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# Pune Urban Biodiversity : A Case of Millennium Ecosystem Assessment

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## Introduction

Love for nature resides amongst all of us, goes the Biophilia hypothesis (Wilson, 1984). This often translates into curiosity and subsequently, careful observation of the environment. Few have both the inclination and the resources to pursue such studies. Such amateur naturalists frequent cities that are centres of education and wealth. Ironically, flourishing cities made up of manmade capital survive by eroding their natural capital. This prompts the naturalist to lament and protest in vain, the so-called development activities that only destroy nature. Lack of good, useful information is a major reason for such shortsighted, unsustainable development. Naturalists have important perceptions about changing environment of the city but rarely record and project those to generate sharp arguments. A strong scientific argument can help, if not guarantee environmental protection. Thus naturalists do not help nature if they fail to build substantive arguments. Some naturalists from Pune, decided to make a difference by overwhelmingly responding to a call by a city-bred NGO, RANWA (Research and Action in Natural Wealth Administration). Incidentally, 'ranwa' means 'wilderness' in vernacular and is a term coined by the editor of this journal Prakash Gole. The enthusiastic response to RANWA's appeal was spearheaded by the Abasaheb Garware College (AGC) faculty and students. This academic collaboration amongst naturalists together with academicians began earlier this year, strengthened and refined by about half a dozen meetings over the year, leading to this publication in the millennium year due to generous help from various quarters! In part, this study was triggered by the vision motivated by the local millennium ecosystem assessment exercise pioneered by Indian Institute of Science (IISc), Bangalore and coauthored by some of us (Gadgil *et al*, 2000).

## Methodology

Unlike the above assessment, we had neither financial nor human resources to investigate the non-living ecosystem components such as soil and water parameters or even air pollution. We attempted to make the best with available human resource, exposed to natural history through earlier efforts like the IISc's college network involving the AGC (Gadgil, 1996 b). Our approach stemmed from the belief that living organisms serve as reliable ecosystem indicators (Hawkswarth, 1995). We began by standardising the methodology so that results across organismic groups become comparable and relate to levels and kinds of human impacts. Thus, a common definition of land and water habitats was arrived at through discussion and literature survey. These habitat types, specified in each organismic manuscript in this volume, are macrohabitats, ranging over the hectare scale (Gadgil, 1996 a). Information on microhabitat i.e. meter scale is also available but not analysed for this publication, which only aims to generate a preliminary, broad scale understanding. The land habitat types, roughly

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in the decreasing order of relative human influence include : forest (F), scrub (S), grasslands (G), plantations (P), agriculture (A) and habitations (H). The first three habitat types constitute the wilderness (W) zone while the latter three types constitute the impacted (I) zone. The aquatic ecosystem classification remained at a broad level – low (W) and high (I) impact zones.

After standerdising the sampling strata, a qualitative sampling scale was designed to rank the abundance/frequency of encounter of species, as we had only a few systematic counts available and that too for a few groups. To cope with the considerable inter-observer variation, we used the ordinal ranking popular amongst naturalists, with qualitative categories like abundant, common, occasional and rare, besides stray. Preferred habitat type of each species around Pune city is indicated in each manuscript, except the stray species. As a matter of fact, aquatic insects could be identified only up to family level while ants and fungi up to genus level.

Sampling intensity varied across organismic groups. For instance, birds are the most intensively studied organisms with many birdwatchers pooling their observations for decades together. In contrast, aquatic invertebrates or ants were seldom studied here earlier, resulting in poor literature. There is no illusion that this volume is a complete and accurate inventory. We believe that this first comprehensive record will trigger debate, criticism, relevant observation and publications, even elsewhere. Further, while invertebrate records are mostly only recent, records of vertebrates or trees indicate species not recorded recently, but reported from literature. This has indeed made this effort a millennium assessment both symbolically and literally! The focus being diversity, no wonder that presentations in this volume have variously evolved. Thus, while Kharat *et al* carefully discriminate driving forces of decline in fish diversity, Patwardhan partitions reported increase in tree diversity to observer biases and errors. Yardi and Korad have shown now intensive and allout search can reveal many new bat species hither to unknown to the region. While habitat typology remains the focal theme of investigation for most groups, emphasis has been given on specific localities of occurrence in case of lower or sedentary groups like ants or fungi.

The study area has a radius of about 30 km from the City Post office. The study area is termed as 'Pune Urban Area' measuring about 700 sq. km and consists of Pune and Pimpri-Chinchwad Muncipal Corporations besides cantonments at Pune, Khadki and Dehuroad. It also includes Talegaon and a few semi-urban villages in the adjoining area including the Sinhagad fort, a favourite nature study spot. The area is situated on the Deccan plateau in the transition zone leading to Western Ghats mountains to the West.

**Results and Discussion**

Table 1 depicts the citywise diversity levels for various organismic groups, with only ant diversity being considerably underestimated. Pune urban area appears to shelter between a third to over two thirds of the total taxic richness reported for vertebrate groups from the whole of the Deccan plateau (Nagalu *et al*. 2000). In part, this high diversity relative to a small expanse can be attributed to location of Pune city in the transitional zone between dryland plateau and moist mountains, connected to the city through hills. This largely explains the higher diversity of Pune urban area than the levels reported for most groups from Bangalore (Karthikeyan, 1999) and Delhi (Anon, 1997). Interesting biogeographic patterns include much lower fish and mammal diversity at Bangalore than Pune, the latter being much better connected to the Western Ghats through rivers and mountains. The Himalayan influence probably explains much higher diversity of birds and fish at Delhi, notwithstanding much lower levels for other groups. Some of these differences can be attributed to differing sampling intensity across cities and groups. To address this difficulty, Gadgil *et al* (2000) provide an interesting statistical technique to estimate total taxonomic richness from distinct subsamples, such as locality wise

**Table 1 Biodiversity of Some Indian Cities**

| Group | Unit | Pune+ | Bangalore* | Delhi† |
|---|---|---|---|---|
| Fungi | Genus | 65 | | |
| Herbs | Species | 600 | | |
| Trees | Species | 350 | | |
| Aquatic insects | Family | 13 | | |
| Snails | Species | 15 | | 23 |
| Ants | Genus | 12 | 73 | |
| Butterflies | Species | 105 | 130 | 50 |
| Fishes | Species | 70 | 40 | 87 |
| Amphibians | Species | 14 | 15 | 7 |
| Reptiles | Species | 50 | 37 | 25 |
| Birds | Species | 300 | 315 | 434 |
| Mammals | Species | 65 | 40 | 32 |

+ Present study, * Karthikeyan (1999), † Anon (1997)

data on occurrence of ants. In any case, the comparison highlights that Indian cities also host phenomenal levels of biodiversity and a few, such as Mumbai or Chennai host even wildlife reserves alongside skyscrapers. This matches the trends elsewhere on the globe (Burton, 1977).

Table 2 indicates that various organismic groups differ considerably with respect to their diversity distribtuion across habitat types and human impact levels. Some groups such as butterflies, reptiles and mammals have almost all their species recorded from wilderness zone while nearly two thirds of them occur in forests. In contrast, diversity of fungi, herbs and trees seems to be as much or more in impacted habitats than in low impact zone. The biodiversity is lower in impacted habitat types in case of sensitive organisms like the fish (Kharat *et al*, this volume) or birds (Ingalhallikar *et al*, this volume) than the less sensitive organisms such as ants (Pachpore *et al*, this volume). Notwithstanding the maintenance of considerable species richness amidst urban habitats, some unique species are even wiped out under human impact, only to be replaced by more tolerant species owing to suitable life attributes like dispersal abilities. Such species substitution explains higher species richness in habitat types such as scrub (a result of moderate human impact), harbouring greater diversity than the most or least impacted habitats. While the habitat approach adopted here highlights a broader picture, much remains to be projected in terms of finer impacts such as loss of squirrel or snake populations due to conversion of old houses in the city into skyscrapers.

The results confirm the widely known trends of an increase in species diversity with moderate disturbance, though severe human influence tends to erode the diversity, except a few stress tolerant species, often having cosmopolitan distribution and wide habitat choice (Daniels *et al*, 1990). Further, rather than the total species diversity, human impact critically affects the diversity of unique species like habitat specialists as also emphasised by Daniles *et al* (1990). Another notable trend is lack of tight correlation across organismic groups, in response to similar human influence as reported in the literature (Kunte *et al*, 1999). For instance, while fish species seem to be sensitive to levels of pollution, besides harvest or introduction of exotic species, aquatic invertebrates appear much less sensitive, notwithstanding the sensitivity mentioned in the literature (Raut *et al*, this volume). The higher diversity recorded in some moderate or high human impacted zones such as the city heart or home gardens must not mislead one to undervalue the less impacted zones like the hill forests surrounding the city. For, these continue to be the biodiversity source while most urban habitats serve merely as sinks, unable to sustain the diversity on their own. For instance, nearly

**Table 2 Habitat level covariation of diversity and exclusivity across organismic groups : Pune Urban Area**

| Group | Unit | Total Urban | % OF TOTAL DIVERSITY | | | | | | | | % UNIQUENESS# | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | *F | S | G | A | P | H | W | I | F | S | G | A | P | H | W | I |
| Fungi | Genus | 65 | 65 | | | | 95 | 40 | 80 | 95 | 5 | | | | 25 | - | 5 | 25 |
| Herbs | Species | 600 | 20 | 10 | 15 | 10 | 20 | 40 | 45 | 55 | | | | | | | | |
| Trees | Species | 350 | 25 | 15 | | | 65 | 15 | 35 | 65 | 75 | 65 | | | 80 | 10 | 95 | 95 |
| Aquatic insects | Family | 13 | | | | | | | 75 | 70 | | | | | | | 40 | 20 |
| Snails | Species | 15 | | | | | | | 60 | 70 | | | | | | | 50 | 40 |
| Ants | Genus | 12 | 45 | | 35 | 35 | 65 | 35 | 50 | 70 | 20 | | - | - | - | 20 | 25 | 15 |
| Butterflies | Species | 105 | 70 | 75 | 40 | 70 | 55 | 35 | 95 | 70 | 15 | 3 | - | - | - | - | 25 | 3 |
| Fish | Species | 70 | | | | | | | 100 | 50 | | | | | | | 30 | 10 |
| Amphibians | Species | 14 | | | | | | | 100 | 60 | | | | | | | 35 | - |
| Reptiles | Species | 50 | 60 | 40 | 40 | 45 | 50 | 15 | 80 | 55 | 25 | 5 | - | - | - | 10 | 25 | 5 |
| Birds | Species | 300 | 35 | 50 | 15 | 30 | 25 | 10 | 95 | 35 | 35 | 5 | 5 | - | - | - | 60 | 5 |
| Mammals | Species | 65 | 60 | 30 | 15 | 30 | 20 | 20 | 65 | 55 | 30 | 10 | 6 | - | - | 6 | 30 | 6 |

* F = Forest, S = Scrub, G = Grassland, A = Agriculture, P =, Plantation, H = Habitation, W = Wilderness (F, S, G), I = Impacted (A, P, H)
# Uniqueness reflects the proportion of exclusive species to the total that inhabit a given habitat type / zone.

a fifth of the butterfly species emerge from their food plants confined to the hill forests (Kunte, this volume) which also exclusively host over a sixth of the bird species, seldom seen elsewhere in the city campus (Ingalhallikar *et al*, this volume). Thus, bird or butterfly richness in the city gardens is inconceivable without the hill forests.

Table 3 presents the past and present landscape composition and ongoing changes, based on perceptions, besides records (Nalavade, this volume). Pune urban area has been expanding at an average rate of about 500m per year for the last two decades or so. Human habitations are encroaching upon the farm land and orchards of the fringe villages. The most suffered habitat type has perhaps been riverine vegetation especially babul (*Acacia nilotica*) tree groves along the rivers Mula and Pawana. Grassland and scrub on the eastern outskirts have also been destroyed. There is heavy pressure on scrub and forest in the hills for fuel wood especially near the hutments e.g. Kelewadi slum adjoining Bhamburda forest park and Mutha canal slums near Parvati-Pachgaon. Bootleggers located in the hills are also responsible for tree cutting. Pune city hosts more than one million vehicles, over three-fourths being two-wheelers. Additional 10,000 vehicle pass through the city every day. The traffic on all the outgoing roads, particularly the high ways, is heavy and continuous, even during night hours. The Mumbai-Bangalore bypass constructed recently skirts the city along the western and south-western margin and virtually cuts through the Parvati-Panchgaon forest park. This study brings out its impacts in terms of loss of amphibian (Padhye and Mahabaleshwarkar, this volume) and mammal (Nalavade, this volume) populations.

Though we do not have complementary data on non-living ecosystem parameters like air, soil and water pollution loads, their monitoring may become gradually possible, through likely collaboration with the international ecosystem assessment (Ayensu *et al*, 1999), that encourages local assessments (Gadgil *et al*, 2000). In any case, the present millennium assessment of living components of an urban ecosystem would set the tone for their ongoing, periodic monitoring, regardless of physio-chemical studies; as already initiated by some authors of this volume (Kunte, 1997). But without eyeing for large, sponsored projects, environmental students from Pune University have voluntarily initiated chemical monitoring of various impact zones of waterbodies around Pune (Ghole, V. S., Jagdale, R., *pers. comm.*), furthering the earlier research (Gunale, 1987).

Our efforts were inspired by the pioneering, amateur effort to compile checklists of urban fauna at Bangalore (Karthikeyan, 1999). Later, we chanced upon a more professional endeavour (Anon, 1997). However, the benchmark publication lacked the details of species habitat preference or relative abundance estimates, prompting us to provide those for the present monitoring around Pune city. Most phenomenal organismic monitoring in India is perhaps the nationwide waterfowl count. While this decade old decentralised effort has inspired thousands of birdwatchers to census bird populations on a predetermined day, every year, no results appear to be churned out or popularised, despite mere compilations since long (Joost, 1987). Unfortunately, the leading national and international agencies like Bombay Natural History Society (BNHS), Asian Wetland Bureau (AWB) appear silent on this count. Interestingly, smaller groups have triggered locality specific data literacy, as evident from the efforts of Prakriti Samsad, a birdwatcher's

**Table 3 Habitat Dynamics of Pune urban Area**

| HABITAT TYPE | % AREA 1950 | % AREA 2000 | CONVERTED INTO | TYPICAL AREAS |
|---|---|---|---|---|
| Forest | 7 | 6 | Plantations | Katraj, NDA, Law college hill |
| Riparian forest | 1 | - | Agriculture | Aundh (Mula river) |
| Scrub/grassland | 10 | 8 | Habitation, Plantations | Malwadi, Nagar road |
| Wastelands | 2 | 1 | Habitation | Nagar road, Solapur road |
| Agriculture | 60 | 40 | Habitation | Manjari |
| Plantations | - | 3 | - | Pachgaon |
| Wetlands | 3 | 2 | Habitation | Pashan, Mula-Mutha |
| Habitation | 15 | 40 | - | All over |

group at Calcutta that has published their data, if not the results or signals, that would gradually emerge (Mukherjii, 1999). Similarly, Kalpavriksh, an NGO is initiating data analysis and publication from monthly bird counts across Delhi over a decade (Kothari, A., *pers. comm.*), besides having recently published a fieldguide to promote monitoring (Smetacek, 2000). The college/NGO network initiated by the IISc, Bangalore, along the Western Ghats (Gadgil, 1996 a, Kunte *et al*, 1999) has also begun emphasising importance of building local assessments and awareness, besides developing the training material (Kunte, 2000). Colleges around Nasik (Acharya, S. *pers. comm.*) and Mangalore (Bhat, G. K., *pers. Comm.*) have already expressed interest in similar assessments and publications next year, besides parallel effort by NGOs in Nagpur city (Ladkhedkar, R. *pers.comm.*)

It is hoped that such studies would promote further scientific development such as a study of plant-butterfly (Kunte, 1997) or fig-bird relationships (Utkarsh and Almeida, 1999), eventually leading to careful ecological monitoring. Such monitoring can help better understanding of the ongoing process of ecorestoration around the Pune city, such as at Pachgaon, Bhamburda and Chandani chowk hills. Here, protection by Forest Department coupled with the vigil by nearby residents who regularly visit these areas for exercise or recreation has facilitated regeneration of natural plants and revival of native fauna. Temple trusts, educational institutions such as 'Dnyanprabodhini', NGOs such as 'Nisargasevak' have also helped this cause. The revival of natural trees or herbs amidst plantations, has triggered colonization of these new habitats by birds, butterflies etc. Notably, even seasonal puddles, formed in these areas now harbour moults of dragonfly nymphs etc. indicating ongoing colonization and establishment of organisms that are highly susceptible to seasonality. Recently increasing tree cover of suitable species in some areas such as the Osho Park has probably similarly helped predominantly Western Ghats dweller butterflies such as the Blue Mormon, seldom seen in the city earlier (Kunte, this volume). An understanding of eco-restoration process can help its manipulation and replication in neighbouring areas and even other cities (Jordan *et al.*, 1987). Besides, such ongoing monitoring can easily detect notable declines in certain species like the sparrows and vultures, being noticed and debated currently (Rahmani, A., *pers. comm.*). If such sudden population fluctuations are any signal of impending calamity, the purpose of monitoring is served much beyond academic interests. Such monitoring can even become quite popular, yet cost effective through internet publicity such as the electronic discussion group of Asian naturalists having thousands of members worldwide (nathistory-india@lists.Princeton.EDU).

Notably, such publications based on long term observations might pre-empt the facile environmental impact assessments (EIAs) that are currently mushrooming like a fashion, such as those on the proposed dams on the river Narmada, where Puneites have made significant contributions either way. While upholding the cause of dam construction, the Supreme Court has often expressed dissatisfaction about superficial environmental assessments. Unfortunately, environmentalists are not equipped with much concrete, scientific data. That scientific data can at times lead to stringent legal action against environmental hazards is proven in case of pollution at Delhi and Agra. Unfortunately, much of the EIA activity is driven by the sponsor's interests in promoting development at the cost of environment. Since RANWA did not seek any targeted sponsorship, this effort lacks such directed loyalty. We hope that this initiative will kick off more such efforts, both locally and elsewhere. Such proactive, decentralised monitoring, especially by the students, is envisioned by the Project Lifescape launched by the Indian Academy of Sciences, Bangalore, to pay tribute to Dr. Salim Ali (Gadgil, 1996 b, Kunte, 2000). If the recent legal activism takes note of such serious publications, environmental care cannot be easily wished away by the shroudy EIAs. It is with this hope that we have uploaded this entire volume on internet (http://www.ranwa.org/punealive)

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# Fungal Genera Distribution Across Pune City

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## Introduction

Kingdom Fungi constitutes the most diverse group of organisms, that also exhibits myriad enigmatic shapes, caps and parasols, balls and crumples sheets, layered plats and overlapping shingles, muted and gaudy. These appear suddenly amongst the fallen leaves, on trees or encrusting dead wood, just after the first shower of the monsoon. Despite their popularity, not many people know mushrooms as being fruiting, rather spore producing bodies of some fungi. Mushrooms possess pigments of various colours viz. white, cream, red, yellow, lavender, blue, green, pink, orange, brown and even black. However, mushroom lack chlorophyll unlike plants and therefore cannot manufacture their own food from solar energy. They absorb their nourishment, primarily carbohydrates, directly from dead or live plants and animals and known as saprophytes. Fine cottony threads called hyphae that are networked into a cobweb, termed mycelium facilitate the absorption. This vegetative part of the fungus lies beneath the soil, lasting from months to millennia, depending on resource supply etc. Under suitable environment, mycelium produces mushrooms i.e. sporophores annually that shade the spores that are wind dispersed and ultimately generate mycelium. Due to good dispersal ability and durability, fungi inhabit soil, animals, leaves, tree trunks, symbiotically or as parasites.

Fungi are crucial in the terrestrial ecosystem, as dominant decomposers. Plant debris that is rich in lignin, that would not yield even to bacteria, is broken down by fungal enzymes. They have application in paper and pulp industries, fruit juice industry, wastewater treatment, textile industry, bakery products, food and feed industry etc. Mushrooms are a delicacy worldwide, white button mushroom (WBM) being the commonest. Some mushrooms e.g. *shiitake, Pleurotus, Auricularia*, even serve as a medicine on several ailments to reduce blood pressure, on diabetes to reduce cholesterol etc. Mushrooms are also used for hallucination. About 10% of mushroom species are even poisonous. Unfortunately, little is studied about ecology of these interesting and useful creatures in India, prompting us to undertake this study.

## Methodology

Different localities in and around Pune were frequently visited, especially during the monsoon of 1999 and 2000. These included forested hills of Sinhagad, Law college and Chandani chowk; banks of Pashan lake, extensive tree plantations in and around University and habitations including small tree plantations around the Fergusson college. In each locality, fungi were collected opportunistically along random paths. The mushrooms were picked up with the help of a scalpel from the soil or the substrate. General habit and habitat, colour, smell (if any), host plant, surrounding vegetation etc. were noted in the field. Mushrooms were photographed prior to picking and then were kept in a paper bag carefully with a label showing the collection number, locality and date. Polypores were removed from the host with the help of hammer and a sharp knife and were kept on a clean

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polythene bag. Puffballs and especially damage-prone stink horns were both carefully preserved in a clean plastic bag. Few specimens of mushrooms and polypores from each collection were kept for sporeprint. Few of the specimens were oven dried at 60°C temperature. The puffballs were also dried and stinkhorns were wet preserved in 2-5% formaline solution. Thin sections of fresh specimens were observed under the microscope after staining with Phloxin and cotton blue stain and mounting in the lactophenol. The polypore sections were first treated with 5% KOH solution and then mounted in lactophenol on a clean glass slide with a cover glass after intensive teasing and staining with cotton blue. As for puffballs, the fruiting body was opened to view the number of peridium layers, presence or absence of mucilage sheath and colour of the gliba. Thin sections of gliba, peridium were mounted in lactophenol after staining the section in cotton blue. Various structures seen in the section were noted down systematically and were used along with the sporeprint for identification, using the standard keys (see bibliography).

**Results and Discussion**

The sampling yielded 71 species belonging to 68 genera from 28 families (see annexure). Ascomycetes members were represented by 4 genera belonging to 4 families. The remaining 64 genera belonged to Basidiomycetes, with mushrooms constituting 38 of them from 12 families, Gastromycetes constituting 13 genera from 10 families and polypores constituting another 13 genera from 6 families. Table 1 illustrates that extensive tree growth, both wild and planted such as around University, harboured most of these while forests along hills harbored about three fourth. About a quarter taxa are recorded only from woodlands/plantations, but not forests. Forests exclusively harbour just three genera. This can be in part attributed to more intensive studies around University campus. While these numbers might change after intensive sampling elsewhere, especially in hill forests, the importance of urban plantations in hosting significant fungal diversity will remain evident. Commonest genera include *Merasmius*, *Hygrocybe*, *Auricularia*, *Hexagonia*, etc.

Table 1 Habitatwise Diversity and Exclusivity of Fungal Genera

| Habitat Type | No. of total Genera | No. of unshared Genera |
|---|---|---|
| Forest (F) | 52 | 3 |
| Plantations (P) | 64 | 15 |
| Habitations (H) | 27 | 0 |
| Lakeside (L) | 33 | 0 |

This high fungal diversity around the University campus can also be attributed to old and extensive tree growth, which shares most taxa with forests, given wide dispersal ability of fungi. In addition, some fungi favour such plantations, such as *Itajahya* associated only with *Dalbergia melanoxylon*, the most extensively planted tree in the University. Some recent finds such as *Battarrea* recorded since a decade is today common as a mycorrhizal association. *Ganoderma*, a root rot fungus reported rare earlier is in fact quite common causing even uprooting of trees. However, some genera have either become rare or locally extinct. We did not actually find the mushroom *Lentinus*, previously recorded. Likewise, *Amanita alboflocossa* is also earlier recorded from Pune but not encountered by us. While greater sampling can help relocate these taxa, the hindrance of stray animals and soil profile modifications due to human activity, dumping of glass, rubber and thermocol waste, urban encroachment, tree cutting etc. pose serious threats to existence of the fungal diversity, especially in the Pune University campus.

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ANNEXURE : Distribution of Fungal Genera Across Habitat Types

F- Forest, S- Scrub, P- Plantation, H- Habitation, L- lake
A- Abundant, C- Common, Ex- Extinct, O- Occassional, R- Rare
LOC (Locality) : C- Chandani Chowk, P- Pashan, R- Range Hills, S- Sinhgad, U- University
Note : Specific localities not indicated for widespread fungi

| Group/Family | Genus | F/S | P | H | L | LOC |
|---|---|---|---|---|---|---|
| **Ascomycetes** | | | | | | |
| | *Daldinia* | C | C | | R | |
| Geoglossaceae | *Geoglossom* | R | A | | | U,C |
| | *Sarcoscypha* | C | R | | R | |
| Xylariaceae | *Xylaria* | C | C | | O | |
| **Agaricales** (Mushrooms) | | | | | | |
| Agaricaceae | *Agaricus* | C | C | C | O | |
| Bolbitiaceae | *Agrocybe* | O | C | C | R | |
| Tricholomataceae | *Anthracophyllum* | O | O | C | R | |
| Auriculariaceae | *Auricularia* | C | C | C | | |
| Bolbitiaceae | *Bolbitius* | C | O | O | R | |
| Tricholomataceae | *Calocybe* | C | C | C | | |
| Cantharellaceae | *Cantharellus* | C | C | R | R | |
| Lepiotaceae ? | *Chlorolepiota* | O | C | R | | |
| Lepiotaceae | *Chlorophyllum* | O | C | C | | |
| Tricholomataceae | *Clitocybe* | C | C | C | R | |
| Bolbitaceae | *Conocybe* | C | C | C | R | |
| Tricholomataceae ? | *Copelandia* | R | | | | S |
| Coprinaceae | *Coprinus* | C | C | C | O | |
| Tricholomataceae | *Favolashchia* | | R | | | U |
| Tricholomataceae | *Hemimycena* | | O | | | U |
| Hygrophoraceae | *Hygrocybe* | R | C | | | U,S |
| Hygrophoraceae | *Hygrophorus* | R | O | | | U,S |
| Tricholomataceae | *Lactocollybia* | | O | | | U |
| Tricholomataceae | *Lentinus* | | R | | | U,Ex? |
| Lepiotaceae | *Lepiota* | O | C | O | O | |
| Lepiotaceae | *Leucocoprinus* | | R | | | U |
| Amanitaceae | *Limacella* | | R | | | U |
| Tricholomataceae | *Lyophyllum* | | O | | | U |
| Lepiotaceae | *Macrolepiota* | O | C | R | | |
| Tricholomataceae | *Marasmiellus* | | R | | | U |
| Tricholomataceae | *Marasmius* | C | A | C | A | |
| Tricholomataceae | *Mycena* | C | A | C | A | |
| Coprinaceae | *Panaeolus* | R | C | | O | U,S,P |
| Strophariaceae | *Pholiota* | R | C | | O | U,S,P |
| Tricholomataceae | *Pleurotus* | C | A | C | O | |
| Entolomataceae | *Rhodocybe* | | R | | | U |
| Tricholomataceae | *Schizophyllum* | C | A | O | R | |
| Tricholomataceae | *Termitomyces* | O | O | | | |
| Tremellaceae | *Tremella* | O | A | | | |
| Tricholomataceae | *Tricholoma* | C | C | O | O | |

FUNGAL GENERA DISTRIBUTION ACROSS PUNE CITY

| Group/Family | Genus | F/S | P | H | L | LOC |
|---|---|---|---|---|---|---|
| Tricholomataceae | *Tricholomopsis* | C | C | C | R | |
| | *Unidentified sp.1* | R | | | | C |
| | *Unidentified sp.2* | R | | | | S |
| **Gasteromycetes** | | | | | | |
| (Puffballs, Stink Horns) | | | | | | |
| Astraeaceae | *Astraeus* | C | C | | C | |
| Tulostomaceae | *Battarrea* | | R | | | U |
| Lycoperdaceae | *Bovista* | C | C | | O | |
| Nidulariaceae | *Cyathus* | C | C | O | C | |
| Geastraceae | *Geastrum* | O | C | R | O | |
| Phallaceae | *Itajahya* | | O | | | U |
| Lycoperdaceae | *Lycoperdon* | C | C | R | O | |
| Phallaceae | *Muntinus* | | R | | | R |
| Astraeaceae | *Myriostoma* | | R | | | U |
| Phallaceae | *Phallus* | R | O | | | U,S |
| Tulostomaceae | *Tulostoma* | | O | | | U |
| | *Unidentified* | | O | | | U |
| **Polypores** (Bracket Fungi) | | | | | | |
| Clavariaceae | *Clavaria* | R | R | | | U,S |
| Polyporaceae | *Daedalea* | O | C | | O | |
| Polyporaceae | *Daedaleopsis* | O | C | | O | U,S |
| Polyporaceae | *Favolus* | R | O | | | |
| Ganodermataceae | *Ganoderma* | C | A | C | C | |
| Polyporaceae | *Hexagonia* | C | A | | R | |
| Hydnaceae | *Irpex* | C | C | | O | |
| | *Laetiporius?* | O | C | | R | U,S |
| Polyporaceae | *Microporus* | O | O | | | |
| Polyporaceae | *Oxyporous* | O | A | | | |
| Hymenochaetaceae | *Phellinus* | C | A | O | C | |
| Podoscyphaceae | *Podoscypha* | C | A | R | | |
| | *Ramaria* | O | C | R | R | |
| | TOTAL | 65 | 64 | 27 | 33 | |
| | UNIQUE | 3 | 15 | 0 | 0 | |

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# Herb Diversity of Some Habitats of Pune City

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## Introduction

Herbs are seasonal plants without woody tissues. Herbs as a group are omnipresent, inhabiting all types of habitats and localities. The herbaceous flora of Pune environs is well documented sinse long (Razi, 1951) but it contains no analysis of the distribution across habitat types and localities except for the modest attempts regarding aquatic plants by Ghate and Vartak (1981). This note thus explores the distribution of species richness across habitat types with focus on Katraj hills, besides looking at the sharing of the flora between hills and the city habitats. The term herb is used in a broad sense here, reflecting all non-tree flowering plants, which include shrubs and climbers.

## Methodology

The flora of Katraj Ghats (Vartak, 1960) is used as the baseline document as it almost covers the wild flora in the Pune city environs. National Defence Academy (NDA), Khadakwasla and Sinhagad hills have about twice and thrice the rainfall respectively while the latter boasts over two times the elevation. Thus, NDA and Sinhagad may harbour some moisture loving species not recorded from Katraj but their floristic records are limited (Santapau, 1951). This note focuses on the immediate neighbourhood of Pune city to explore the pattern of species sharing across the hillocks and the urbanised areas. Based on descriptions and field visits, the distribution remarks from Katraj flora (Vartak, 1960) were assigned to following habitat types in the decreasing order of human influence :

1. Spur, Ghat, Ravine, Base : Forest/scrub (low human impact)
2. Hedges : thickets and fences (medium human impact)
3. Village, Garden, Roadside : Human dwellings (high human influence)
4. Grassland and sandy soils : (low human impact)
5. Stream, stream bank, tank, pond, waterlogged soil : Riparian (variable human impact)

The species richness i.e. number of species recorded from each of these habitat types was enumerated with minor modifications from field observations. Secondly, the degree of sharing of species between Katraj, Pachagaon (Kulkarni *et al*, 1989), Law College hills (Kumbhojkar *et al*, 2000) and the Ganeshkhind campus (Varadpande, 1974) is also estimated, the last being more human influenced than others. We could access only the analysis (Vartak, 1959) but not the species list of the flora of Fergusson College campus and hills, which could have given a better understanding of species thriving or even flourishing under pronounced human influence. As for aquatic plants, Ghate and Vartak (1981) provide a comprehensive baseline document for the Pune environs as Katraj flora mentions only a few of them. The aspect of distribution of the species therein across habit classes and localities is numerically represented here.

## Results and Discussion

The herb flora of Pune city environs is estimated to consist of about 600 species. Table 1 lists the five most dominant families and their species richness, which is similar to the floristic pattern mentioned by Dr. Vartak

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Table 1 Most dominant families in the herb flora of Pune city

| Family | No. of Spp. |
|---|---|
| Poaceae | 100 |
| Asteraceae | 60 |
| Cyperaceae | 40 |
| Fabaceae | 30 |
| Mimosaceae | 20 |

Table 2 Habitat-wise distribution of flowering plants at Katraj hills

| Habitat Type | % of Total (510) Spp. |
|---|---|
| Forest/scrub | 30 |
| Hedges | 6 |
| Habitation | 40 |
| Grassland | 15 |
| Riparian | 15 |

(Vartak, 1960). Some species like *Brassica juncea, Linum usitatissium, Sesamum indicum*, etc. inhabit all localities while those confined to wilderness localities like Katraj include *Impatiens balsamina* and *Raphanus sativus*. Prominent escapes from cultivation, now naturalised in wilderness zones include *Cosmos bipinnatus*. Many herbs have medicinal value and some are even intensively harvested such as *Asparagus racemosus, Curculigo orchidoided, Gloriosa superba* and even weeds like *Mimosa pudica*.

Herb species constitute over two thirds of the total flora in low impact areas like Katraj hills while just the half in high impact zones like the Fergusson college (Vartak, 1959). Nearly half the herb species from the Katraj flora inhabit Pachgaon, Law College and Vetal hills while Ganeshkhind area shelters over two thirds. Interestingly, other hills around Pune hardly shelter any species not recorded from Katraj though Ganeshkhind area harbours a few such species, primarily exotic cultivars. Each of these areas harbours over 300-400 species i.e. two thirds the species richness of Katraj. The Fergusson College Campus is reported to have sheltered over 600 species (Vartak, 1959). Thus, while human influence appears to markedly alter species composition, species richness is maintained or even enhanced.

Table 2 indicates that nearly half the species inhabit human influenced areas like gardens, fields, roadside etc. Less than a tenth of the species are cultivated while just over a tenth are weeds, primarily exotic. The wilderness (forest, scrub, grasslands, riparian) preferring species constitute just less than two thirds the flora of Katraj, some of them also thriving under human influenced habitats as noted above.

Table 3 shows that the Mutha river harbours over 80% of the aquatic flowering plants recorded from Pune city environs, while seasonal puddles host lowest species richnes, about a quarter of those found in the Mutha river. Amongst perennial stagnant waterbodies, Pashan lake hosts the most species while Padmavati pool the least. About a third species also colonise abandoned stone quarries.

The nature of changes in herbaceous flora is hardly studied, primarily due to difficulties in fixing the

**Table 3 Habit-wise distribution of aquatic flowering plants diversity : Pune city**

| Habit | Mutha River | Pashan Lake | Bhosari Tank | Katraj Reservoir | Padmavati Pond | Monsoon puddles | Quarry Ponds |
|---|---|---|---|---|---|---|---|
| Aquatic | 8 | 8 | 5 | 4 | 4 | 2 | 3 |
| Attached floating | 3 | 4 | 3 | 0 | 2 | 0 | 0 |
| Free Floating | 5 | 1 | 2 | 0 | 1 | 2 | 1 |
| Amphibious | 15 | 10 | 7 | 8 | 4 | 3 | 5 |
| Marshy | 43 | 34 | 29 | 31 | 20 | 13 | 19 |
| Submerged | 6 | 6 | 3 | 0 | 0 | 2 | 3 |
| Wetland | 22 | 16 | 12 | 12 | 8 | 6 | 15 |
| TOTAL | 102 | 79 | 61 | 55 | 39 | 28 | 46 |

location of given species. Nevertheless, Joshi *et al* (1992) mention the loss of 30 species from Vetal hills in Pune city, of which over three fourths are herbaceous, causing concern. While the authors fix the blame of local extinction of species on the biotic factors such as grazing, the role of encroachments by development projects like housing colonies and roads needs exploration. There has been public concern about loss of rare species, particularly herbs that tend to be ignored, such as *Ipomoea sp.* along the river bank at Vitthalwadi due to so called development (Ingalhallikar, 2000).

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