



**BIOINFORMATICS ON THE ECOLOGICAL AND
EVOLUTIONARY DIVERGENCES OF HERBACEOUS PLANTS
GROWING IN BARODA REGION**

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SUMMARY

Over the past few decades advances in the field of biology coupled with advances in computer technologies led to an explosive growth in the biological information generated by the scientific community. This deluge of information has, in turn, led to an absolute requirement for computerized databases to store, organize and index the data, and for specialized tools to view and analyze the data. Bioinformatics or biological information technology is the most powerful and fast developing sector in the information technology. It is essentially a fusion of various facets of biological sciences (functional, structural and technological) with mathematics, computer and information technology. Bioinformatics can be defined as the area/branch of information technology that deals with all aspects of biological systems- 'data mining' with the aim of conservation, sustainable utilization that converts bio-resources into economic wealth. It thus involves information pertaining to biological resources, inventory documentation, acquisition, processing, storage, distribution, analysis and interpretation, that combines the tools and techniques of mathematics, computer science and biology with the aim of understanding the biological significance of variety of data. Today the information technology has become the most useful tool for documentation of information on different aspects. With the development of many user-friendly software packages, faster chip sets, larger storage devices, etc , there has been amazing progress made in this field that has led the world to come much closer and easily accessible today for any desired information pertaining to biological diversity.

In terms of floral biodiversity, India has rich flora of about 45,000 species ranging from algae, fungi, mosses, ferns, lichens, conifers and flowering plants. Flowering plants make about 17,500 species in the form of trees, shrubs and herbs. Amongst the three, herbaceous group comprises of a large number of species, few of which remain imperceptible because of its inconspicuous looks and small size. The remarkable evolutionary success of angiosperms is such that this division deserves special attention. Major

information on the subject is in the form of printed books, journals or on the labels of millions of specimens in various herbarium collections. The major endeavor needed in this field lies in building up an easy methodology which helps in quick and correct identification of these less noticed plants and along with that edifice a devise which stores the inventory of the existing flora of the country at one place that can be easily accessible to every one interested. One of the easiest and convenient methodologies of identification is through the field photographs of individual plants. Information technology offers an efficient and feasible technique to handle the task of maintaining exhaustive information in an electronic format. Easy accessibility makes it convenient to use. Building a database is vital for any organization. The photographic database has its own importance and can be widely used in various fields.

Another aspect to look into is evolution in biological divergency. The capacity to evolve is an essential characteristic of all life. Plants clearly have sophisticated methods of determining the environment they experience. This ability has important consequences for evolution of morphology, physiology and life history. Natural environmental can generate powerful selection pressures, enough to drive evolution forward at a great pace if the variation is present. There is a range of good evidence that short term evolution can take place in relation to the climatic fluctuation. Even in normal conditions, most climatic factors are strongly fluctuating. Although, there is usually a regularity due to seasons, there is also a strong stochastic element. This has caused the evolution of strong physiological and phenological plasticity in most of species which allows individual, and therefore species, to cope with wide range of climatic conditions during their life times. When populations of organisms spread over a large area, groups can be under different environmental conditions and reproductively isolated. For plants, their time of flowering, bud break and leaf fall, and their temperature tolerance is adapted to the local environment. When plants colonize a new environment, with little existing vegetation they have an opportunity to develop a variety of forms to fill different ecological niches. This leads to phenotypic plasticity. Phenotypic plasticity is the ability of individuals to alter its physiology, morphology and/or



behavior in response to a change in the environmental conditions and the potential for an organism to produce a range of different, relatively fit phenotypes in multiple environments

Increased human population in the last few decades demanding development in various spheres has resulted directly or indirectly in sudden and often far reaching disturbances in natural ecosystems. Humans have started to realize the tremendous impact their activities has on other species with which they share the resource of earth. Population of scores of species are diminishing or disappearing locally, regionally and finally leading to the global extinction. Extinction *per se* is not a creation of humans or their activities. It is a natural phenomenon. Anthropogenic activities are making species more vulnerable to extinction. Human pressures are larger in urban systems bringing huge variations in the local flora and fauna. The natural ecosystems are gone at least in big cities and their places have been substituted by synthetic or artificial ecosystems. Baroda city and its surroundings is an example of an urban ecosystem where tremendous urbanization and industrialization during last 4 decades have changed the whole environment. In coherence with global climate, regional weather conditions are getting changed augmenting the magnitude of problems faced by the local biota. The synergistic effect of biotic stress on the quality and quantity of vegetation cover at Baroda and its surrounding region is being studied. Emphasis is given on scrutinizing herbaceous vegetation in the selected study area. Compared to trees and shrubs which live for highly variable period, herbaceous plants grow, flower and form fruits completing life cycle in less than a year's period. The plants are sensitive and respond quickly to the anthropogenic pressures. Their short period of life span facilitates to monitor the changes/variations occurring during their life cycles. An electronic database of herbaceous vegetation of the study region developed can be linked to any of the larger databases for wider dissemination of knowledge. Availability of past published records of vegetal cover of Baroda and its surrounding facilitated to look for evolutionary variations however small they could be

The major objective of the study was preparing a database for the existing herbaceous vegetation.

Looking into the ecological divergences and evolutionary trends of herbaceous plants growing in Baroda and surrounding regions.

The area selected for the study includes Baroda city and Savali taluka of Baroda district. Area of Baroda district lies between $22^{\circ} 0'$ and $22^{\circ} 30'$ N latitude and $73^{\circ} 0'$ and $73^{\circ} 30'$ E longitude. The area is transversed by rivers namely Vishwamitri, Mahisagar, Meni and their tributaries. Immense urbanization in the area has resulted in bringing variations in the existence of natural vegetation.

The area of Savali taluka lies between $22^{\circ} 30'$ and $22^{\circ} 55'$ N latitude and $73^{\circ} 0'$ and $70^{\circ} 20'$ E longitude. The area is traversed by various rivers namely Mahisagar, Meshri, Kawach, Goma, Karad, Vishwamitri and their tributaries. The area is agriculture dominated. Here as compared to regions of Baroda city, urbanization and industrialization are at small scale, hence natural vegetation is seen spread across the area.

Floristic details of past decades for the study area are available as under-

- 1) 1967 A study on the flora and vegetation of Baroda and environs including an account of Cyperaceae of Gujarat - Ph. D. Thesis by Prof. S. D. Sabnis
- 2) 1973 : Studies on the flora and vegetation of Savli taluka - Ph. D. Thesis by Dr. S. N. Padate
- 3) 1980: Studies on the residual urban vegetation system at Baroda - Ph. D Thesis by Dr. S. N. Patil

Compilation of previously available data for the study area was done in a specific format. 6 sampling sites were selected in the sub areas of Baroda region (Nandesari, IPCL, Laxmi Vilas Palace and Timbi) and Savli region

(Mevli and Goral) based on the variety of habitat and levels of anthropogenic pressures and disturbances for ecological studies. The areas were visited regularly at an interval of 15-20 days. Ten sampling plots of (1m × 1m size) were laid randomly at each sampling site. Details relating to the frequency, density and abundance were estimated from the sampled plots. Observations were gathered for three consecutive years. Details pertaining to the phenology, phenological plasticity, major associations, distribution and the current status were congregated for all the located herbaceous plant species. The results thus obtained are compared with the data available from 1967, 1973 and 1980 to find the kind of plasticity in the distribution and diversity of herbaceous vegetation.

One of the major objectives of the study was to prepare a digital database of herbaceous plants of Baroda and environs. The digital database contains details of 465 plant species belonging to 74 families in HTML format.

Study reported plant species, *Aeschynomene villosa* Poir. which is a new report for India. It was confirmed with BSI, Calcutta. A specimen was deposited at M.S. Univ. herbarium (BARO).

Based on the disturbance gradient and anthropogenic pressure levels, the phenological cycle of the herbaceous plants varied. In more disturbed sites i.e. Nandesari and IPCL, species richness and number of dominant species in the community was less compared to less disturbed sites. Life cycle duration of the plant growing at Nandesari and IPCL was curtailed compared to other sites. Moreover the reproductive phase at these sites started early and was of shorter duration as compared to those growing at lesser disturbed sites. Plants tried to wind up their reproductive phase to minimize their exposure to stress conditions in the disturbed sites. Because of high grazing pressures plants at Nandesari and IPCL showed morphological variations which included stunted growth compared to that of plants growing in other undisturbed sites. The effect of industrial pollution was observed on the floral

coloration and vegetative texture in the sites at Nandesari and IPCL. The floral coloration was found faded and the leaf showed browning and loss of pigmentation which is a mere effect of industrial pollution.

Phenotypic variations were noted amongst the plants growing in Baroda and Savli region. The two regions varied in the microenvironmental conditions because of the disturbance levels. Effect of microenvironmental conditions on herbaceous plants was observed in the height characteristics and corresponding reproductive output. Plants of Savli region were taller with bigger foliage compared to plants of Baroda. Correspondingly the reproductive output was also found more in plants growing at Savli region.

There existed 98% similarity in the species variety but a major difference existed in the densities of these species. Percentage of plants occurring with high density were more in Savli region compared to Baroda region where as percentage of plants occurring with moderate and low density was high in Baroda region compared to Savli region. This was the effect of higher fragmentation prevailed in the available wild habitats in Baroda region due to high human population rates, high degree of industrialization, urbanization, commercialization and other anthropogenic pressures.

Metapopulation study has resulted in identifying three ranges of metapopulation structure – broad, moderate and narrow. The plants falling in broad range inhabited a wide range of habitats in the study region and found to have high probability to continue through generations. Even if one of the habitat is fragmented or disturbed or destroyed, then the continuity of those plant is persevere through the other range of habitats. The plants falling in the moderate range of metapopulation were distributed in specific habitat across the area but their status in that specific habitat was very high. The probability of these plants to continue is secured in a particular region until the specific habitats are protected. The disturbance or destruction of habitat might result in lowering down the population composition of this particular group of

plants The plants with narrow range were those which were seen growing in a specific habitat or were distributed in a narrow pocket of a particular region only with meager density. The extinction risk of this group of plants is high as the disturbance, fragmentation or clearance of that particular habitat might result in disappearance of these plants from the region.

Comparison of current records with past data of Baroda and Savli resulted in identifying the impact of changes in landuse pattern and variations in meteorological parameters since last 4 decades. It resulted in the shift of reproductive phase initiation. Curtailing of reproductive period in the herbaceous plants was also noticed High amount of land conversion in residential, industrial and commercial areas and has resulted in density shifts in some and local extinction of a good number of plants reported as rare in the previous records. The changed characters are seen to continue with uniformity during the three years of the study.

The plant species possessing a group of characteristics like habitat unspecific, longer duration of flower opening, life cycle of more then 6 months duration, smaller size of flower and seeds, variety in associated species, climbing nature, rooting at nodes, etc. are found to continue with high density for many generations

Herbarium comparison with past records was done for the plant species which had shown a steep decline in density compared to past records. The study reported that sizeable number of plants had shown reductions in size and number of flower, fruit & seed, in the size of plant, in branching pattern, finally affecting the size of population. These reasons might have eventually resulted in declining the population by lowering down the reproductive out put resulting in the density decline of plants in the region Past records depict that the plants were growing in sizeable populations in the reported localities which were continuous (un-fragmented). The same areas are now showing high amount of fragmentation due to developmental activities and are

influenced by high levels of disturbance which is the probable reason for the isolation of population of the plants. The effects of isolation and change in microenvironmental conditions have resulted in peripheral populations diverging from central populations both morphologically and genetically. This might have led to lower levels of gene flow between populations. Populations with very low levels of variability and adaptability to evolve for changing environmental conditions, including climate change has resulted in altering morphological characters, lowering reproductive output and reducing the population size.



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