The Vegetation of Baroda and Environs

The area under study displays a remarkable diversity of floristic composition, although it is a part of a thickly populated and highly industrialised region of Gujarat. Most of the land has either been brought under the plough or used for construction of roads, factories and residential buildings with the result that the natural vegetation has become conspicuous by its absence and is present only in the form of a few relict communities in the remotest and comparatively inaccessible corners. The ravines at Bhimpura and Vasad present a biotic climax of ravine thorn forests, differing to a certain extent in their floristic composition.

In such a biotically disturbed area, the weed flora of the cultivated fields, waste land or ruderal flora, the hedge flora occupy position of prime importance and easily form the most conspicuous aspect of vegetation. With more and more of land utilization, an absolute change in the existing vegetational pattern of the area is clearly indicated in the mot too distant future.

I. The vegetation of ravines:

The vegetation of the ravines formed by river Mahi at Vasad and Meni at Bhimpura is a characteristic example of retrogression due to severe denudation, erosion and the ever present biotic factors like grazing, felling of trees for fuel etc. The ground is usually broken as a result of gully erosion of unconsolidated soils.

The low forests occupying the area may be designated as ravine thorn forests, which form a subgroup of tropical thorn forests according to Champion and Seth (1964, pre-publication copy). Such forests are widely distributed in the arid and semi-arid zones of the earth where the total rainfall ranges from 50-100 cm. The vegetation here consists of widely-spaced, dominant, armed, drought-resisting trees and shrubs presenting on the whole a very open appearance. It has also two aspects (i) permanent vegetation of low trees and shrubs present throughout the year and (ii) seasonal aspect of temporary vegetation consisting of low, annual herbs growing mainly during the short spell of rains every year.

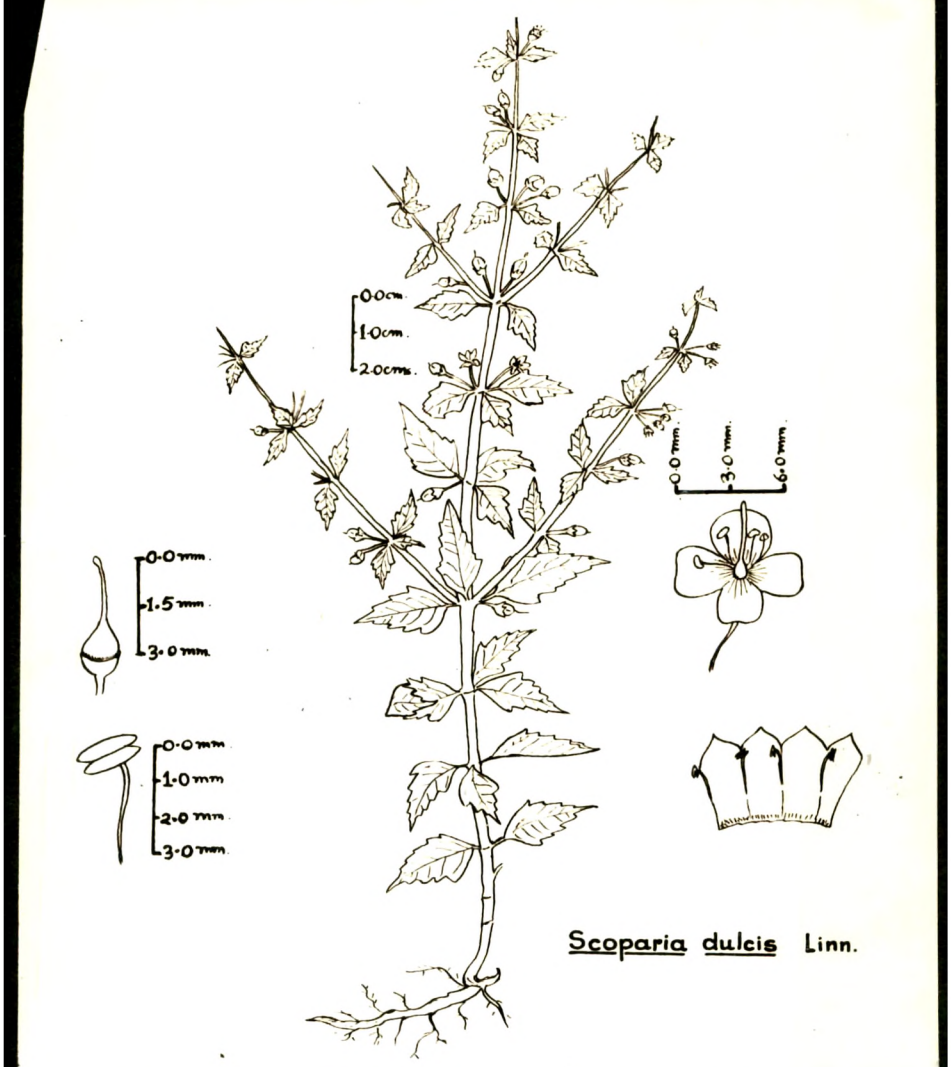
The complicated ravine systems at Bhimpura and Vasad support similar type of vegetation differing to

a slight extent in their floristic composition. At Bhimpura, the permanent vegetation consists of a dominant association of Acacia nilotica and Salvadora persica along a few other important co-dominants like Acacia senegal, Salvadora oleoides and Prosopis spicigera (Plate no.2). Interspersed with the tree population are a group of low, bushy shrubs stunted in appearance and xeromorphic in character. The commonest shrubs in order of their abundance may be listed as under:

Maytenus emarginatus; Zizyphus mauritiana; Balanites aegyptiaca; Dichrostachys cinerea; Capparis decidua; Zizyphus oenoplia etc..

In addition, a few shrubs and undershrubs were also noted either in the open or in the shade of the thickets formed by the bushy shrubs and trees. These include Hibiscus micranthus, Abutilon indicum, A. ramosum, Cadaba fruticosa, Kirganelia reticulata, Tephrosia hamiltonii etc..

With the advent of the monsoon, a number of annual or perennial herbs make their appearance on the hitherto open areas between the permanent trees and shrubs. The whole area, therefore, assumes a fresh, green look. The commonest early monsoon herb species are Convolvulus



Scoparia dulcis Linn.

PLATE NO. - 2

A typical Ravine Thorn Forest at Bhimpura.

PLATE NO. - 3

Dalechampia climbing on spiny shrubs of Capparis.

microphyllus, Borreria articularis, B. stricta, Evolvulus alsinoides, Catharanthus pusillus, Elytraria acaulis, Leucas biflora, Trianthema portulacastrum, Alternanthera pungens, A. paronychioides, Boerhavia diffusa, Cyperus rotundus, Hybanthus enneaspermus etc. followed by Sida acuta, S. rhombifolia var. retusa, Indigofera linnaei, Alysicarpus monilifer, Emilia sonchifolia, Cassia pumila, Tribulus terrestris, Corchorus aestuans, Ocimum americanum, Sesamum indicum, Martynia annua, Sclerocarpus africanus, Achyranthes aspera var. porphyristachya and many others during mid - or late monsoon.

The ravine thorn forests at Vasad present a similar pattern of vegetation, as pointed out earlier. The dominants here are Acacia nilotica and Prosopis spicigera with the other usual tree species met with at Bhimpura. Mention may be made here of the presence of Commiphora roxburghii and absence of Salvadora oleoides in these thorn forests.

The commoner shrubs are Capparis decidua, Zizyphus nummularia, Maytenus emarginatus, Securinega virosa, Zizyphus mauritiana, Diospyros cordifolia, Kirganelia reticulata etc..

The other less important shrubs or undershrubs include Xanthium strumarium, Indigofera tinctoria,

Plumbago zeylanica, Indigofera trita, Abutilon indicum, Tephrosia hamiltonii and Cadaba fruticosa.

The monsoon aspect of vegetation presents a number of herbaceous species. In addition to the ones commonly met with at Bhimpura, special mention may also be made of Crotalaria medicaginea, Triumfetta rhomboidea, Cassia tora, Acanthospermum, Indigofera linifolia, I. hochstetteri and Convolvulus arvensis.

The climbers and twiners include Clitoria ternatea, Rhynchosia minima, Ipomoea sindica (on low herbs), I. nil, I. muricata and Dalechampia scandens var. Cordofana, which is found climbing on some spiny shrubs and is for the first time reported from India (plate no. 3).

II. Vegetation along the banks of rivers - Vishwamitri, Mahi, Meni and Dhadhar

The vegetation along the banks of the rivers has permanent and seasonal aspects in addition to an ephemeral aspect. All these rivers show considerable fluctuation in the level of water. During the monsoon, the rivers are flooded and their waters inundate large areas of the tributaries and low-lying tracts. In

these months, only the permanent vegetation of the elevated banks exists and is dominated by a number of tree species. This permanent vegetation is largely edaphically controlled and the water current has no effect on it whatsoever as it is beyond the reach of water except in years of excessive rainfall. This particular type of vegetation, which comprises woody perennials, occupies the 'upper storey'.

The 'middle storey', which corresponds to the sloping banks, exhibits a permanent vegetation consisting of various low shrubs, undershrubs and a few perennial herbs during the dry months and a number of annuals during the monsoon. The vegetation of this storey is also not commonly subject to very great changes as it is also, to a large extent, edaphically controlled.

It is the 'lowermost storey' which is solely controlled by the water current itself and hence supports an 'ephemeral vegetation' during the dry months. This 'ephemeral vegetation' consists of submerged or emerged aquatics near the water and other water-loving annual or perennial herbs on the wet, muddy or sandy banks. When the water level rises during the monsoon, the 'ephemeral vegetation' is destroyed.

The vertical zonation of vegetation exhibited by these rivers is, to a very great extent, affected by biotic factors like grazing, clearing the banks for cultivation, removal of sand or clay for construction purposes, construction of embankments, widening of the rivers etc.

The river Vishwamitri takes its origin in the Pavagadh hills, which lie (45 km.) to the N.E. of Baroda. The river flows through the city of Baroda. Buring monsoon the river is in spate and the banks are flooded. After monsoon, the water level goes down, exposing the banks throughout. In the month of October, the banks are all muddy showing a sparse vegetation. It is only during the dry months that both the permanent and the ephemeral vegetation of the banks could be studied simultaneously. The study is restricted to about (16 km.) of the bank area including that of its tributaries.

The permanent vegetation of the elevated banks (upper storey) consists of a number of tree species which may be listed in their order of abundance as follows:

Acacia nilotica, Pithecellobium dulce, Pongamia pinnata, Borassus flabellifer, Streblus asper, Ficus benghalensis, Prosopis spicigera, Limonia acidissima,

Aegle marmelos, Ailanthus excelsa, Phoenix sylvestris, and Ficus glomerata (Plate no.4).

During monsoon a number of climbers on low shrubs or trees along hedges and annual herbs are also met with here.

The middle storey is occupied by a number of communities of Xanthium strumarium, Argemone mexicana, Calotropis gigantea, C. procera, Peristrophe bicalyculata, Achyranthes aspera var. porphyristachya, Kirganelia reticulata, Sorghum halepense, Pongamia pinnata (in various stages of development), Lantana camara var. aculeata, Tephrosia hamiltonii, Alhagi pseudalhagi, Abutilon indicum and Zizyphus mauritiana. During monsoon the bare areas are occupied by a number of erect or prostrate herbaceous species. Mention may be made of Cassia tora, C. occidentalis, Crotalaria medicaginea, Xanthium strumarium, Hybanthus enneaspermus, Sida acuta, S. alba, Bergia odorata, Heylandia latebrosa, Convolvulus microphyllus, Evolvulus alsinoides, Solanum surattense, Enicostema verticillatum, Tricholepis glaberrima, Elytraria acaulis and Boerhavia diffusa.

As mentioned earlier, the lowermost storey consists of an ephemeral vegetation which is solely controlled by the water current. As the water level decreases on the

PLATE NO. - 4

Vegetation along the river banks of Vishwamitri. Xanthium strumarium occupying the sloping banks (middle storey) while, Acacia nilotica, Phoenix sylvestris, Pithecellobium dulce on the elevated banks (upper storey).

advent of the dry months, the muddy banks are left exposed. These then support a vegetation consisting of water-loving herbaceous species like Alternanthera sessilis, Phyla nodiflora, Sphaeranthus indicus, Cyperus michelianus subsp. pygmaeus, Ammania baccifera, Gnaphalium indicum, G. pulvinatum, Bacopa minnieri, Stemodia viscosa, Verbascum chinense, Canscora diffusa, Glinus oppositifolius, Trianthema portulacastrum, Eclipta prostrata, Lindenbergia indica, Nicotiana plumbaginifolia, and Sutera dissecta.

Growing as emerged or amphibious hydrophytes, were recorded plants like Scirpus littoralis var. subulatus, Cyperus difformis, Elipta prostrata and Scirpus maritimus. The water surface vegetation shows an association of Ipomoea aquatica and Spirodela polyrhiza floating along the fringes of the banks at a number of places, while the submerged aquatic communities include Hydrilla verticillata, Ceratophyllum demersum, Vallisneria spiralis, Najas sp. Hydrodyction sp. at a few places formed large mats on the water surface.

With a few heavy showers in the month of July, the river swells considerably and inundates completely the lowermost storey with the result that the ephemeral vegetation described above is totally destroyed. During

this period of the monsoon, there is a fluctuation in water level and whatever the plants present are subjected to periodic flooding. It has been observed that Cynodon dactylon survives inspite of the flooding and forms the dominant community of such mud flats. This state continues till the months of October-December, when the water level decreases to its maximum. The mud flats then lose the excessive moisture content with the result that the herbaceous species, which form the main component of the ephemeral vegetation of the lowermost storey, begin to come up.

Mahi is the largest amongst the four and has a vast sandy bed. The vertical zonation of the vegetation of Mahi river banks was studied at places nearabout Vasad and that of Meni at Singharot-Umeta. The vegetation at both these places is very similar with a few minor differences in the floristie composition. The permanent vegetation of the upper and middle storeys consists of trees and shrubs like Acacia nilotica, Limonia acidissima, Pithecellobium dulce, Ailanthus excelsa, Capparis decidua, Securinega virosa and Kirganelia reticulata. The sandy beds are differentiated into (i) dry sands away from the water current and (ii) wet sands near water. On the dry sands of the river beds, typical

communities of Tamarix ericoides were observed (plate no.5) along with Xanthium strumarium, Tephrosia hamiltonii, Crotalaria medicaginea, Borreria articularis, Polycarpaea corymbosa, Mollugo cerviana, Cyperus arenarius, Cressa cretica, Chrozophora rottleri, Crotalaria verrucosa, and seedlings of Pongamia pinnata. The wet sandy banks support Fimbristylis dichotoma, Gnaphalium indicum, Polygonum plebeium, Cyperus michelianus subsp. pygmaeus, Eleocharis atropurpurea, Ammania baccifera, Rotala serpylifolia, Glossostigma spathulatum, Sphaeranthus indicus, Indigofera cordifolia and Phyla nodiflora. At Vasad, few amphibious hydrophytes like Scirpus maritimus, Scirpus littoralis var. subulatus and Cyperus difformis were observed. The water surface supports a submerged vegetation of aquatics such as Vallisneria spiralis, Najas marina var. muricata, Hydrilla verticillata and Chara sp.

The vegetation along the banks of river Dhadhar was studied at places nearabout Shahapura. The banks are steep and there is no sandy bed. The vertical zonation was clearly observed. Though great changes in the floristic composition of middle and lower storeys were noticed, the upper storey showed the presence of dominants like Allanthus excelsa, Acacia nilotica and Pithecellobium dulce. The middle storey supports an

Typical community of Tamarix ericoides on sandy river beds.

PLATE NO. - 5

association of grasses, Sorghum halepense and Saccharum spontaneum. The silvery-white, shining inflorescences of the latter add to the beauty of the landscape. Interspersed with these grasses are Triumfetta rotundifolia and Rungia repens. Ipomoea sindica was seen twining round these plants. The lowermost storey has a rich carpet vegetation of among many others Cyathocline purpurea, Cansocora diffusa, Grangea maderaspatana, Scirpus strobilinus and Verbascum chinense.

The amphibious hydrophytes growing on the fringes of water mainly consist of a dominant association of Typha angustata - Scirpus martitimus alongwith other co-dominants like Scirpus littoralis var. subulatus, Cyperus pangorei, Aeschynomene indica and Polygonum barbatum.

The water surface supports a few submerged aquatics such as Vallisneria spiralis, Hydrilla verticillata and Potamogeton perfoliatus.

III. The vegetation of ponds, puddles and other low-lying areas

The aquatic plants are the denizens of ponds, puddles and other low-lying areas, which like the river, exhibit fluctuations in water level. These fluctuations determine the succession of vegetation occupying the sloping banks,

water fringes and also the water surface. The floristic composition of the vegetation occupying the different zones is however subject to changes due to various edaphic and biotic factors.

There are numerous such habitats in Baroda and its environs. Almost every village has a small pond for storage of water to be used for a variety of purposes. Most of these, due to excessive biotic interference, do not support any vegetation on or in the body of water but only show the presence of wetland species occupying the banks. Only the more important aquatic habitats, which have comparatively less of biotic interference, and at the same time show interesting zonation of vegetation, have been selected for the study.

The aquatic communities of the ponds and puddles investigated so far include the following:

A. Free floating communities

I. Plankton - Abundantly found in steady or very slowly flowing water. ex. Hydrodictyon, Tetraspora, Zygnema etc.

II. Higher plants - Occur in still waters of ponds or puddles. ex. Utricularia stellaris, Ceratophyllum demersum, Lemna gibba, Spirodela polyrhiza, Azolla sp. etc.

B. Communities of rooted plants entirely submerged and found in fairly deep or sometimes in shallow waters on soft, muddy substrata.

ex. Potamogeton pectinatus, P. crispus, Hydrilla Verticillata, Naias sp., Vallisneria spiralis, Nechamandra alternifolia, a number of sp. of Chara and Nitella.

C. Communities of rooted and submerged plants with floating leaves - found in clear waters generally in the sheltered regions of ponds and puddles.

ex. Nymphaea nouchali, N. stellata, Nelumbo nucifera, Nymphoides cristatum, N. indicum, Trapa, Marsilea sp., Ipomoea aquatica, Neptunia prostrata, Hygroryza aristata and Pseudoraphis spinescens.

D. Marsh communities - Marsh plants occur with their roots in water logged soils. The plants occupy the fringes of ponds and puddles and are commonly described as amphibious hydrophytes.

ex. Limnophyton obtusifolium, Scirpus littoralis var. subulatus, S. maritimus, Eleocharis dulcis, Typha angustata, Cyperus esculentus, Aeschynomene indica, Jussiaea perennis, Hygrophila

auriculata, Cyperus difformis, Ammania baccifera, and Eleocharis acutangula.

The various aquatic communities listed above are present on the surface of water or near the banks, especially when the ponds are flooded. When the water level recedes, the wet banks are exposed, which exhibit a luxuriant growth of a carpet vegetation consisting of Alysicarpus vaginalis, Bacopa monnieri, Blepharis molluginifolia, Dentella repens, Enicostema verticillatum, Gnaphalium indicum, G. pulvinatum, Polycarpon prostratum, Trigonella occulta, Hoppea dichotoma, Heylandia latebrosa, Hybanthus enneaspermus etc.

During the dry phase of summer, the vegetation becomes sparse. On the elevated banks Argemone mexicana, Capparis decidua, Xanthium strumarium, Alhagi pseudalhagi are usually noticed with a few wetland species still persisting because of the moisture available in the soil.

The dry beds of ponds and puddles exhibit a characteristic plant community of Chrozophora prostrata, Glinus lotoides, Coldenia procumbens, Cressa cretica, Heliotropium supinum, Polygonum plebeium etc..

The roadside ditches, during monsoon, show the presence of Ipomoea aquatica, Lemna gibba, Spirodela polyrhiza etc. on the waters and Limnophyton

obtusifolium, Hygrophila auriculata, Caesulia axillaris etc. along the banks. The dry phase vegetation is similar to that found in ponds or puddles.

Details of distribution of the aquatic plants in the various important localities have been presented in a tabular form. This would enable one to have a clear idea of the floristic composition of the various aquatic habitats.

The distribution of these aquatic plant communities in the various areas in certainly interesting. From the distribution chart, it may be concluded that the North-East, East and South-East areas of the region under study are considerably rich in quality and quantity as compared to the rest of the areas. These differences in the distribution can be attributed to the various conditions which are responsible for the development of macroscopic plants in water bodies. These conditions can be classified as physical, chemical and biotic. Physical factors include amptitude of water level, turbidity and sedimentation, type of bottom and depth and temperature of water. The chemical factors include oxygen tension, nutrients, acidity and alkalinity. Human and animal activities also play a significant role in the development and distribution of the higher

aquatic plants. Unless a detailed ecological study of the different ponds in Baroda and its environs is made, this peculiar pattern of distribution of the aquatic communities cannot be accounted for.

For a fuller description of the various aquatic habitats and the vegetation occurring there, the reader is referred to authors' paper published in the JIBS. 40(1): 121-130, 1961.

Distribution of aquatic plants in the different habitats of Baroda and environs

[1]Race-course, Gotri, Bhimpura, Singharot.

[2]Nizampura, Chhani, Koyali, Bajuva, Dashrath upto Vasad.

[3]Harni, Sama, Amaliyara, Virod, Bhaniara, Morlipur.

[4]Panigate area, Nimetta, Shripur timbi.

[5]Pratap-nagar, Sewage disposal area, Kapurai, Kelanpur, Kundhela, Tatarpur, Mastupur.

[6]Lalbag, Makarpura, Sundarpura, Shahapura, Por, Vernama.

[7]Wadsar, Bhayali, Sangma, Padra Road.

[8]City proper (University campus, Laxmi Vilas Palace compound, Sirsa, Varoshia tanks, Vaidawadi, Vishwamitri banks)

-Absent X Present * Abundant

Name of the plant	1	2	3	4	5	6	7	8
Nymphaea nouchali	-	-	*	*	X	-	-	*
N. stellata	-	-	*	X	*	-	-	*
Nelumbo nucifera	-	-	*	*	-	-	-	-
Melochia corchorifolia	X	X	X	X	X	-	-	X

Name of the plant	1	2	3	4	5	6	7	8
Corchorus capsularis	*	-	X	*	X	-	-	-
Sesbania ~~bipinnata~~ bispinosa	X	-	X	X	X	-	X	X
Aeschynomene indica	X	X	*	*	X	X	-	-
Neptunia prostrata	-	-	X	-	X	-	-	-
Rotala indica	-	-	X	-	-	-	-	-
Ammannia multiflora	-	-	*	*	X	-	-	-
A. baccifera	X	X	*	*	X	X	X	X
Jussiaea perennis	X	X	*	*	X	X	X	X
Trapa sp.	*	-	X	*	X	-	-	X
Eclipta prostrata	X	X	*	*	X	X	X	X
Caesulia axillaris	X	X	X	X	X	X	X	X
Nymphoides indicum	-	-	X	X	X	-	-	-
N. Cristatum	-	-	*	X	X	-	-	-
Hydrolea zeylanica	-	-	-	-	-	X	X	-
Ipomoea aquatica	X	X	*	*	*	X	X	X
Limnophila indica	X	-	X	X	-	-	-	-
Bacopa monnieri	X	X	X	X	X	X	X	*
Dopatrium junceum	-	-	X	X	-	-	-	-

Name of the plant	1	2	3	4	5	6	7	8
Utricularia stellaris	-	-	X	X	X	-	-	X
U. reticulata	-	-	X	X	-	-	-	-
Hygrophila auriculata	X	X	X	*	*	X	X	X
H. polysperma	-	-	X	-	X	-	-	-
Alternanthera sessilis	X	X	X	X	X	X	X	X
A. paronychioides	X	-	X	-	X	-	-	-
Ceratophyllum demersum	-	-	X	X	X	-	-	X
Hydrilla verticillata	X	X	X	X	X	X	X	X
Nechamandra alternifolia	-	-	*	X	-	-	-	-
Vallisneria spiralis	-	X	X	X	-	X	-	X
Ottelia alismoides	-	-	-	X	-	-	-	-
Monochoria vaginalis	X	-	X	X	X	-	X	-
Typha angustata	-	-	-	X	X	X	-	X
Spirodela polyrhiza	X	-	X	X	X	X	-	X
Lemna gibba	-	-	X	X	-	-	-	-
Sagittaria sagittifolia	-	-	X	X	X	-	-	-

Name of the plant	1	2	3	4	5	6	7	8
S. guyanensis subsp. lappula	-	-	X	X	X	-	-	-
Limnophyton obtusifolium	X	-	*	*	X	-	-	X
Tenagocharis latifolia	-	-	*	X	-	X	-	-
Najas minor	-	-	X	X	X	-	-	X
Najas minor var. muricata	-	*	-	X	-	-	-	X
Aponogeton natans	-	-	X	X	X	-	-	X
Potamogeton nodosus	-	-	X	X	X	-	-	X
P. crispus	-	-	-	-	-	X	-	X
P. pectinatus	-	-	X	X	-	-	-	-
Eriocaulon sp.	-	-	*	X	X	-	-	X
Cyperus difformis	X	X	*	*	X	X	X	X
Eleocharis dulcis	-	-	*	*	X	-	-	X
Scirpus maritimus	X	X	*	*	X	X	-	X
S. littoralis var. subulatus	-	-	*	*	X	X	-	X
Coix lacryma-jobi	-	-	-	*	-	-	-	-
Hygoryza aristata	-	-	*	*	X			X
Pseudoraphis spinescens	-		X	X	X	-	-	X
Oryza rufipogon	-	-	*	*	X	-	-	-

IV. The vegetation of roadsides and hedges

As stated earlier, most of the area has been brought under the plough or used for the construction of roads, buildings, factories etc.. The vegetation along roadsides and hedges, therefore, assumes a position of very great prominence.

The hedges are planted either for the protection of fields or for demarcating the boundaries of fields or residential areas. A number of perennial shrubs or even small trees have been used for the purpose. The commonest among them are Euphorbia neriifolia, E. tirucalli, Capparis decidua, Lawsonia inermis, Annona squamosa, Diospyros cordifolia, Maytenus emarginatus, Clerodendrum phlomidis, C. inerme, Streblus asper, Zizyphus mauritiana, Z. oenoplia, Caesalpinia crista, Calotropis procera, Capparis sepiaria, Salvadora persica, Opuntia elatior and Zizyphus nummularia.

The hedge plants during monsoon support a number of climbers, which persist only in a dry, fruiting stage during summer. The climbers or twiners include plants like Ipomoea obscura, I. dishroa, I. nil, I. sepiaria, I. sinensis, I. angulata, I. cairica, I. fistulosa, Merremia aegyptia, Operculina turpethum, Maerua arenaria,

Capparis zeylanica, Rhynchosia minima, R. rothii, Clitoria ternatea, Mucuna prurita, Canavalia gladiata, Abrus precatorius, Blastania fimbristipula, Coccinia cordifolia, Melothria maderaspatana, Luffa acutangula, L. echinata, Cocculus hirsutus, Tinospora cordifolia, Cissampelos pareira, Cardiospermum halicacabum, Passiflora foetida, Cayratia carnosa, Leptadenia reticulata, Pergularia daemia, Telosma pallida, Dioscorea bulbifera etc., etc.

Between the hedges and the roadsides are usually present the roadside ditches, which during the monsoon are filled with water and support a typical hydrophytic vegetation. During the summer, the ditches dry and present the characteristic community of prostrate, xerophytic plants, which is always associated with the dry beds of ponds and puddles.

Along the roadsides - highways, small roads, cart tracks, foot tracks - various plant association have been recognised.

I. Xanthium strumarium - Crotalaria medicaginea association. This is by far the commonest and is a dominant association at number of places. The other plants noted here are Cassia tora, C. occidentalis, Tephrosia hamiltonii, T. hirta, Acanthospermum hispidum

along with small herbaceous plants like Enicostema verticillatum, Cyperus rotundus, Commelina nudiflora, Digera muricata, Alysicarpus monilifer, Heylandia latebrosa, Indigofera linnaei, Evolvulus alsinoides etc., etc.. After the monsoon, this seasonal vegetation dwindles and only the perennials persist in a dry, fruiting stage during the summer.

II. Xanthium strumarium - Acanthospermum hispidum association. This association was observed along with other co-dominants like Calotropis gigantea, Triumfetta rhomboidea, Cassia tora and C. occidentalis. At few places, pure stands of Xanthium, Acanthospermum (plate no. 6) and Calotropis were noted. Calotropis was especially common on building sites.

III. Crotalaria medicaginea - Tephrosia hamiltonii association was noted along with Moschosma polystachyum, Barleria prionitis, Malvastrum coromandelianum, Sida veronicifolia, Desmodium gangeticum, Tridax procumbens, Tephrosia strigosa, Bergia ammannioides, Vicoa indica, Indigofera cordifolia etc..

IV. Tephrosia hamiltonii - Triumfetta rhomboidea association along with Cassia tora, C. occidentalis, Solanum surattense and Plumbago zeylanica was noted a few places.

PLATE NO. - 6

An Acanthospermum community along roadsides at Vasad.

PLATE NO. - 7

A number of annuals and perennial occupy the cracks and crevices of old walls.

V. Xanthium strumarium - Balanites aegyptiaca was also noted on the outskirts of the city along with Abutilon indicum, Tephrosia hamiltonii, Leonotis nepetaefolia and Cassia auriculata.

VI. Triumfetta rhomboidea - Xanthium strumarium association was observed along with the usual plants like Cassia tora, C. occidentalis and Sida acuta.

VII. Hyptis suaveolens - Croton bonplandianum association. A rare association along nallahs and roadsides observed only at the Industrial estate, Gorwa. These roadside weeds have not yet spread properly.

In addition to these more important associations, a few plants were observed in pure stands in restricted localities i.e. Withania somnifera is sewage disposal area, Solanum surattense, Argemone mexicana, Datura metel and Martynia annua on rubbish heaps along roadsides.

A number of trees are specially planted along roadsides for shade, for the edible fruits or for ornamental purposes. They are Syzygium cumini, Azadirachta indica, Ficus benghalensis, Polyalthia longifolia, Dalbergia sissoo, Peltophorum pterocarpum, Cassia fistula, C. renigera, Tamarindus indica, Delonix regia, Mangifera indica, Pithecellobium dulce, Thespesia

populnea, Millingtonia hortensis etc..

V. Weed flora of the crop fields

Weeds are a menace to agriculture. They compete with the crop plants for water, mineral nutrients and light, thereby causing great damage resulting in a substantial decrease in the yield. Taking into account only the direct losses caused by weeds in the principal cereal and cash crops, the amount comes to nearly 37,00 million rupees, which is a staggering amount.

Depending upon the situation in any particular instance, the weed control technique employed may be cultural, biological, chemical or any judicious combination of these. The choice of the method is guided by, among other factors, the characteristics of the weeds concerned.

A major part of the area under study has now been brought under cultivation and hence the weed-flora attains a position of prime importance in the overall picture of the vegetation and flora of Baroda.

The agricultural operations start with the monsoon in June. The sowings made during this period lead to the harvest in the winter. This is known as the 'kharif' season. Rice is the main kharif crop. The

second crop season begins in the winter. This is a rainless period and the crops mature either in the presence of artificial irrigation or by the moisture left in the soil on account of monsoon rains,or the heavy dew of the winter. The crop is harvested in the dry months of February and March and is known as the 'rabi' crop or the winter crops. The important rabi crops studied for the weed flora are wheat, Mustard, leguminous crops such as grams, cajans etc., vegetables like brinjal, Tomato, Carrot, Radish and other miscellaneous crops such as Onion, Garlic, Chilly, Lucerne and Tobacco.

The plants which are essentially weeds of cultivation have been enumerated. They have been classified as 'kharif' and 'rabi' weeds, depending upon the season in which they are frequently met with in crop-fields. Separate keys to the identification of these weeds have been appended to help the agriculturists to know their enemies. The keys are based on simple, macroscopic characters.

The more prominent 'kharif' weeds are as follows:

Melochia corchorifolia; Ammania baccifera; Jussiaea perennis; Eclipta prostrata; Caesulia axillaris; Dopatrium junceum; Hygrophila auriculata; Alternanthera

sessilis; Tenagocharis latifolia; Cyanotis axillaris; Cyperus difformis; Cyperus iria; Oryza rufipogon; Isoetes coromandeliana etc.

For complete list of 'kharif' weeds and their identification refer to the key in Appendix I.

The more prominent or abundant 'rabi' weeds may be listed as follows:

Portulaca oleracea; Sida alba; Tribulus terrestris; Trianthema portulacastrum; Blumea lacera; Tridax procumbens; Anagallis arvensis var. coerulea; Cuscuta chinensis; Solanum nigrum; Orobanche cernua var. nepalensis; Boerhavia diffusa; Digera muricata; Amaranthus spinosus; Chenopodium album; Euphorbia geniculata; Asphodelus tenuifolius; Setaria tomentosa; Cenchrus biflorus etc., etc..

For the complete list of 'rabi' weeds and their identification please refer to the key in Appendix II. Members of Cyperaceae and Gramineae have not been included in the keys for obvious reasons.

VI. Old wall flora

In Baroda and its environs, there are a number of sites like dilapidated or abandoned buildings, deserted

wells and even newly constructed buildings which support a characteristic flora in the cracks and crevices. The wall flora is controlled by the nature of the exposed surface, which generally consists of disintegrated bricks and mortar, decayed remnants of plant material and also all kinds of debris. Water is also an important factor, which has great influence on the wall flora. The seasonal rainfall during monsoon or dew during the winter are the real sources of water supply. At times the leakage from the water storage tanks on the top of the buildings forms a constant source of water supply irrespective of the season. Inspite of the availability of water, it is always the water retention capacity of the substratum which influences the vegetation of such places. Temperature has an important role to play, while the biotic factors are much less important, although the renovation of old houses or changes in construction do affect the vegetational set-up of the walls.

In this work we have not attempted to study the effect the various factors on the vegetation occurring in the cracks and crevices of old walls. We visited a number of such sites and studied the floristic composition of the vegetation occurring there and also the seasonal changes taking place.

The floristic composition of these old walls etc. displays remarkable changes with the change in the season. During the dry months of summer, excepting the hardy, woody perennials, the vegetation on the exposed walls perishes. The surviving perennials also present an unhealthy, depauperate appearance. The common woody perennials are Cryptostegia grandiflora, Salvadora persica, Clerodendrum phlomidis, Ficus religiosa F. benghalensis, Calotropis procera, C. gigantea, Lantana camara var. aculeata, Ficus hispida, Capparis zeylanica, Cadaba fruticosa, Zizyphus mauritiana, Azadirachta indica, Syzygium cumini and Tamarindus indica (Plate no. 7). At a number of places, especially in shade, Tridax procumbens and Launaea nudicaulis were observed in dry fruiting stage.

With the onset of the monsoon, the woody perennials start fresh vegetative activity and thus appear healthy, even though they are generally stunted in appearance as compared to those growing at the ground level. A number of herbaceous annuals then make their appearance. They are Peperomia pellucida, Kickxia ramosissima, Enicostema verticillatum, Gomphrena celosioides, Vernonia cinerea, Heylandia latebrosa, Ageratum conyzoides, Indigofera cordifolia followed later in the season by Sida acuta, S. veronicifolia, Elytraria

acaulis, Aristida adscensionis, A funiculata, Lindenbergia indica, Boerhavia diffusa, Amaranthus spinosus, Tridax procumbens, Acalypha indica, Launaea nudicaulis, Euphorbia hirta, Blumea mollis, B. lacera, Solanum surattense, Peristrophe bicalyculata, Abutilon indicum, A. ramosum, Cyperus rotundus, Oldenlandia corymbosa, Achyranthes aspera var. porphyristachya, Eclipta prostrata, Solanum nigrum, Phyllanthus fraternus, Cayratia carnosa etc.

VII. Vegetation of an abandoned garden

Like many other Indian cities, Baroda also boasts of a number of well laid-out gardens and lawns. There a few gardens which were once looked after but have now been abandoned. The Laxmi Vilas Palace garden, which is situated on the West of the Baroda city, and which has an area of approx. 5 Sq. Km. is an ideal example of such abandoned gardens. The vegetation of this area is peculiar in many ways and differs markedly from that of the rest of the area under study.

The abandoned garden, referred to above is very near the city proper and is protected on all sides by high iron fencing. People are not allowed to enter these premises without previous permission from the

palace authorities and as such there is very little possibility of the vegetation being tampered with by human agency. 'Navlakhi' is a small part of this garden, where only people have an easy access.

The palace was constructed in the year 1880 and along with it, the garden was laid out. At that time, there were a number of well-kept lawns, some beautiful avenues lined on both sides by ornamental trees like Borassus flabellifer, Ficus benghalensis, Peltophorum pterocarpum, Tamarindus indica, Pterospermum acerifolium, Casuarina equisetifolia, Polyalthia longifolia and many others. The rock garden under the thick canopy of Anogeissus, Cordia and Azadirachta had Agave, Sansevieria and Bamboos on the borders and some ferns like Adiantum and Nephrolepis in between the rock clefts. The coolness of the place facilitated the growth of these ferns. In addition to these, there were a number of beautiful roads (sandy or cobbled), a few artificial ponds, a small zoo or 'Harankhana', where deers, sambars and wild boars were let loose in their natural habitats. The garden was then in charge of some eminent european horticulturists, who were responsible for the excellent maintenance of the garden and also for the introduction of a number of exotic trees, shrubs and seasonal plants. This large scale introduction of

exotic plants added to the charm of the garden. Some of these plants still exist in a cultivated or wild state along with a few introduced weeds, which are almost exclusive to this area and are not to be found anywhere outside the premises.

Now the situation is quite changed than what must have been some twenty years ago. Part of the area has been brought under cultivation. This has facilitated the entry of some adventive weeds. Remnants of the avenues and rock garden still exist but in an altogether different state. The once beautiful roads and lawns are still there but they now present a very gloomy appearance. During the last ten years only a small portion (in front and backside of the palace) of the garden has been looked after, leaving the rest to its own destiny. Natural causes such as the invasion of wild plants and escape of the once introduced and cultivated plants have played havoc with the result that the whole appearance of a well laid-out garden has changed to a considerable extent. (Plate no.8)

Lawns can be classified into roadside lawns (lawns between the road and the hedge) or lawn islands (lawns surrounded by roads on all sides or by tall trees and shrubs. The roadside lawns show a peculiar zonation of

A. L.V. Palace Gardens. Only a portion of the garden is well looked after.

B. The Rock garden, which is now invaded by many sturdy plants like Lantana, Clerodendrum, Pupalia and Antigonon.

PLATE NO. - 8

plants with Tridax procumbens right on the border and sometimes even on roads. The other important plants, which exhibit a luxuriant growth during the monsoon are Commelina nudiflora, Sida alba, Cymbopogon martinii. The lawn islands have Agave, Casuarina, Tamarindus, Gliricidia, Peltophorum, a number of species of Cassia, Guzuma, Santalum, Azadirachta etc. surrounding them. Under the thick canopy of the trees mentioned above, gregarious growth of an association of shade-loving plants like Abutilon ramosum and A. indicum along with Peristrophe bicalyculata, Achyranthes aspera var. porphyristachya, Pupalia lappacea and Lagasca mollis, Balinvillea acmella is usually noticed. The lawns which are open to direct sunlight are occupied by Cymbopogon martinii, Triumfetta rhomboidea, Pavonia zeylanica etc.. All these shrubs or undershrubs growing in sun or shade and also the hedges near and around the lawns have suffered considerably from the competition of climbing species, which derive support from them and ultimately smother them. The chief climbing and smothering species are Coccinia cordifolia, Antigonon leptopus, Diplocyclos palmatus, Trichosanthes cucumerina and Mucuna pruriya. This is the usual monsoon aspect of the vegetation of the lawns in sun or shade. In the dry months of summer, the tall trees or shrubs remain,

keeping many bare areas in between, which may be occupied by some perennial grasses.

The 'rock garden' which was specially designed to be the most beautiful and coolest part is now in a more or less desolate condition. The ferns have disappeared but the Agave, Sansevieria and bamboos still exist. The rocks are completely covered over with the growth of Antigonon leptopus. The passage in between the rocks is invaded or at places completely blocked by the vigorous growth of sturdy shrubs like Lantana camara var. aculeata, Plumbago zeylanica, Pupalia lappacea, Abutilon indicum and Clerodendrum phlomidis.

The 'harankhana' has a small area which is protected on all sides by iron fencing and brick walls. The walls show the presence of Lantana camara var. aculeata, while the space between the wall and the iron fencing is occupied by Saccharum spontaneum and Calotropis procera. The central portion of this trampled and uneven ground is dominated by an association of the tussock-forming grass Heteropogon contortus. Now the animals have been shifted from this place and hence plants like Evolvulus alsinoides, Zornia gibbosa, Hybanthus enneaspermus and Lindernia ciliata have started invading this land. The artificial mounds in

the same area at present support Heteropogon contortus along with Triumfetta rhomboidea, Cassia tora, Ocimum americanum and Borreria articularis.

Various plants or plant communities have started invading the sandy or cobbled roads. The roads can be classified into two main groups (a) those which are trodden frequently (b) those left untrodden. The roads which belong to the first group show the presence of prostrate plants like Euphorbia bombaiensis, Heylandia latebrosa, Elytraria acaulis and Eragrostis sp., probably because of the capacity of these plants to withstand trampling. At the junction of such roads, where the effect of treading or trampling is minimum, an association of Indigofera cordifolia, Tridax procumbens and Crotalaria medicaginea is particularly noticed. On some roads, where motor cars ply regularly (near the agricultural farm), a peculiar vegetation of Sida acuta, Polycarpaea corymbosa, Gomphrena celosioides, Tribulus terrestris and Heylandia latebrosa is usually observed in between the car tracks. Some sandy roads belonging to the second category and which are completely abandoned or very rarely used exhibit a peculiar zonation of plant associations on both the sides of the 'foot track' in the center. On the sides of the 'foot track' Elytraria acaulis is present followed by

Sida alba, Urena lobata and a typical association of Pupalia, Achyranthes, Peristrophe and Barleria under the shade of trees. On the completely abandoned cobbled roads, an association of Sida acuta, S. alba and Urena lobata is noticed, along with prostrate plants like Heylandia latebrosa and Oplismenus burmannii and even woody perennials like Lantana camara var. aculeata, Abutilon indicum, Pongamia pinnata and Ficus hispida in all stages of development.

After the thorough exploration of this area, we are tempted to call it a 'wild garden' a stage intermediate between the wild and the cultivated. If condition remain unchanged for some years, it will be interesting to watch the shape of things to come.