

A STUDY OF THE HYDROPHYTES OF BARODA AND ENVIRONS

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IN India the systematic and ecological study of the hydrophytes as a group has not received adequate attention, although such a study has always yielded very useful data on the ecology, floristic composition and various other aspects of this interesting group of plants. Mention must be made of a few notable contributions such as Biswas and Calder's (1937) book on the marsh and aquatic plants of India; Kapadia's (1950) booklet on the plant-life of Mahagujarat, wherein he lists some of the common aquatic plants of this region; Saxton and Sedgwick's (1918) *Flora of North Gujarat*, in which a broad ecological classification of the flora is given and a few others by Ratnam and Joshi (1952), Mirashi (1954, 1957), Navalkar (1956) and Kachroo (1956). But, as far as the authors are aware, no work is done on the floristic composition and distribution of the aquatic plants in this part of the Bombay State.

A beginning in this direction is made by the authors in the present paper. As far as the study of the hydrophytes of Baroda is concerned, the only work that has been done, deals with the seasonal variations in the vegetation and phenology of the plants occurring in and around a pond at Harni, a village 2½ miles N.E. of Baroda. In the present paper, it is proposed to give a comprehensive data on the distribution and floristic composition of the hydrophytes occurring in the various habitats of Baroda and its rich environs.

AREA OF STUDY

An area of about 50 sq. miles has been selected for this particular study. The accompanying map shows the area surveyed so far.

Baroda was the capital of the former Baroda State. It is one of the important cities of the Bombay State and is 110 ft. above sea-level. The climate is more or less tropical. Highest humidity is recorded during the months of June-September. March-May are the driest months having lowest humidity. All these climatic factors have a profound influence on the vegetation in general and the aquatic flora in particular. Soil varies from black alluvial to red loam and is comparatively dry except in the rainy season.

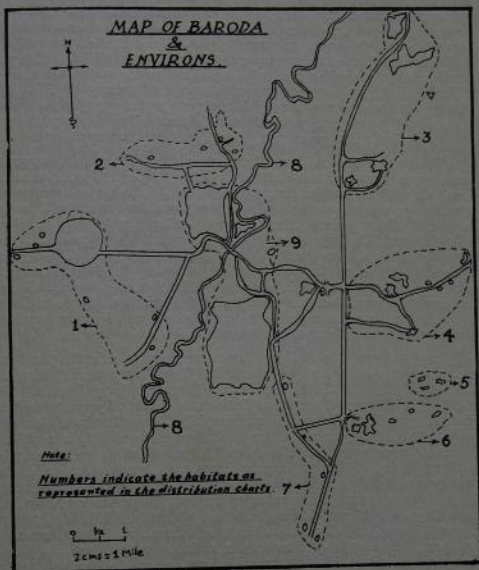
HABITATS

Hydrophytes are the denizens of ponds, puddles and marshes and hence were studied from such localities in Baroda. There are a number of ponds, natural or artificial; a great number of puddles, which are dry in the hot months and are filled up during the monsoons; River Vishwamitri and tributaries and a number of marshes or swamps, which exhibit a wide variety of aquatic flora. For our convenience, we have divided the area of study into 9 smaller areas, each of them having a number of habitats, where hydrophytic flora can flourish. The areas are Race-course, Nizampura and Chhani, Harni, Panigate, Sewage-Disposal, Pratap-Nagar, Lalbaug and Makarpura, River Vishwamitri and tributaries and finally the City area. Each area is fairly large and as such only the most important habitats have been taken into consideration while preparing the distribution chart.

DESCRIPTION OF THE PONDS

Race-course, Nizampura and Chhani, Lalbaug and Makarpura and the City areas are comparatively poorer in aquatic flora. Some marshes in the Race-course area show *Limnophila heterophylla*, *Sesbania bipinnata*, *Scirpus supinus*, *Caesulia axillaris* and *Ludwigia parviflora*. *Ipomoea aquatica*, *Asteracantha longifolia*, *Eclipta prostrata* are some of the dominant plants in many of the ponds or puddles in the above-mentioned areas. The marshes near the 'Nagarwada Talao' in the City area support an association of *Limnophyllum obtusifolium* and *Asteracantha longifolia*. *Isoetes coromandeliana*, *Butomopsis lanceolata* and *Scirpus quinquefarius* are some of the noteworthy plants of this area.

In the Harni area are included the Harni ponds (I and II), Varoshia and Sirsia ponds and 'Vaidawadi' an outlet for the Sirsia pond. The Harni ponds are perennial, though the water-level goes down considerably during the hot months. The aquatic flora here consists of *Nymphaea stellata*, *Nelumbium speciosum*, *Neptunia oleracea*, *Lagarosiphon alternifolius* in their waters, *Limnophila indica*, *Butomopsis lanceolata*, *Isoetes coromandeliana*, *Eleocharis plantaginea* as amphibious hydrophytes near the banks and *Enicostemma verticillatum*, *Elytraria acaulis*, *Acanthospermum hispidum* on their wet slopy banks. The marshes and the rice-fields round about show the presence of *Eriocaulon* sp., *Ludwigia parviflora*, *Dopatrium junceum* and *Utricularia reticulata*. *Potamogeton crispus* and *Hydrilla verticillata* are some of the important plants found in one distant corner of the Sirsia pond. As the water-level in this pond goes up, the overflowing water is drained through a canal known as 'Vaidawadi'. This canal supports a rich hydrophytic flora of *Nymphaea stellata*, *Ipomoea aquatica*, *Pseudoraphis aspera*, *Ceratophyllum demersum* in the waters, *Eleocharis plantaginea* and *Limnophyllum obtusifolium* as amphibious hydrophytes and *Cyanotis axillaris* and *Phaseolus trilobus* on the wet banks. On the advent of the dry months, *Ipomoea aquatica* dominated the water surface as well as the muddy banks. *Asteracantha longifolia* became more



aggressive occupying the area previously occupied by *Limnophyllum obtusifolium*. A considerable portion of the wet banks was exposed with the result that *Blepharis molluginifolia*, *Vernonia cinerea*, *Alysicarpus vaginalis* became firmly established. As the canal was reduced to its maximum, *Ipomoea aquatica*, *Marsilia quadrifolia*, *Gnaphalium indicum* and *Dentella repens* formed the main component of the vegetation present at that time.

Panigate area is probably the richest as far as the aquatic vegetation is concerned. Most of the temporary ponds in this area are utilised for the cultivation of water-chestnuts, though during the dry months, they show the presence of *Hydrilla verticillata*, *Azolla* sp., *Juncellus*

pygmaeus, *Potentilla supina* and *Gnaphalium indicum*. *Ottelia alismoides* is found in a small temporary pond in this area. Dudheshwar Mahadeo pond supports an association of *Nymphaea stellata*, *Ipomoea aquatica* on its waters and *Cyperus esculentus*, *Scirpus articulatus*, *Caesulia axillaris*, *Ludwigia parviflora* on the muddy water-logged banks, while Madhavpura pond exhibits a similar type of association on its surface-waters but differs in its fringe vegetation, which consists mainly of *Eleocharis plantaginea*-*Limnophytum obtusifolium*-*Oryza sativa* var. *fatua* community. Small ponds and puddles near 'Mohmed Talao' show the presence of *Sagittaria guyanensis*, *Ceratophyllum demersum*, etc.

The Sewage Disposal area shows a striking difference in its aquatic flora, which abounds in most of the nitrophilous species like *Asteracantha longifolia* and *Eclipta prostrata*. The marshes (whole area is saturated with sewage water throughout the year) show a dominance of *Juncellus laevigatus*, *Cyperus brevifolius*, *Cyanotis axillaris* and *Phyla nodiflora*. 'Koma' and 'Dudhiya' ponds have a vegetation very much different from that of any of the ponds in the area surveyed so far. These ponds are completely occupied on their surface-waters by the alga, *Microcystis*. Along the margins can be found plants like *Lemma polyrhiza*, *Ceratophyllum demersum*, *Ipomoea aquatica* and *Typha* sp. Kapuria Talao supports an association of *Eleocharis plantaginea*-*Nymphaea stellata* along with *Limnanthemum cristatum* and *Scirpus maritimus*.

Pratap-Nagar area includes Danteshwar ponds, Mandir pond and a number of puddles and water canals. Danteshwar ponds lie on the S.E. of the Baroda City, near Pratap-Nagar Railway Station. The ponds show a luxuriant growth of *Utricularia stellaris*, *Nymphaea stellata*, *Hydrilla verticillata*, *Lagarosiphon alternifolius*, *Trapa bispinosa*, *Marsilea quadrifolia*, *Aeschynomene indica* in its waters and *Phyla nodiflora*, *Merremia emarginata*, *Dentella repens*, *Eclipta prostrata* on its margins and wet banks. *Trigonella occulta* forms the carpet vegetation during the dry months when the water level goes down considerably. Around the main ponds, there are number of temporary water collections which invariably show *Monochoria vaginalis* in the centre and Marsh plants like *Ludwigia parviflora*, *Caesulia axillaris*, *Murdannia nudiflora*, *Annonia baccifera*, *A. multiflora*, *Fimbristylis miliacea* and *Cyperus difformis* along its margins. Such water collections, when dry during the hot months, show a luxuriant growth of *Heliotropium supinum*, *Chrozophora prostrata*, *Glinus lotoides* and *Polygonum plebejum*. Mandir pond supports an association of *Eleocharis plantaginea*-*Nymphaea stellata* along with *Hygrophiza aristata*, *Asteracantha longifolia* near the margins and *Fimbristylis junciformis* and *Juncellus pygmaeus* on its banks. The puddles in the area show a dominance of *Lemma polyrhiza*. The water canals have *Ceratophyllum demersum* in its waters and *Eclipta prostrata* and *Cyperus bulbosus* on its banks.

The River Vishwamitri takes its origin in the Pavagadh Hills and runs through the city of Baroda. During the monsoons, the river is usually in spate and the banks are flooded with the result that no vegetation is seen during these months. After the monsoons, the water level goes down, exposing the banks throughout. In the month of

October, the banks are muddy, showing a very sparse vegetation. At this time *Xanthium strumarium*, *Crotalaria medicaginea* and *Asteracantha longifolia* are the only plants available. During the dry months, *Lemna polyrhiza*, *Marsilea quadrifolia*, *Scirpus litoralis*, *Cyperus difformis*, *Bacopa monnieri*, *Canscora diffusa*, *Annamia baccifera*, *Gnaphalium indicum*, *G. pulvinatum*, *Sphaeranthus indicus*, *Verbascum coromandeliana*, *Phyla nodiflora* among others were collected. A thorough exploration of the banks is utterly necessary to throw some light on the problem of seasonal variations in the vegetation.

In the artificial ponds in the University area *Pistia stratiotes*, *Cyperus alternifolius*, *Equisetum debile* are some of the hydrophytes grown for ornamental or study purposes.

DISCUSSION

The aquatic and sub-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* (Vishwamitri waters), *Tetraspora* (Vaidawadi), *Zygnema* (Harni pond), etc.

II. Spermatophyta—Occur in still waters of the puddles; ex., *Utricularia*, *Lemna*, etc.

B. Communities of rooted plants entirely submerged— Found in fairly deep waters on the substrata of soft mud. ex., *Chara*, *Nitella*, *Lagarosiphon*, etc.

C. Communities of rooted and submerged plants with floating leaves—

Found in clear waters in the sheltered regions of the puddles and ponds, ex., *Nymphaea*, *Limnanthemum*, *Trapa*, etc.

D. Marsh communities—

Marsh plants tend to occur with their roots in water-logged soils. These plants are very common and occupy large areas. ex., *Limnophytum*, *Scirpus*, *Aeschynomene*, etc.

Most of the ponds are flooded during the monsoons and show the presence of some of the aquatic communities mentioned above, on its surface or near the banks. The water level subsequently goes down, exposing the wet banks which invariably show a luxuriant growth of a carpet vegetation of herbaceous plants such as *Acanthospermum hispidum*, *Alysicarpus vaginalis*, *Bacopa monnieri*, *Bergia odorata*, *Blepharis molluginifolia*, *Cyanotis axillaris*, *Dentella repens*, *Elytraria acaulis*, *Enicostemma verticillatum*, *Gnaphalium indicum*, *G. pulvinatum*,

Distribution of Hydrophytes in the various habitats of Baroda and environs.

No.	Name of the Plant	1	2	3	4	5	6	7	8	9
1	<i>Nymphaea stellata</i> Willd.	..	-	-	x	x	x	x	-	-
2	<i>Nelumbium</i> <i>speciosum</i> Willd.	..	-	-	*	x	-	-	-	-
3	<i>Melochia corchorifolia</i> L.	x	x	x	x	-	x	x	-	x
4	<i>Corchorus capsularis</i> Linn.	..	x	-	-	x	-	-	-	-
5	<i>Sesbania bipinnata</i> Fawc. et Rendl.	..	x	-	x	x	-	-	-	-
6	<i>Aeschynomene indica</i> L.	..	x	x	x	*	-	x	-	-
7	<i>Neptunia oleracea</i> Lour.	-	-	x	-	-	x	-	-	-
8	<i>Ammannia multiflora</i> Roxb.	..	-	-	x	x	-	x	-	-
9	<i>Ammannia baccifera</i> L.	..	x	x	x	*	x	x	x	x
10	<i>Ludwigia parviflora</i> Roxb.	x	-	x	x	x	x	x	-	-
11	<i>Trapa bispinosa</i> Roxb.	..	-	-	x	*	-	x	x	-
12	<i>Eclipta prostrata</i> Linn. Mantiss.	..	x	x	x	x	*	x	x	x
13	<i>Caesulia axillaris</i> Roxb.	x	x	x	x	x	x	x	x	x
14	<i>Limnanthemum indicum</i> Thw.	..	-	-	x	x	-	x	-	-
15	<i>L. cristatum</i> Griesb.	..	-	-	*	*	x	x	-	-
16	<i>Ipomoea aquatica</i> Forsk.	x	*	x	*	x	x	x	x	x
17	<i>Limnophila indica</i> Linn. Druce.	..	-	-	x	x	-	-	-	-
18	<i>L. heterophylla</i> Benth.	..	x	-	x	x	-	x	-	-
19	<i>Dopatrium junceum</i> Ham.	-	-	x	x	-	x	-	-	-

No.	Name of the Plant	1	2	3	4	5	6	7	8	9
20	<i>Utricularia stellaris</i> L. ..	-	-	x	x	-	x	-	-	-
21	<i>U. reticulata</i> Smith. ..	-	-	x	x	-	-	-	-	-
22	<i>Asteracantha longifolia</i> Nees. ..	x	x	x	.	.	.	x	x	x
23	<i>Hygrophila serpyllum</i> T. Anders. ..	-	-	x	x	-	x	-	-	-
24	<i>Alternanthera sessilis</i> R. Br. ..	x	x	x	x	x	x	x	x	x
25	<i>Ceratophyllum demersum</i> Linn. ..	-	-	x	x	x	x	-	-	-
26	<i>Hydrilla verticillata</i> Presl.	x	x	x	x	-	x	x	-	x
27	<i>Lagarosiphon alterni-</i> <i>folius</i> Roxb. Druce ..	-	-	x	x	-	-	-	-	-
28	<i>Vallisneria spiralis</i> Linn.	-	-	x	x	-	-	-	x	-
29	<i>Ottelia alimoides</i> Pers. ..	-	-	-	x	-	-	-	-	-
30	<i>Monochoria vaginalis</i> Presl. ..	x	-	x	x	-	x	-	-	-
31	<i>Typha</i> sp. ..	-	-	-	-	x	-	-	-	x
32	<i>Lemna polyrhiza</i> Linn. ..	x	x	x	x	x	x	-	x	x
33	<i>L. gibba</i> Linn. ..	-	-	x	x	-	-	-	-	-
34	<i>Sagittaria sagittifolia</i> Linn. ..	x	-	x	x	-	x	-	-	x
35	<i>S. guyanensis</i> H.B. & K.	-	-	x	x	-	-	-	-	-
36	<i>Limnophytum obtusi-</i> <i>folium</i> (Linn.) Miq. ..	x	-	x	.	-	x	-	-	x
37	<i>Butomopsis lanceolata</i> Kunth. ..	-	-	x	x	-	x	-	-	x
38	<i>Aponogeton monostachyon</i> L. ..	-	-	x	x	-	x	-	-	-

No.	Name of the Plant	1	2	3	4	5	6	7	8	9
39	<i>Potamogeton indicum</i> Roxb.	..	..	..	×	×	..	..	..	..
40	<i>P. crispus</i> L.	..	..	..	×	..	..	..	..	..
41	<i>Eriocaulon</i> sp.	..	..	..	×	×	..	×	..	×
42	<i>Cyperus brevifolius</i> Hassk.	..	..	×	×	*	*	..	×	×
43	<i>Juncellus laevigatus</i> C.B. Cl.	..	..	×	×	*	*	×	×	×
44	<i>Cyperus difformis</i> Linn.	×	..	×	×	*	×	*	×	×
45	<i>C. esculentus</i> L.	..	..	×	×	..	×	..	×	..
46	<i>C. exaltatus</i> Retz.	..	..	..	×	..	×	..	×	..
47	<i>Eleocharis plantaginea</i> R. Br.	..	..	..	*	*	..	*	..	×
48	<i>Fimbristylis miliacea</i> Vahl.	..	..	..	×	×	..	*	..	×
49	<i>F. quinqueangularis</i> Vahl.	..	×	×	×	×	..	×	..	×
50	<i>Scirpus articulatus</i> Linn.	..	×	..	*	*	..	×	×	..
51	<i>S. litoralis</i> Schrad.	..	..	..	*	*	..	×	×	*
52	<i>S. supinus</i> Linn.	..	×	..	×	×	..	..	×	×
53	<i>Hygrophiza aristata</i> Nees.	..	..	..	*	*	..	×	..	×
54	<i>Pseudoraphis aspera</i> Pilger.	..	..	..	×	×	..	..	..	..
55	<i>Oryza sativa</i> var. <i>fatua</i> .	×	×	..	*	*	×	×	..	×
56	<i>Isoetes coromandeliana</i> L.	..	..	..	×	..	..	..	..	×
57	<i>Marsilea quadrifolia</i> L.	×	×	..	*	*	×	..	×	×
58	<i>Azolla</i> sp.	..	..	..	×	×	×	×	..	..

1. Race-course area; 2. Nizampura and Chhani area; 3. Harni area;
4. Panigate area; 5. Sewage Disposal area; 6. Pratap-nagar area;
7. Lalbaugh and Makarpura area; 8. River Vishwamitri and tributaries. 9. City
area.

.., Absent.

×, Present.

*, Abundant.

Heylandia lutebrasa, *Hybanthus emeaspermum*, *Juncellus pygmaeus*, *Lauraea nudicaulis*, *Potentilla supina*, etc.

During the dry months, the water level recedes to its maximum and the ponds and puddles present a characteristic plant community consisting of *Argemone mexicana*, *Athagi camelorum*, *Chrozophora prostrata*, *Coldenia procumbens*, *Cressa cretica*, *Heliotropium supinum* and *Polygonum plebejum* on their exposed soils.

The 58 species (excluding the wetland and terrestrial species) encountered in the survey belong to 46 genera and 27 families. Families in groups, other than the angiosperms, include the Isoetaceae, Salviniaceae and Marsileaceae. Of the 24 families of angiosperms, there are 9 monocotyledonous and 15 dicotyledonous families. The percentage of the monocot and dicot families in this survey comes to 37 and 63 respectively. The monocot families contribute 30 species distributed among 23 genera, while the dicot families have 25 species dispersed through the remaining genera. Though the ratio of the number of monocot families to that of dicot families comes to 1:1.7, the ratio of the number of species belonging to those classes is 1:1.1.

The distribution of these aquatic plant communities in the various areas is 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 amplitude of water level, turbidity and sedimentation, type of bottom and depth and temperature of water. The chemical factors like oxygen tension, nutrients, acidity and alkalinity are always more important. 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 is made, this peculiar pattern of distribution of the aquatic communities cannot be accounted for.

SUMMARY

1. An introduction stressing the need of a comprehensive data on the floristic composition and distribution of the aquatic plant communities occurring in Baroda and its rich environs.
2. Description (location, climate, etc.) of the area of study is also given. The area is divided into 9 smaller areas.
3. Description of the various ponds and puddles with a brief account of the aquatic flora occurring there.
4. A distribution chart, giving in details the distribution of the aquatic plants in the various habitats of Baroda and environs. Only the most important habitats have been taken into consideration while preparing the chart.

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