VEGETATION

General Aspect of Vegetation

The whole coastal area under investigation is more or less plain and is irregular in its outline broken by the estuaries of Mahi, Narmada, Tapti and remarkably featureless with a slope perceptible only in the flow of the rivers. The plains are mostly under plough and hence hedge flora and weed flora form a prominent part of the vegetational pattern. Areas which are not under cultivation develop into wastelands occupied by a few herbaceous and woody species.

There are a few important lakes or ponds, roadside ditches and puddles, which support rich aquatic vegetation. The pond vegetation shows seasonal variations due to fluctuations in the water level. The ditches and puddles, when filled with water during the rains support various hydrophytic plant communities and ephemeral xerophytic plant communities on drying out, during late winter and summer.

The entire coastline from Khambhat to Umargam is either marshy or sandy except at Daman and Meh dungri where it is rocky. The classification of coastal vegetation proposed by Champion and Seth (1968) and modified by Rao and Sastry (1972, 1974) has been followed here. Based upon the vegetation, edaphic features and other habitat factors, the following three sub-types have been studied. I. Strand; II. Estuarine and Salt Marsh; and III. Semi arid coastal plain.

Various aspects of vegetation have been discussed in detail under the following heads :

1. Coastal Vegetation,

2. Aquatic Vegetation,

3. Vegetation of waste lands and roadsides,

4. Hedge flora and weed flora of cultivated fields.

The vegetation of the coast has been discussed in detail, as very little information is available on it.

1. Coastal Vegetation

The coastal vegetation of Gujarat state from Khambhat to Umargam is divisible into three sub-groups : I. Strand, II. Estuarine and Salt Marsh, and III. Semi-Arid Coastal Plain.

I. STRAND VEGETATION

The strand habitat is portion of the land immediately adjacent and parallel to the sea shore under the direct influence of salt spray. The vegetation is characteristic with open, mat forming pioneer species followed by scattered herbs, shrubs and trees spread along the area beyond the high tide limit or the back shore region. It is studied under two topographic zones : Sand Strand and Rock strand.

Sand Strand

This habitat covers quite a larger areas along the shore

line. It is nowhere continuous but often broken mainly by muddy shores, and only at Daman and Meh dungri by rocky shores. The vegetation along the sandy beaches exhibits following zonations. This type of vegetation is observed at Dahej, Hajira, Dumas, Tithal, Dandi and Nargol.

(i) Open Pioneer Zone : This zone is the first in the supra tidal region immediately preceeding the drift line. It exhibits sparse vegetation. The pioneer species is Ipomoea pes-caprae (L.) R. Br. (Plate No. 1). Associated species noted are Cynodon dactylon (L.) Pers., Cyperus arenarius Retz., Launaea pinnatifida Cass., Portulaca oleracea Linn., Sesuvium portulacastrum Linn., Suaeda nodiflora Mog., Sporobolus sp. and Aeluropus lagopoides (L.) Trin. ex Thw. This zone is succeeded by closed herbaceous zone. (Plate No. 2).

(ii) Closed herbaceous zone : Here the vegetation attains a little more density with some mat forming herbaceous plants. It is characterised by the presence of herbs like Aristolochia bracteata Lamk., Borreria articularis (L. f.) F.N.Will., Goniogyna hirta (Willd.) Ali, Psilostachys sericea Hook. f., Enicostemma hyssopifolium (Willd.) Verd., Cyperus aristatus, Ipomoea pes-caprae (Linn.) R.Br., Launaea pinnatifida Cass., Tribulus terrestris Linn., Phyla nudiflora Linn., Polycarpaea corymbosa Lamk., Portulaca oleracea Linn., Euphorbia zornioides Boiss, Perotis indica (L.) O. Ktze., Mollugo nudicaulis Lamk., Gisekia pharnoceoides Linn., Solanum surattense Burm. f., Fimbristylis polytrichoides (Retz.) Vahl, and Gloriosa superba Linn.

PLATE No. 1. *Ipomoea pes-caprae* (L.) R. Br., a pioneer species at some places otherwise common all along the sandy coast.

PLATE No. 2. *Sesuvium portulacastrum* L., *Suaeda nudiflora* Mog. and *Aeluropus lagopoides* (L.) Trin. ex Thw. in the sandy soil at Dumas.

(iii) Middle mixed or bushy zone : This zone is composed of mixed vegetation of herbaceous species with some sub shrubby or bushy plants. Main components of herbaceous species are Phyllanthus niruri Linn., P. maderaspatensis Linn., Zornia gibbosa Span., Gomphrena celosioides Mart., Corchorus aestuans Linn., Euphorbia hirta Linn., E. hypercifolia var. parviflora Hook., Coldenia procumbens Linn., Perotis indica (L.) O. Kuntz., Boerhavia diffusa Linn., Borreria articularis (Linn. f.) F.N.Will., B. stricta Schum., Heliotropium curassavicum Linn., and Indigofera cordifolia Heyne. Crotalaria linifolia L. f., C. verrucosa L., Cassia auriculata L., Tephrosia hirta Ham., T. purpurea Pers., Solanum surattense Burm. f., S. trilobatum L., Opuntia elatior Mill., Grewia tenax (Forsk.) Fiori, Calotropis procera R. Br., C. gigantea (L.) R. Br., Capparis decidua (Forsk.) Edgew., Jatropha gossypifolia Roxb., Tamarix ericoides Rottl. (Plate No. 3), Vitex negundo L., and Clerodendrum inerme Gaertn. form chief components of sub-shrubby or bushy plants. This zone which is an admixture of herbs, shrubs and creepers, gradually merges with a few taxa attaining tree stature to form an open inner woodland zone.

(iv) Inner woodland zone : The commonly observed trees and plants with arborescent habit are Prosopis cineraria (L.) Macbr., P. juliflora DC., Borassus flabellifer Linn., Thespesia populnea (L.) Soland ex Correa, Derris indica (Lamk.) Bennet., Salvadora persica Linn., S. oleoides Dcne and Cocos nucifera Linn. From the above mentioned species Prosopis juliflora DC.,

PLATE No. 4. Prosopis juliflora DC. in flowers and fruits, forms gregarious, dense thickets at Hajira.

PLATE No. 3. *Tamarix ericoides* Rottl. one of the chief sub-shrubby components of the middle mixed or bushy zone.

P. cineraria (L.) Macbr. and Borassus flabellifer Linn. are self-sowing, forming extensive pure strands at Dahej, Hajira, Dumas, Tithal etc. These tree species support climbers like Gloriosa superba Linn., Leptadenia reticulata Wt. & Arn., Pergularia daemia (Forsk.) Chiov., Pentatrophis Cynanchoides R. Br., Sarcostemma secamone (L.) Bennet., Telosma pallida (Roxb.) Craib and Hemidesmus indicus R. Br.. At places, dense groves of Pandanus odoratissimum L. f. with branching stems bearing dense, long leaved crowns supported by stilt roots and with extremely sweet scented inflorescences are also noted. Besides Casuarina equisetifolia Linn., Eucalyptus Sp., Cocos nucifera Linn., are some of the commonest cultivated trees. Only at Hajira, Prosopis juliflora forms gregarious, dense thickets over extensive area. This zone gradually merges into the waste lands and cultivated fields in the hinter land region in the coastal belts. (Plate No. 4).

Rock Strand

This type of habitat which is pre-dominant in Saurashtra and Kutch is much limited to a small area at Daman and Meh dungri region of the area under investigation. The flora and vegetation of this area is mostly composed of both inland and coastal plants. For the purpose of study this area is divided into following three zones.

(a) Zone of rocky slopes and humps : This zone is formed by the cutting and breaking of rocks due to constant action of huge

tides. It is regularly inundated by high tide and is mostly exposed during low tide only. This rocky area support only algal species belonging to Enteromorpha, Ulva, Dictyota, Sargassum and Turbinaria.

(b) Zone of rocky relief sloping inland : This zone is composed of exposed flat rocks with pot-holes and crevices having a thin cover of sand. Such a habitat supports a limited number of annuals and perennials. The interesting plants noted here are Euphorbia thymifolia Linn., Goniogyna hirta (Willd.) Ali, Indoneesilla echioides (L.) Sreem., Kickxia ramosissima (Wall.) Janchen., Hybanthus enneaspermus (L.) F.Muell., Lepidagathis trinervis Wall. ex Nees, Lindenbergia muraria (Roxb.) P. Bruchl., Tridax procumbens Linn. and Portulaca quadrifida Linn.

(c) Zone of inland gravelly or rocky habitat : The vegetation of this zone is composed of spiny thickets and shrubby herbs. Dominant shrubby species encountered in this habitat are Zizyphus oenoplia Mill., Z. nummularia (Burm.f.) Wt. & Arn., Dichrostachys cinerea (L.) Wt. & Arn., Maytenus emarginatus (Willd.) Ding Hou, Capparis decidua (Forsk.) Edgew. and Barleria prionitis Linn. Climbing plants like Cayratia carnosa (Lamk.) Gagnep., Cissus quadrangularis Linn., Cannavalia gladiata (Jacq.) DC., Tinospora cordifolia (Willd.) Miers., Luffa acutangula Linn. and Hemidesmus indicus R. Br. are commonly observed in this habitat. In addition, a few undershrubs and herbs are also noted either in the open or in the shade of the thickets formed by bushy and shrubby plants. These include Acalypha indica Linn., Achyranthes aspera var.

porohyristachya Hook. f., Acanthospermum hispidum DC., Pavonia zeylanica Cav., Echinops echinatus Roxb., Alysicarpus monilifer (L.) DC., Blumea obliqua (L.) Druce, Indigofera cordifolia Heyne, Lepidagathes trinervis Wall. ex Nees and Hybanthus enneaspermus (L.) F. Muell.

II. Estuarine and Salt Marsh Vegetation

A. Estuarine Vegetation

An estuary is "an embayment of water at the margin of sea in which there is a considerable mixture of fresh and salt water". Salinities are consequently lower within the estuary than the open sea. Estuaries are formed in the narrow boundary zone between the sea and the land and their life is generally short. Their form and extent is being constantly altered by erosion and deposition of sediments and drastic effects are caused by a small raising or lowering of the sea level. Throughout the estuary, deep areas commonly contain laminated mud, related to a turbidity maximum. Laminated mud is also present on the estuary margins adjacent to the salt marsh.

An estuary has three features, one it is coastal, second it involves the mixing of two kinds of water, sea water and fresh water with different salinity and the third feature is, its circulation is strongly influenced by the presence of boundaries. Estuaries tend to be very active geological environments because the dynamic processes of the sea meet

frontally with the processes of the land augmented the flow of river water and sediments. (Plate No. 5).

Estuarine vegetation is generally composed of dense woody plants, shrubs and succulent herbs in varying proportions distributed on an uneven coastline lying under constant pressure of tidal and fresh water resources. The major Indian estuaries are mostly located along the east coast whereas it is confined to sea inlets, small river mouths, lagoons, bays and back water systems along the west coast.

In Saurashtra, the estuarine vegetation is very poor but it is a little better represented along the Gujarat coast from Khambhat to Umargam. In this, there are three noteworthy estuaries known as Mahi, Narmada and Tapti. They exhibit notable similarities in floristic composition.

The euestuarine zone is not well represented in these estuaries. A robust spiny grass Urochondra setulosa (Trin.) Hubb. forms more or less pure formations in the euestuarine region.

The chief floristic components in the prohaline zone are Avicennia alba Blume, Excoecaria agallocha Linn., Acanthus ilicifolius Linn., Sonneratia apetala B. Ham., Cenchrus biflorus Roxb. and Fimbristylis cymosa R. Br.

Dominant taxa of euhaline zone are species of Suaeda, Heliotropium curassavicum Linn., Aeluropus lagopoides (L.) Trin. ex Thw., Sesuvium portulacastrum Linn., Salicornia bractiata Roxb. and Cressa cretica Linn.. Other species noted are

PLATE No. 5. Steep banks along the Mahi estuary at Dhuvaran damaged due to heavy flooding by river waters and on slaught of heavy tidal waves, showing sparse vegetation.

Enicostema hyssopifolium (Willd.) Verd., Cyperus rotundus Linn. (Plate No. 6).

Aliabet, a small island in Narmada estuary about a kilometer long (E-W) and half a kilometer in breadth shows vegetation of tidal mangrove sub-type of pro-estuarine type. It is characterized by the presence of abundantly and luxuriantly growing scrubs and tree species of mangroves dispersed on a low lying shallow relief which is all the while under constant effect of tides. The main components of this tidal mangroves are Avicennia alba Blume, Acanthus ilicifolius Linn., and Sonneratia apetala B. Ham.. Some of the rarely noted species are Sesuvium portulacastrum Linn., Aeluropus lagopoides (L.) Trin. ex Thw., Arthrocnemum indicum Mog, Urochondra setulosa (Trin.) Hubb., Suaeda maritima Dumort. and Rhizophora mucronata Lamk.

B. Salt Marsh Vegetation

Except strand and estuarine vegetation mentioned above, rest of the coastal vegetation falls under this category. It is composed of the small river deltas, the creeks and backwater shallow areas under the influence of tides. This type of vegetation is observed at Umargam, Nargol, Golwad, Tithal, Bilimora, Dandi, Hajira, Dahej, Dumas and Khambhat. Muddy sea shores, quiet bays and shallow inlets are the habitats for mangrove vegetation. Mangroves form a distinct belt which is followed by sandy saline area and salt pans. The main features of the salt marsh vegetation is zonation. Different components

PLATE No. 6. Suaeda nudiflora Mog. along with Suaeda monoica Forsk. on the muddy coast at Chokari - Mahi estuary.

of the salt marsh flora are studied under the following community types :

(a) Avicennia alba community :- The community mostly dominates parts of sea-shores at Umargam, Nargol, Golwad and Bilimora. Its presence is noted near the coastline but in the interior sheltered sandy and muddy areas; due to severe biotic activities its thicket forming feature is rarely observed. Other co-dominants of this community are Scirpus maritimus Linn., Acanthus illicifolius Linn., Salicornia bractiata Roxb., Sonneratia apetala B. Ham. and Fimbristylis cymosa R. Br. (Plate No. 7).

(b) Aeluropus lagopoides community : This community is characteristic of saline areas where it forms extensive mats and tolerates some inundation with sea water. Its chief associates are Sesuvium portulacastrum Linn., Sporobolus sp., Suaeda nudiflora Mog., S. monoica Forsk. and Fimbristylis littoralis Gaudich.. It is a wide spread community in the area under investigation. (Plate No. 8).

(c) Atriplex stocksii community : It often forms pure strand or found scattered along saline areas adjoining the mangrove zone. Sometimes also found behind Aeluropus lagopoides zone.

(d) Suaeda nudiflora community : It is abundant along the fringes of inland creeks and shallow muddy areas of Khambhat, Chokari, Dahej, Dumas where it forms impressive mats. In most of the places, it forms pure stands but at places it is also observed

PLATE No. 8. A close-up of Avicennia alba Blume, a dominating mangrove with pneumatophores.

PLATE No. 7. *Avicennia alba* Blume community in the background along the inland canal. In the foreground is *Suaeda nudiflora* and *Aeluropus lagopoides* (L.) Trin. ex Thw.

growing with Aeluropus lagopoides (L.) Trin. ex Thw., Urochondra setulosa (Trin.) Hubb., Cynodon dactylon (L.) Pers., Cressa cretica Linn. and Suaeda monoica Forsk. (Plate Nos. 9 & 10).

(e) Fimbristylis cymosa community : It becomes dominant towards the interior and noted at Hajira, Magdalla and Bhimpore. Other species noted in this community are Scirpus maritimus Linn., Urochondra setulosa (Trin.) Hubb. and Aeluropus lagopoides (L.) Trin. ex Thw.

(f) Salvadora persica community : This community dominates parts of sea-shore at Dahej, Nargol and Golwad. Other associates are Avicennia alba Blume, Aeluropus lagopoides (L.) Trin. ex Thw., Zizyphus nummularia, Cynodon dactylon and Suaeda fruticosa. (Plate No. 11).

(g) Urochondra setulosa community : Urochondra setulosa a good sandbinder, is an inland salt marsh plant commonly found in association with Aeluropus lagopoides (L.) Trin. ex Thw., Scirpus maritimus Linn. and Fimbristylis cymosa. R. Br.

(h) Cressa cretica community : This is usually noted in places having high salinity. It is often observed in pure stands. At times found mixed with Suaeda fruticosa Forsk. and Aeluropus lagopoides (L.) Trin. ex Thw.

Soils from the salt pans from Khambhat, Dahej, Dumas are loam, silty clay loam or silty loam with mild to moderate

PLATE No. 11. A *Salvadora persica* community at Dahej along with *Avicennia alba* Blume, *Zizyphus nummularia* and *Aeluropus lagopoides* (L.) Trin. ex Thw. associates.

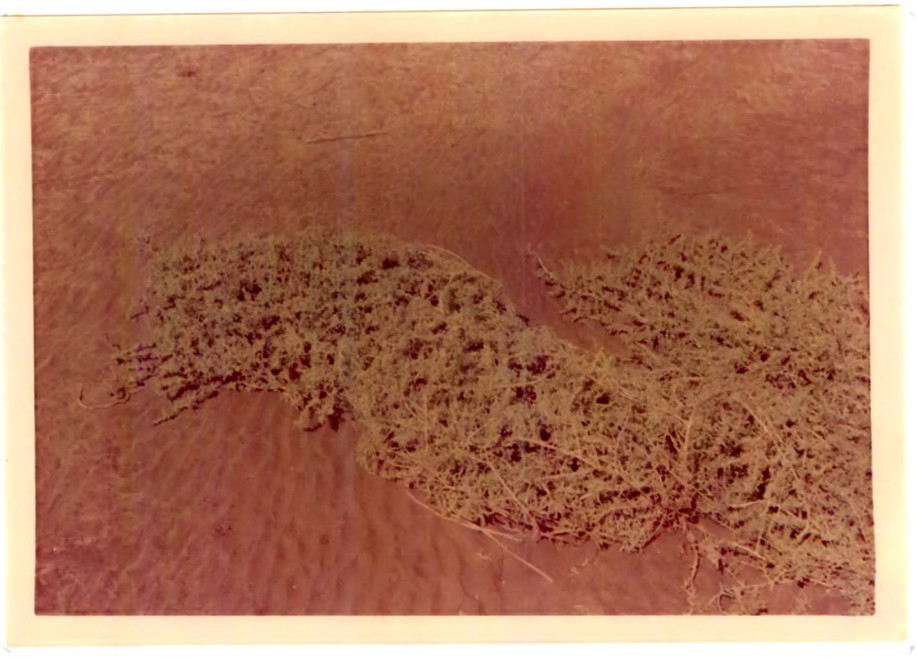

PLATE No. 10. A close view of *Suaeda nudiflora* Mog.

PLATE No. 9. Saline non-cultivable but vegetated zone supporting pure strand of Suaeda nudiflora Mog.

alkalinity. Their organic matter contents are much higher than the soils from strand habitat. (Table III & I). These low-lying, moist lands usually become dry during dry season. They fringe the shore line and exhibit interesting plants and habits. Though near the sea, these lands are not directly connected with it and as such support a characteristic vegetation of their own. The main occupents of these areas at Khambhat are Portulaca quadrifida Linn., Alternanthera sessilis (Linn.) DC., Bacopa monnieri (L.) Pennell, Eclipta prostrata (L.) Linn., Euphorbia microphylla Heyne ex Roth, E. zornioides Boiss., Cyperus rotundus Linn. and Brachiaria ramosa (Linn.) Stapf. Other taxas noted rarely in this habitat are Goniogyna hirta (Willd.) Ali, Eragrostis ciliaris (L.) R. Br., Sporobolus marginatus Hochst. ex A. Rich., Polycarpea corymbosa (L.) Lamk., Justisia precumbens var. simplex (D.Don) Yamazaki, Bergia odorata Edgew. and Digera muricata (L.) Mart.. At Dahej and Dumas, this habitat chiefly composed of Urochondra setulosa (Trin.) Hubb., Eclipta prostrata (L.) Linn., Phyla nodiflora (L.) Greene., Goniogyna hirta (Willd.) Ali, Bacopa monnieri (L.) Pennell. and Cressa cretica Linn. Other plants of this area are Ammannia baccifera Linn., A. multiflora Roxb., Tephrosia hirta Ham., Leucas biflora R. Br., Crotalaria medicaginea Lamk., Eragrostis viscosa (Retz.) Trin. and Euphorbia hypericifolia Linn.

III. Semi-Arid Coastal Plain

This plain is comparatively elevated and is away from tides. It lies behind the strand habitat or salt marshes, slacks and

muddy formations. The vegetation of this area is a mixture of inland open communities forming scrub forests and is represented by the following community types(Plate No. 12) :-

(i) Community of Hyphaene indica :- It is noted only along the coastal plain around Daman. At places it is found in dense patches. Other chief associates are Phoenix sylvestris (L.) Roxb., Borassus flabellifer Linn., Cassia auriculata Linn., Butea monosperma (Lamk.) Taub. and Salvadora persica Linn..

(ii) Community of Calotropis procera :- It is noted at several places in dry sandy soils. It is found scattered all along the plain. Its main associates are Capparis decidua (Forsk.) Edgew., Cassia auriculata Linn., Cassia occidentalis Linn., Dichrostachys cinerea (L.) Wt. & Arn., Butea monosperma (Lamk.) Taub., Eragrostis ciliaris (L.) R. Br., Achyranthes aspera Linn. and Barleria prionitis Linn..

(iii) Community of Prosopis cineria : It is found in pure stand in certain localities away from the strand belt. Other chief components of this community are Cassia auriculata Linn., Mimosa hamata Willd., Calotropis gigantea (L.) R. Br., Zizyphus nummularia (Burm. f.) Wt. et Arn., Pupalia lappacea (L.) Juss., Tribulus terrestris Linn. and Boerhavia verticillata Poir..

(iv) Community of Capparis decidua (Plate No. 13) : This community forms pure stand in Meh dungri area only. Its other occupants are Maytenus emarginata (Willd.) Ding Hou, Zizyphus nummularia (Forsk.) Edgew., Cassia auriculata Linn., Plumbago zeylanica Linn., Pupalia lappacea (Linn.) Juss.,Aplude varia etc.

PLATE No. 13. A degraded Capparis scrub with Meytenus emarginata (Willd.) Ding Hou and Apluda varia occupying the slopes of the elevated coast at Meh dungri.

PLATE No. 12. General view of an elevated plain away from tides and lying behind strand habitat, supporting a scrub.

Aquatic Vegetation

The vegetation of Ponds, Puddles and other low-lying areas :

There are a number of ponds, natural or artificial, a greater number of puddles which are dry in hot months and are filled up during the monsoon and a number of marshes or swamps, which exhibit a wide variety of aquatic vegetation due to fluctuations in water level. The floristic composition of the vegetation occupying the different zones is, however, subject to changes due to various biotic and edaphic factors.

Astercantha longifolia Nees, Amaranthus spinosus Linn., Ammannia baccifera Linn., Phyla nodiflora Linn., Ipomoea aquatica Forsk., and Eclipta erecta Linn. are common in moist situations. At some places along the Mahi estuary, e.g. at Chokeri pure formations of Bacopa monnieri Penn. was met with in a dirty pool.

The vegetation of dried ponds and ditches consists mainly of Astercantha longifolia Nees, Mollugo lotoides W. & A., Polygonum plebejum Linn., Coldenia procumbens Linn., Xanthium strumarium Linn., Eclipta erecta Linn., Ammannia baccifera Linn., Heliotropium indicum Linn., and species of Eragrostis and Cenchrus.

Most striking peculiarity of the area under investigation is that the region towards south i.e. towards Surat at Dumas, Magdalla, Bhimpore, Tithal, Meh dungri, Umrat is all studded with a number of ponds, many of which hold water throughout the

year while along the Mahi estuary there is only one notable pond at Chokari.

Most of the villages have ponds for storage of water, to be used for various purposes. Most of these do not support any vegetation on or in the water due to excessive biotic interference. These ponds show the presence of wet-land species occupying the banks. Only the important aquatic habitats with comparatively less of biotic interference and which at the same time show interesting zonation of vegetation have been selected for the study.

The aquatic communities of the ponds investigated include the following :

(i) Free floating communities :-

(a) Plankton - commonly observed in sluggish water - species of Cladophora, Spirogyra, Zygnema, Spirulina, Oedogonium, Mycrocystis, Gleotrichia, Diatoms and desmids.

(b) Higher plants - Azolla pinnata and Spirodela polyrhiza occur in steady waters of ponds and puddles.

(ii) Submerged rooted communities :-

Usually found in deep waters or at times in shallow waters on soft, muddy bottom. Common plant species observed are Hydrilla verticillata, Najas minor, Ottelia alismoides, Potamogeton crispus, P. pectinatus, P. perfoliatus and Vallisneria spiralis. In Najas and Hydrilla even the flowers are submerged while in rest of the plants, the flowers are above the surface of water.

(iii) Submerged rooted communities with floating leaves :
(Plate Nos. 14 and 15).

These are usually found in clear and shallow to deep waters. Nelumbo nucifera, Nymphaea nouchali and N. pubescens usually occupy the deeper regions of waters, while Nymphoides indicum, N. cristatum, Neptunia prostrata and Ipomoea aquatica are found in shallow waters near margins.

(iv) Marsh communities (Plate No. 16) :-

These plants are always rooted in water or water-logged soils. They withstand occasional flooding and are found occupying large areas all along the fringes of ponds and puddles. They are commonly known as amphibious hydrophytes.

Common plant species noted are Cyperus esculentus, Hygrophila auriculata, Ammannia baccifera, Limnophyton obtusifolium, Typha angustata and Cyperus difformis.

(v) Wetland Communities :-

When the water level recedes, the wet muddy banks are exposed and are occupied by these hygrophilous communities. Bacopa monnieri, Gnaphalium indicum, Phyla nodiflora, Cynodon dactylon, Enicostema hyssopifolium, Cyperus arenarius, Goniogyna hirta and Aeschynomene indica are some of the wetland species which are common in the area under study.

When the ponds and puddles are flooded, various hydrophytic communities mentioned above are present on or near water. During

PLATE No. 14. Nymphaea pubescens Willd.; Limnophyton obtusifolium (Linn.) Mig. and Scirpus littoralis Shrad. var. subulatus (Vahl) Chiov. at Khambhat.

PLATE No. 15. *Nymphaea pubescens* Willd. & *Ipomoea aquatica* Forsk. association at Tithal.

PLATE No. 16. A typical marsh community of Typha angustata Bory. & Chaub.

summer, the water level recedes to its minimum and many of the ponds and puddles completely dry, exposing their bottoms. These exposed surfaces show deep crevices characteristic of the black clayey soil. The vegetation of this area is characterised by xerophytic annuals like Grangea maderaspatana, Polygonum plebejum, Glinus lotoides, Heliotropium supinum, Chrozophora prostrata, Coldenia procumbens, Cressa cretica and Perennials like Alhagi pseudalhagi, Argemone mexicana, Xanthium strumarium and Solanum surattense.

Vegetation of waste lands and roadsides

The waste lands include the garbage heaps near human habitation and vast areas which are barren due to over grazing and tree-felling activities. The garbage heaps usually support plants like Achyranthes aspera Linn., Calotropis gigantea (L.) R. Br., Cassia occidentalis Linn., C. tora Linn., Amaranthus spinosus Linn., Cleome gynandra Linn., Withania somnifera (L.) Dunal, Solanum surattense Burm. f., Datura metel Linn., Martynia annua Linn., Physalis minima Linn., Boerhavia diffusa Linn., Corchorus olitorius Linn., Goniogyne hirta (Willd.) Ali, Xanthium strumarium, Linn., Commelina benghalensis Linn., Sida acuta Burm. f., Trianthema portulacastrum Linn., and Tridax procumbens Linn. which are arranged in their order of dominance. Other rare taxa noted in this type of habitat are Blepharis repens (Vahl) Roth, Blumea oblique (L.) Druce, Blumea eriantha DC., Lindenbergia muraria (Roxb.) R. Brudt. and Ocimum gratissimum Linn.,

Open barren waste lands support permanent vegetation consisting mainly of woody perennials like Acacia nilotica ssp. indicum (Benth.) Brenan; Pithecolobium dulce (Roxb.) Benth.; Capparis decidua (Forsk.) Edgew., Calotropis gigantea (L.) R. Br., Zizyphus nummularia (Burm. f.) Wt. & Arn. and Abutilon indicum (L.) Sweet. Other annual species observed are Acanthospermum hispidum DC., Cassia tora Linn., C. occidentalis Linn., Sida acuta Burm. f., Triumfetta rotundifolia Lamk., Portulaca oleracea Linn., Glinus lotoides Linn., Corchorus aestuans Linn., C. olitorius Linn. and Vernonia cinerea (L.) Less., while Waltheria americana Linn., Evolvulus alsinoides Linn., Convolvulus microphyllus Sieb. ex Spreng., Pavonia zeylanica Cav. are observed occasionally.

In Khambhat, however, Withania somnifera Dunal and Jatropha gossypifolia Linn., are very common near the outskirts of the town. Certain tree species like Delonix elata (L.) Gamble, Pithecolobium dulce (Roxb.) Benth., Acacia nilotica ssp. indicum (Benth.) Brenan., Moringa oleifera Lamk. are commonly planted near human habitations.

The roadsides support various plant associations depending upon the state of the soil and the extent of biotic influences. The composition of this vegetation thus changes from place to place. In general, the following types are commonly recognised.

(i) Xanthium strumarium - Crotalaria medicaginea association :-

This is the commonest and most dominant association. The

co-dominants are Cassia tora Linn., C. occidentalis Linn., Tephrosia hamiltonii J.R.Drumm. and Acanthospermum hispidum DC.. During monsoon, a few spreading herbaceous plants capable of withstanding trampling are usually noticed. They are Alysicarpus monilifer (L.) DC., Goniogyne hirta (Willd.) Ali, and Boerhavia diffusa Linn. along with a few spreading grasses. The sturdy perennials in dry, fruiting stage are the only survivals during summer.

(ii) Xanthium strumarium - Calotropis gigantea association :-

This association was observed only along Dabka - Chokari road. Other common associates are Crotalaria medicaginea Lamk., Argemone mexicana Linn., Cassia auriculata Linn. C. occidentalis Linn., C. tora Linn., Barleria prionitis Linn. Capparis decidua (Forsk.) Edgew., Dactyloctenium aegyptium (L.) Beauv., Sida cordata (B. f.) Brass., S. acuta Burm. f., Solanum surattense Burm. f. and Zizyphus nummularia (Burm. f.) Wt. & Arn..

(iii) Tephrosia hamiltonii - Cassia tora association :-

The common associates of this association are Sida acuta Burm. f., Tridax procumbens Linn., Indigofera tinctoria Linn., Setaria glauca (L.) Beauv., Dinebra retroflexa (Vahl) Panz., and Eragrostis viscosa (Retz.) Trin.

(iv) Tephrosia hamiltonii - Triumfetta rhomboidea association :-

The usual associates of this are Chloris virgata Sw., Eragrostis ciliaris (L.) R. Br., E. viscosa (Retz.) Trin. along with Cassia tora Linn., C. occidentalis Linn., Solanum surattense

Burm. f. and Sida alba Linn.

(v) Cassia tora - Cassia occidentalis association :-

This is less frequently observed. The common associates are Tephrosia hirta Ham., T. hamiltonii J.R.Drumm., Trichodesma zeylanicum (Burm. f.) R. Br., Triumfetta rotundifolia Lamk., Echinops echinatus Roxb. and Argemone mexicana Linn..

(vi) Zizyphus nummularia - Capparis decidua association :-

The usual associates of this are Cassia auriculata Linn., Echinops echinatus Roxb., Alhagi pseudalhagi (M.Bieb.) Desv., Chloris virgata Sw., Eragrostis ciliaris (L.) R. Br., Eragrostis tenella (L.) B. ex R. & S., Peristrophe bicalyculata (Retz.) Nees, Tridax procumbens Linn. and Sida acuta Burm. f.

Very often these hardy, typical roadside plants are found to be making inroads into the forests clearly indicating increased biotic activity.

Trees are planted along roadsides for shade or for their edible fruits and ornamental value. The common tree species are Tamarindus indica Linn., Azadirachta indica A. Juss., Syzygium cumini (L.) Skeels., Manilkara hexandra (Roxb.) Dubard., Ficus benghalensis Linn., F. amplissima Sm., F. religiosa Linn., Thespesia populnea (L.) Soland ex Corr. and Derris indica (Lamk.) Bennet.

Hedge Flora and Weed Flora of Cultivated Fields :

Hedge Flora :

Hedges of plant species like Euphorbia nerifolia Linn., E. tirucalli Linn., E. heterophylla Linn., Lawsonia inermis Linn. and a number of tree species are usually grown to demarket the boundaries of agricultural fields and residential areas. Finding congenial conditions under the shade of hedge species, other members of the hedge flora develop in natural course. The hedges support quite a large number of climbers and twiners.

Other commoner shrubs met with in hedges are Annona squamosa Linn., Kirganelia reticulata Baill., Clerodendrum multiflorum (Burm. f.) O. Kuntze, Capparis sepiaria Linn., Lycium barbarum Linn., Cadaba fruticosa Druce, Bougainvillea spectabilis Willd., Zizyphus maurtiana Lamk.. A number of trees like Acacia nilotica ssp. indica Del., Mangifera indica Linn., Salvadora persica Linn., Streblus asper Lour. and Moringa oleifera Lamk. are observed. Occasionally, Abutilon indicum Sweet., Caesalpinia crista Linn. and Gloriosa superba Linn. are found to be locally abundant in hedges.

During rainy season, these hedges support a number of woody climbers like Abrus precatorius Linn., Maerua oblongifolia A. Rich., Clitoria ternatea Linn., Pergularia daemia Chiov., Merremia aegyptia (L.) Urb., and herbaceous climbers such as Ipomoea obscura Ker-Gawl., Rhynchosia minima DC., Cissampelos pareira var. hirsuta (Buch. ex DC.) Forman., Ipomoea nil Roth..

Under the shade of these hedges, many erect or straggling herbs like Hybanthus enneaspermus Muell., Sclerocarpus africanus Jacq., Pupalia lappacea Juss., Blepharis maderaspatensis Roth, Borreria articularis Will., Polygala erioptera DC. and Tridax procumbens Linn. are commonly found.

Weed Flora :

A large portion of the area along the sea coast is under cultivation. Agriculture has almost reached the sea coast, at places within a kilometer. In such areas salt tolerating crops are cultivated. The crop plants and their weed flora, therefore form an important part of the vegetation of the area under investigation.

Crops which are sown in monsoon and harvested in winter are called kharif crops. Second crop season begins in the winter. This is rainless period and crops mature either in the presence of irrigation or by moisture left in the soil on account of monsoon rains or heavy dew of the winter. The crop is harvested in dry months of February and March and is known as the winter crop or Rabi crop. In some areas after the "Kharif" crops, fields remain fallow. These crops and fallow fields exhibit a variety of weed flora consisting of annual or perennial herbs and grasses.

Important Kharif crops are Oryza sativa Linn. and its varieties, Pennisetum typhoideum (Burm.) Stapf & Hubb.,

Gossypium herbaceum Linn.

Prominent annual and perennial Kharif weeds found in paddy are Aeschynomene indica Linn., Dopatrium junceum (Roxb.) Buch.-Ham ex Benth., Cyperus rotundus Linn., Ludwigia perennis Linn., Sesbania bispinosa (J.) F. & R., Cyperus iria Linn., Eleocharis atropurpurea Kunth, Caesulia axillaris Roxb,, Ammannia multiflora Roxb. and Melochia corchorifolia Linn.. In fields other than paddy are found Cleome gynandra Linn., Euphorbia hirta Linn., Hedyotis corymbosa (L.) Lamk., Abelmoschus manihot (L.) Medic., Cenchrus biflorus Roxb., Commelina benghalensis Linn., Eragrostis tenella (L.) Beauv., Corchorus fascicularis Lamk., Sopubia delphinifolia (Roxb.) G. Don and orchid Habenaria marginata Colob.

The important Rabi crops are Triticum aestivum (Wheat), Nicotiana tabacum (Tobacco) and Cajanus cajan (Cajan Pea). Most common Rabi weeds are Euphorbia dracunculoides Lamk., E. perbracteata Gage, E. microphylla Heyne ex Roth, Orobanche cernua var. nepalensis DC., Solanum nigrum Linn., Asphodelus tenuifolius Cav., Vicoa indica (Willd.) DC., Cenchrus biflorus Roxb., Portulaca oleracea Linn. and a host of other herbs and grasses.

During winter and summer, the fallow fields support a luxuriant growth of shruby plants like Alhagi pseudalhagi (M. Bieb.) Desv., Echinops echinatus Roxb., Heliotropium supinum Linn., Dichanthium annulatum (Forsk.) Stapf, Dactyloctenium aegyptium (L.) Beauv., Argemone mexicana Linn., and Trichodesma zeylanicum (Burm. f.) R. Br.