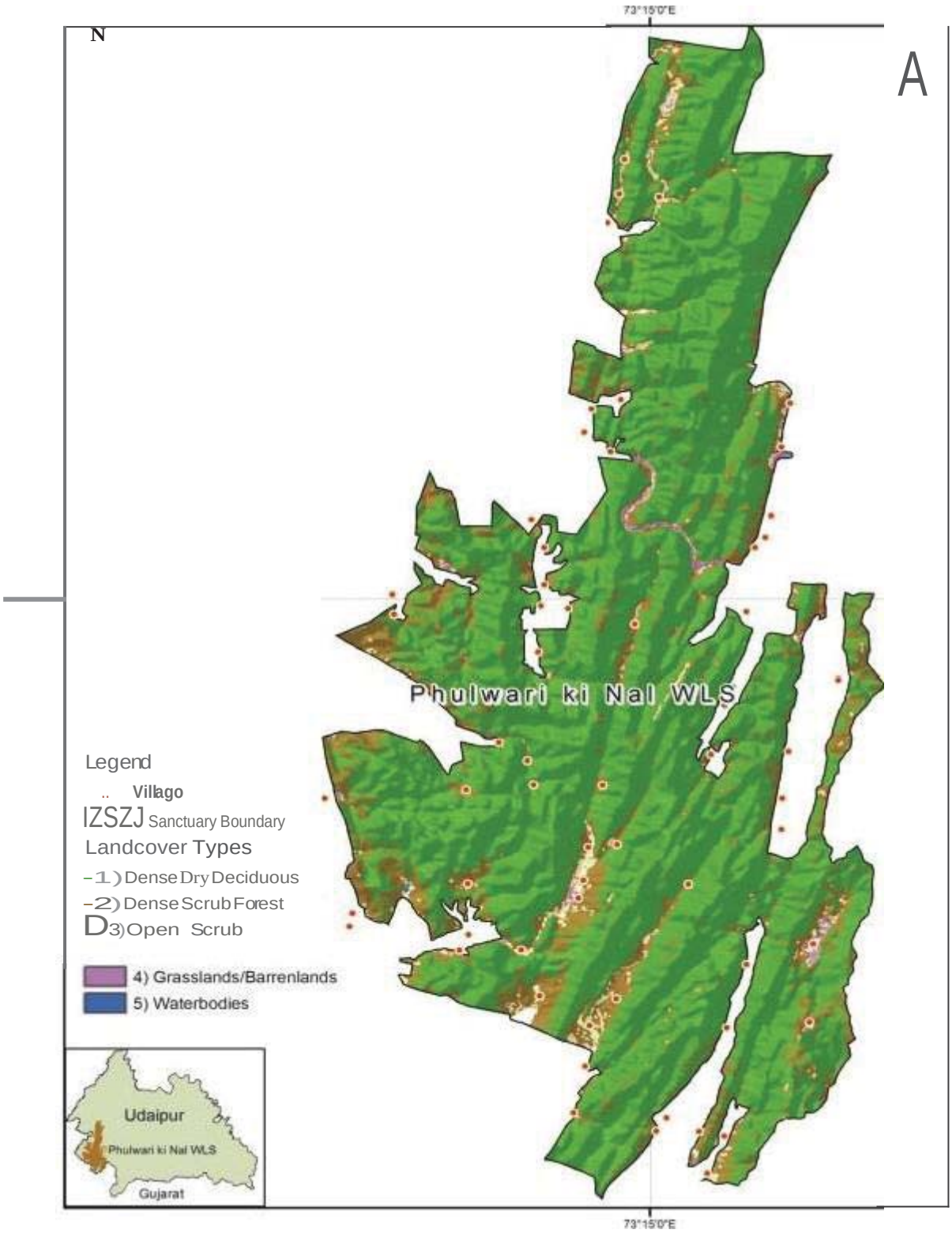


PLATE 2 : PRESENCE OF LIANAS AND EPIPHYTES IS A FEATURE OF GOOD FOREST

(A) *Ce/astrus panicu/ata* (B) *Da/bargia vou/ubilis*
(C) *Ficus banghalensis* growing as an epiphyte on a forked stem of *Butea monosperma*
(D) *Ficus re/igiosa* encircling a *Phoenix* sy/vestis as epiphyte

PLATE 3 : FAUNAL DIVERSITY

(A) Isabellina whip snake {B) Large Brown Flying Squirrel (C) Painted Francolin (D) Russell's Viper
(E) Indan Softshell Turtle (F) Brahminy Kite (G) Slender Racer Snake
(H) Dropping of Yellow-footed Green Pigeon • agent of seeds despersal (I) Indian Pangolin

PLATE 4 : FLORAL DIVERSITY

Costus speciosus

Acampe praemorsa

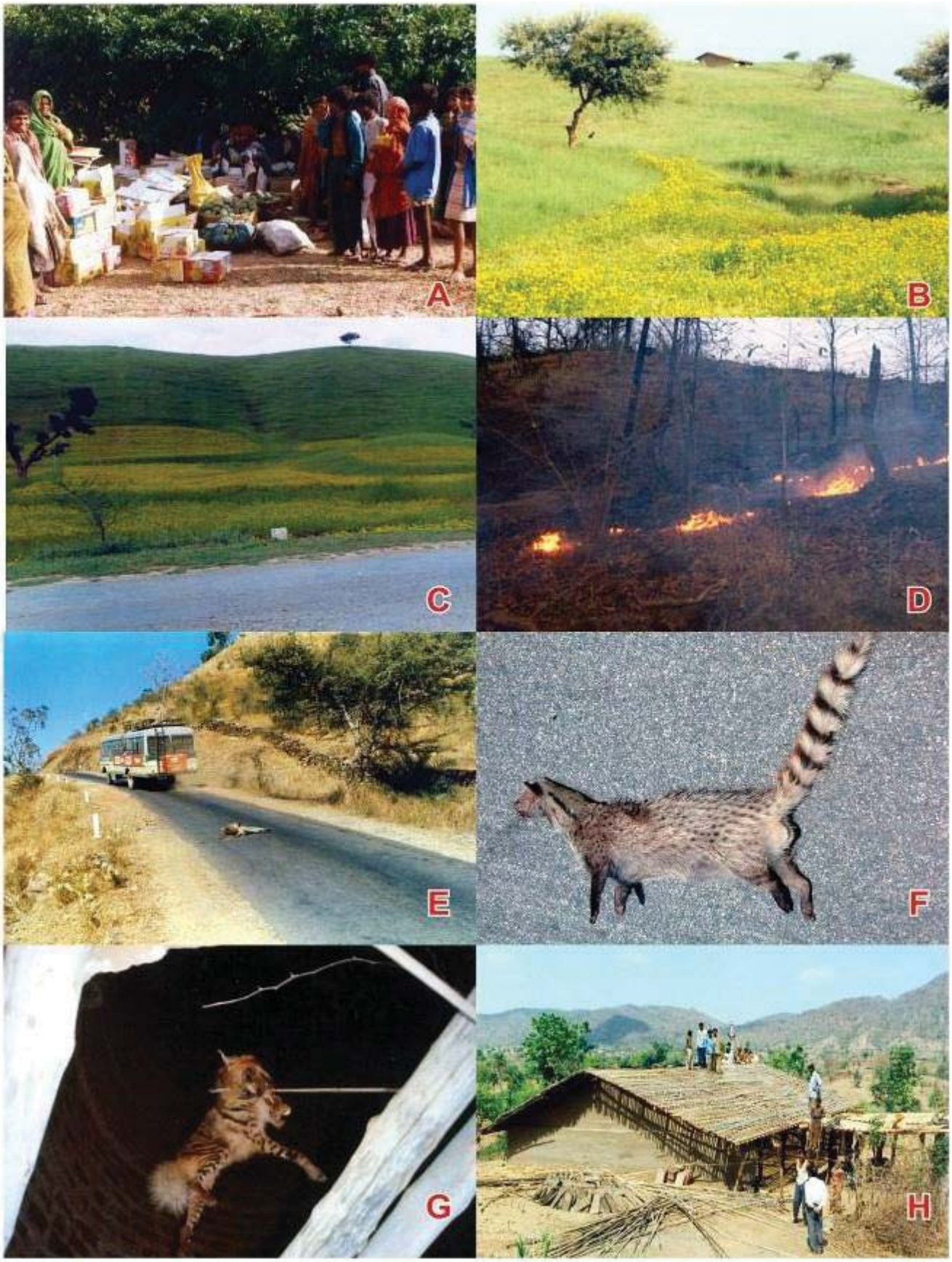
Aerides crispum

Butea monosperma var. *lutea*

PLACE 5 : FLORAL DIVERSITY

(A) *Anogeissus sericea* (B) *Ensete superbum*
(C) Largest *Ficus benghalensis* tree of Rajasthan state is present near Madri village
(D) River *curve* lag

PLATE 6 ECOLOGICAL PROBLEMS OF BASIN AREA



(A) Over fruit collections (B) Destruction of forests on hill slopes for agriculture (C) Destruction of Grasslands for agricultural (D) Fire is used as a tool for encroachment (E) Road accidents take heavy toll from wild animals (F) Victim of road accident (G) Wells without perapet wall take heavy toll from wild animals (H) Over use of wood cause destruction of forest

PLATE 7 ECOLOGICAL PROBLEMS OF BASIN AREA

(A) Kathodi use iron snare to capture the langurs (B) Fate of captured langurs (C) Destruction of forest (D) Destruction of forest (E) Wild animal trade (F) Effect of poisoned grains (G) Effect of poisoned grains (H) Safe basking areas are not available for Crocodiles (I) Probably last tiger of Phulwari Sanctuary (1960)

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