



THE VETAL HILLS: AN URBAN WILDSCAPE IN PERIL

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Abstract

The Vetal Hill complex, an urban green space, is located in the heart of the city of Pune, India. The aim of the present work was to evaluate the total species lost prior to 1997 as well as to record new additions to the flora. The most recent flora of this hill complex has been used as a central reference. Past published records and herbaria data were consulted for plants that have not been recorded and opportunistic visits made to the hills resulted in additions to the flora. The study disclosed the loss of 84 species from this hill complex (54 species reported in the present study along with 30 species mentioned in earlier literature) over a period of more than 110 years, with 72 native species out of 84 showing a distinct decline. Twenty species are reported as additions to the flora out of which eleven are exotics and nine native. Regular monitoring is crucial in understanding such long term changes in any forested area. This hill complex is an important forest patch in the city that has undergone severe habitat degradation over the years and hence is in urgent need of conservation.

Key Words: floristic diversity decline, India, monitoring, native species, Pune, urban green space.

Introduction

The proportion of urban residents is increasing globally and thus the subject of urban ecosystems is gaining importance (Savard *et al.* 2000). Increasing urbanization can cause alteration of habitats including fragmentation of natural vegetation, increase in regional temperature, degradation of air and water quality, and soil erosion all affect species composition and proportion of alien species (Moore & Palmer, 2005; Tratalos *et al.* 2007).

Urban green spaces can support significant biodiversity and are of great importance as they help in mitigating the urban heat island phenomenon, carbon sequestration, recharge ground water, and provide suitable habitat for rare and endemic species (Nehru *et al.* 2012; Singh *et al.* 2010). Vetal Hill and its neighbouring hills are one such urban forest that provides invaluable ecosystem services for the city of Pune.

The city of Pune (formerly Poona) in Maharashtra State, India, has been fortunate to boast a rich history of botanical workers since the early 19th century (Razi, 1952). Botanical studies by Blatter & McCann (1935), Burns & Chakradev (1921), Cooke (1901–1908), Dalzell & Gibson (1861), Ghate (1993), Graham (1839), Gunjatkar & Vartak (1982), Narayanayya (1928), Vartak (1959a, b, c), and Woodrow (1897-1898) deal indirectly with the flora around the city; whereas works by Bonde (1988), Ghate & Vartak (1981), Kulkarni *et al.* (1989), Kulkarni & Kumbhojkar (1995), Nagare *et al.* (1990), Puri & Jain (1960), Puri & Mahajan (1958), Varadpande (1974), and Vartak (1958, 1964) deal directly with the flora of different geographical areas of Pune.

The hills in and around the city have also received considerable attention from botanists since the early 20th century. The Vetal and adjacent group of hills have been well studied by Burns (1931), Ezekiel (1917-1918), and Phadnis (1925), followed by more recent studies by Joshi (1991), Joshi *et al.* (1992, 1994), Joshi & Kumbhojkar (1997), and Punalekar *et al.* (2010).

Joshi *et al.* (1992) presented a comparative account and highlight species missing from the flora of Ezekiel (1917-1918). Yet, a review and comparison of other literature apart from Ezekiel with the flora of Joshi & Kumbhojkar (1997) remains undone. Hence, the aim of this paper is to enumerate such lesser known plants from Vetal Hill and surroundings that were listed in earlier sources but are absent in the latest comprehensive published flora of Joshi & Kumbhojkar. Also, we wish to highlight some additions to the flora of the hills.

Study Area

The city of Pune is located at the confluence of the Mula and Mutha rivers on the Deccan Plateau in western Maharashtra. The Vetal Hills as defined in this paper refers to a group of three hills (Vetal Hill, Law College Hill and Chaturshingi Hill) that are inter-connected. (18°30'N to 18°32'N and 73°48'E to 73°49'E). The Vetal Temple on Vetal Hill is the highest point in the region with an elevation of 705 m. Law College Hill is located to the southeast and Chaturshingi Hill is north of Vetal Hill (Fig. 1).

Three distinct seasons are observed in Pune: The summer lasts from February to May with an

average high temperatures ranging from 31.9° C to 36.9° C. The winter lasts from November to January with average low temperatures from 14.4° C to 11.0° C. The monsoon season lasts from June to October with an annual rainfall of 29.17 inches (=740.918 mm).

The underlying rock in the entire region is basalt. The vegetation type in the hills is Tropical southern dry mixed deciduous (Type 5A/C3) as classified by Champion & Seth (1968) with the *Anogeissus-Lannea-Boswellia* community being common. Other common plants are *Capparis grandis* L.f., *Grewia tiliifolia* Vahl, *Dolichandrone falcata* (Wall. ex DC.) Seem., *Santalum album* L., *Azadirachta indica* A. Juss. *Cassia tora* L., *Mimosa hamata* Willd., and such exotic plants as *Gliricidia sepium* (Jacq.) Kunth, *Eucalyptus globulus* Labill., and *Leucaena leucocephala* (Lam.) de Wit.

Materials and Methods

The study was divided into two sections. The first was a review of the available literature and herbarium data for species reported before 1997 but not mentioned by Joshi & Kumbhojkar (1997). [This excluded already analyzed data from Ezekiel (1917-1918)]. The second part consisted of opportunistic visits made by the first author which resulted in the collection of specimens that are here considered to represent additions to the flora of the Vetal Hills.

All scientific names were corrected for synonyms using The Plant List (2013) with this information corrected based on more up-to-date nomenclatural information. Out of all the sources reviewed pertaining to the flora of these hills, Cooke (1901–1908), Razi (1952), Vartak (1959a), Agharkar Herbarium of the Maharashtra Association (AHMA), and the herbarium of the Botany department, Fergusson College, Pune, India, were found to contain plants that were lacking in the 1997 flora. Some species were reported missing by more than one of the above sources (e.g., *Echinochloa colona* (L.) Link) as indicated in Appendix I.

For the second part of the study, opportunistic visits were made from January 2012 to July 2014 with the specimens collected deposited at AHMA. Specimens were identified using Cooke (1901–1908), Lakshminarasimhan (1996), Singh & Karthikeyan (2000), Singh *et al.* (2001),

Ingalhalikar & Barve (2010), and Potdar *et al.* (2012).

Results

Section 1: A total of 51 plants were found in Razi (1952) that were absent in Joshi & Kumbhojkar (1997) as well as Ezekiel (1917–1918). This indicates that over a period of 45 years, 51 species have disappeared from the study area. From Vartak (1959a), a single species, *Diospyros melanoxylon* Roxb., which was mentioned as “common” on the Vetel Hills is missing from the latest flora. The herbarium records at AHMA revealed three species: *Eriocaulon cinereum* R. Br., *Dopatrium junceum* (Roxb.) Buch.-Ham. ex Benth., and *Vitex pinnata* L. that were found missing from the latest flora. From the herbarium of the Botany Department of Fergusson College, three species, namely *Callistemon lanceolatus* (Sm.) Sweet, *Holmskioldia sanguinea* Retz., and *Erigeron bonariensis* L. were found not mentioned in the 1997 flora. Cooke (1901–1908) has two species (*Grewia abutilifolia* Vent. ex Juss. and *Fimbristylis complanata* (Retz.) Link) not reported by other workers. Thus, a total of 60 plants are listed in Appendix I which were reported earlier but vanished by 1997.

Section 2: Visits made during 2012–2014 resulted in the collection of 26 plants not listed in Joshi & Kumbhojkar (1997). Of these, six species (*Dalbergia latifolia* Roxb., *Diospyros melanoxylon*, *Acacia ferruginea* DC., *Albizia lebbek* (L.) Benth., *Gardenia turgida* Roxb., and *Arthraxon lanceolatus* (Roxb.) Hochst.) were reported by Razi (1952) and by Vartak (1959a) indicating that these plants were overlooked by Joshi & Kumbhojkar (1997). Thus a net of 20 species are listed as additions to flora (Appendix II). Of these, eleven species are exotics (*Michelia champaca* L., *Khaya senegalensis* (Desv.) A. Juss., *Cassia roxburghii* DC., *Senna siamea* (Lam.) H.S. Irwin & Barneby, *Terminalia catappa* L., *Grevillea robusta* A. Cunn. ex R. Br., *Ceiba pentandra* (L.) Gaertn., *Parkinsonia aculeata* L., *Euphorbia milii* Des Moul., *Zinnia peruviana* (L.) L., *Cuphea hyssopifolia* Kunth) and nine are native (*Bambusa arundinacea* Willd., *Murraya koenigii* (L.) Spreng., *Saraca asoca* (Roxb.) W.J. de Wilde, *Ficus virens* Aiton, *Senegalia polyacantha* (Willd.) Seigler & Ebinger, *Albizia procera* (Roxb.) Benth.,

Albizia amara (Roxb.) Boivin, *Cadaba fruticosa* (L.) Druce, and *Schleichera oleosa* (Lour.) Oken).

Thus out of 60 species that vanished prior to 1997, the aforementioned six species were collected again during 2012–2014. Hence, we report 54 species that have disappeared. Along with the 30 species mentioned missing by Joshi *et al.* (1992) and 54 species listed in the present study, a total 84 species are now extirpated. Out of these, 72 species were native and 12 were exotics.

Additional remarks: Of all the areas, we would like to highlight some areas of botanical importance. The Law College Hill and the plateau just above it (18°31'08.14"N, 73°49'25.86"E) houses many rare plants. *Cochlospermum religiosum* (L.) Alston, *Dalbergia latifolia* and *Jatropha nana* Dalzell & A. Gibson are rare in general, but seen abundantly on the plateau. Locally rare plants (as per Joshi & Kumbhojkar, 1997) like *Hardwickia binata* Roxb., *Semecarpus anacardium* L.f., and *Manilkara hexandra* (Roxb.) Dubard, as well as a lesser known tree, *Gardenia turgida*, are seen near the pathways leading to the temple (Fig. 2). Other areas, including the area behind the Vetel Temple (18°31'33.78"N, 73°48'54.03"E), the grassland beyond the quarry (18°31'57.97"N, 73°49'01.18"E), and the slopes of Patrakar Nagar (18°31'26.16"N, 73°49'20.01"E) also support a fair percentage of native vegetation and hence should be protected. Herbarium specimens of *Gardenia turgida* and *Schrebera swietenoides* Roxb. dating back to 1902, are shown below (Figs. 3 & 4).

Discussion

The 84 species reported extirpated in the Vetel Hill complex is compiled from sources starting from Cooke (1901–1908) to Joshi & Kumbhojkar (1997) and on to the present day span more than 110 years and this indicates an alarming rate of species loss. This number is by no means insignificant and highlights the rapid change in species composition on these hills. Out of the 84 species most were natives, an unambiguous indication of a rapid decline of the native vegetation in this area.

Six species that were listed before 1997 and also collected during 2012–2014 point out that they

were/are of rare occurrence and thus not collected. The eleven exotic species listed as additions to flora pose a potential threat being invasive and spreading on the hills. At present, exotics like *Michelia champaca*, *Ceiba pentandra*, *Cassia roxburghii*, *Khaya senegalensis*, *Euphorbia milii*, *Cuphea hyssopifolia*, *Grevillea robusta*, and *Terminalia catappa* were probably planted by the local authorities and do not seem to be invasive. On the other hand, *Senna siamea*, *Zinnia peruviana*, and *Parkinsonia aculeata* seem to be spreading probably due efficient seed dispersal.

Improving the biodiversity of urban ecosystems is important (Savard *et al.* 2000) due to the multiple ecosystem services they provide. Regular monitoring of any ecosystem with respect to its status and condition at several points in time is crucial for better management (Noss, 1999). The Vetal Hill complex has been subjected to such periodic monitoring since the early 20th century and continuing such studies will help give us a better understanding of the health of this ecosystem.

Unplanned plantation programmes of exotic as well as native species, fires, and changing land-use are some of the threats that these hills currently face. Understanding and protecting the original dry deciduous nature of these forests and implementing suitable plantation programmes [similar to those discussed by Kulkarni & Kumbhojkar (1997)] of plants that have been extirpated due to anthropogenic pressures would help in the conservation of this unique urban ecosystem.

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Appendix I: List of species not reported by Joshi & Kumbhojkar (1997); * plants that were mentioned in the earlier literature as well as collected during the present study; HFCBD, Herbarium of Fergusson College Botany department (not a standard acronym); LCH, Law College Hill; VH, Vetal Hill; CH, Chaturshingi Hill; **See the end note below.

Family	Species	Source	Loc.
Acanthaceae	<i>Andrographis echioides</i> (L.f.) Nees	Razi (1952)	LCH
	<i>Asteracantha longifolia</i> Nees	Razi (1952)	LCH
	<i>Calophanes dalzellii</i> T. Anderson ex Bedd.	Razi (1952)	LCH
	<i>Justicia simplex</i> D. Don	Razi (1952)	LCH
	<i>Rungia repens</i> (L.) Nees	Razi (1952)	LCH
Anacardiaceae	<i>Buchanania lanzan</i> Spreng.	Razi (1952)	LCH
Apocynaceae	<i>Wrightia tinctoria</i> R. Br	Razi (1952)	LCH
Asclepiadaceae	<i>Ceropegia tuberosa</i> Roxb.	Razi (1952)	LCH
	<i>Cyathocline purpurea</i> (Buch.-Ham. ex D. Don) Kuntze	Razi (1952)	LCH
Asteraceae	<i>Erigeron bonariensis</i> L.	HFCBD	VH
	<i>Lactuca runcinata</i> DC. ex Wight	Razi (1952)	LCH
Boraginaceae	<i>Heliotropium ovalifolium</i> Forsk.	Razi (1952)	LCH
	<i>Heliotropium supinum</i> L.	Razi (1952)	LCH
Burseraceae	<i>Garuga pinnata</i> Roxb.	Razi (1952)	LCH
Caesalpiniaceae	<i>Cassia auriculata</i> L.	Razi (1952)	LCH
	<i>Cassia marginata</i> Roxb.	Razi (1952)	VH
Capparaceae	<i>Capparis divaricata</i> Lam.	Razi (1952)	LCH
Celastraceae	<i>Celastrus paniculatus</i> Willd.	Razi (1952)	LCH
Cleomaceae	<i>Cleome monophylla</i> L.	Razi (1952)	LCH
Combretaceae	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Razi (1952)	LCH
Commelinaceae	<i>Cyanotis axillaris</i> (L.) D. Don ex Sweet	Razi (1952)	LCH
Cyperaceae	<i>Fimbristylis complanata</i> (Retz.) Link	Cooke (1903)	CH
Ebenaceae	<i>Diospyros melanoxylon</i> Roxb.*	Vartak (1959a)	VH
Eriocaulaceae	<i>Eriocaulon cinereum</i> R. Br.	AHMA 14027, 28	VH
	<i>Acalypha malabarica</i> Müll.Arg.	Razi (1952)	LCH
	<i>Euphorbia elegans</i> Spreng.	Razi (1952)	LCH
	<i>Euphorbia tirucalli</i> L.	Razi (1952)	VH
	<i>Jatropha glandulifera</i> Roxb.	Razi (1952)	LCH
Euphorbiaceae	<i>Phyllanthus niruri</i> L.	Razi (1952)	LCH
	<i>Holmskioldia sanguinea</i> Retz.	HFCBD	VH
	<i>Leonotis nepetifolia</i> (L.) R. Br.	Razi (1952)	LCH
	<i>Albizia lebbek</i> (L.) Benth.*	Razi (1952)	LCH
Mimosaceae	<i>Acacia ferruginea</i> DC.*	Razi (1952)	LCH
Myrtaceae	<i>Callistemon lanceolatus</i> (Sm.) Sweet	HFCBD	VH
Orchidaceae	<i>Habenaria longicalcarata</i> A. Rich.	Razi (1952)	LCH
	<i>Aeschynomene indica</i> L.	Razi (1952)	LCH
Papilionaceae	<i>Crotalaria linifolia</i> L.f.	Razi (1952)	LCH
	<i>Crotalaria mysorensis</i> Roth	Razi (1952)	LCH
	<i>Dalbergia latifolia</i> Roxb. *	Razi (1952)	LCH
	<i>Desmodium diffusum</i> DC.	Razi (1952)	LCH
	<i>Taverniera nummularia</i> DC.	Razi (1952) Cooke (1903)	LCH
Poaceae	<i>Andropogon pumilus</i> Roxb.	Razi (1952)	LCH
	<i>Arthraxon lanceolatus</i> (Roxb.) Hochst.*	Razi (1952)	LCH

	<i>Arthraxon microphyllum</i> (Trin.) Hochst.	Razi (1952)	LCH
	<i>Brachiaria ramosa</i> (L.) Stapf	Razi (1952)	LCH
	<i>Cenchrus biflorus</i> Roxb.	Razi (1952)	LCH
	<i>Chionachne semiteres</i> (Benth.) Henrard	Razi (1952)	LCH
	<i>Cymbopogon citratus</i> (DC.) Stapf	Razi (1952)	LCH
	<i>Echinochloa colona</i> (L.) Link	Razi (1952) AHMA 11176-7	LCH
	<i>Pennisetum hohenackeri</i> Hochst. ex Steud.	Razi (1952)	LCH
	<i>Setaria intermedia</i> Roem. & Schult.	Razi (1952)	LCH
	<i>Sorghum purpureosericeum</i> (A. Rich.) Schweinf. & Asch.	Razi (1952)	LCH
	<i>Themeda quadrivalvis</i> (L.) Kuntze	Razi (1952)	LCH
Rubiaceae	<i>Gardenia turgida</i> Roxb.*	Razi (1952)	VH
Scrophulariaceae	<i>Dopatrium junceum</i> (Roxb.) Buch.-Ham. ex Benth.	AHMA 5487, 88	VH
	<i>Corchorus fascicularis</i> Lam.	Razi (1952)	LCH
Tiliaceae	<i>Corchorus trilocularis</i> L.	Razi (1952)	LCH
	<i>Grewia abutilifolia</i> Vent. ex Juss.	Cooke (1903)	
	<i>Grewia obtusa</i> Wall. ex Dunn	Razi (1952)	LCH
Verbenaceae	<i>Vitex pinnata</i> L.	AHMA 14034	VH

Appendix II: Additions to flora discovered during the present study; LCH, Law College Hill; VH, Vetal Hill; CH, Chaturshingi Hill.

Family	Species	Loc.	Remarks
Asteraceae	<i>Zinnia peruviana</i> (L.) L.	LCH	Exotic weed seen spreading
Bombacaceae	<i>Ceiba pentandra</i> (L.) Gaertn.	VH	Planted
	<i>Cassia roxburghii</i> DC.	CH	Planted
	<i>Senna siamea</i> (Lam.) H.S. Irwin & Barneby	LCH	Few well-grown planted specimens
Caesalpiniaceae	<i>Parkinsonia aculeata</i> L.	VH	Only a single plant seen
	<i>Saraca asoca</i> (Roxb.) Willd.	VH	About a dozen trees planted, growing well
Capparaceae	<i>Cadaba fruticosa</i> (L.) Druce	CH	Couple of plants seen
Combretaceae	<i>Terminalia catappa</i> L.	VH	Planted
Euphorbiaceae	<i>Euphorbia milii</i> Des Moul.	VH	Planted near temples
Lythraceae	<i>Cuphea hyssopifolia</i> Kunth	VH	Planted
Magnoliaceae	<i>Michelia champaca</i> L.	LCH	A couple of young trees seen
Meliaceae	<i>Khaya senegalensis</i> (Desv.) A. Juss.	CH	Planted
	<i>Senegalia polyacantha</i> (Willd.) Seigler & Ebinger	CH	Occasionally seen
Mimosaceae	<i>Albizia amara</i> (Roxb.) Boivin	LCH VH CH	Native and plenty of well grown trees seen
	<i>Albizia procera</i> (Roxb.) Benth.	CH	Couple of trees
Moraceae	<i>Ficus virens</i> Aiton	LCH CH	Few well grown trees seen
Poaceae	<i>Bambusa arundinacea</i> Willd.	VH	Planted and growing well
Proteaceae	<i>Grevillea robusta</i> A. Cunn. ex R. Br.	VH	Planted
Rutaceae	<i>Murraya koenigii</i> (L.) Spreng.	VH	Planted
Sapindaceae	<i>Schleichera oleosa</i> (Lour.) Oken	VH	A fine grove of three full grown trees seen along the pathway

****End note:** The authors have retained the taxonomic disposition of families in the above tables as cited in the references; likewise, we have kept the species names used by those authors. We are well aware that both Caesalpiniaceae and Mimosaceae are best retained in a broadly defined Fabaceae which includes Papilionaceae. Also, we are aware that *Phyllanthus* is now assigned to Phyllanthaceae, and Tiliaceae may be assigned to a broadly defined Malvaceae although there are current systems of classification that accept Tiliaceae. A number of species have been revised since the above cited publications made their appearance. For example, *Grewia obtusa* is now considered to be a synonym of *G. bracteata* Roth and *Acacia polyacantha* is now *S. polyacantha* (Willd.) Seigler & Ebinger. The name, *Erigeron linifolius*, is more a matter of taxonomic opinion than nomenclature with opinions varying on accepting *E. bonariensis* L. or *Conyza bonariensis* (L.) Cronquist. In either case there is no debate that *E. linifolius* is a synonym. As may be seen from our use of species names in our text, we have attempted to use current nomenclature.

PLATE 3

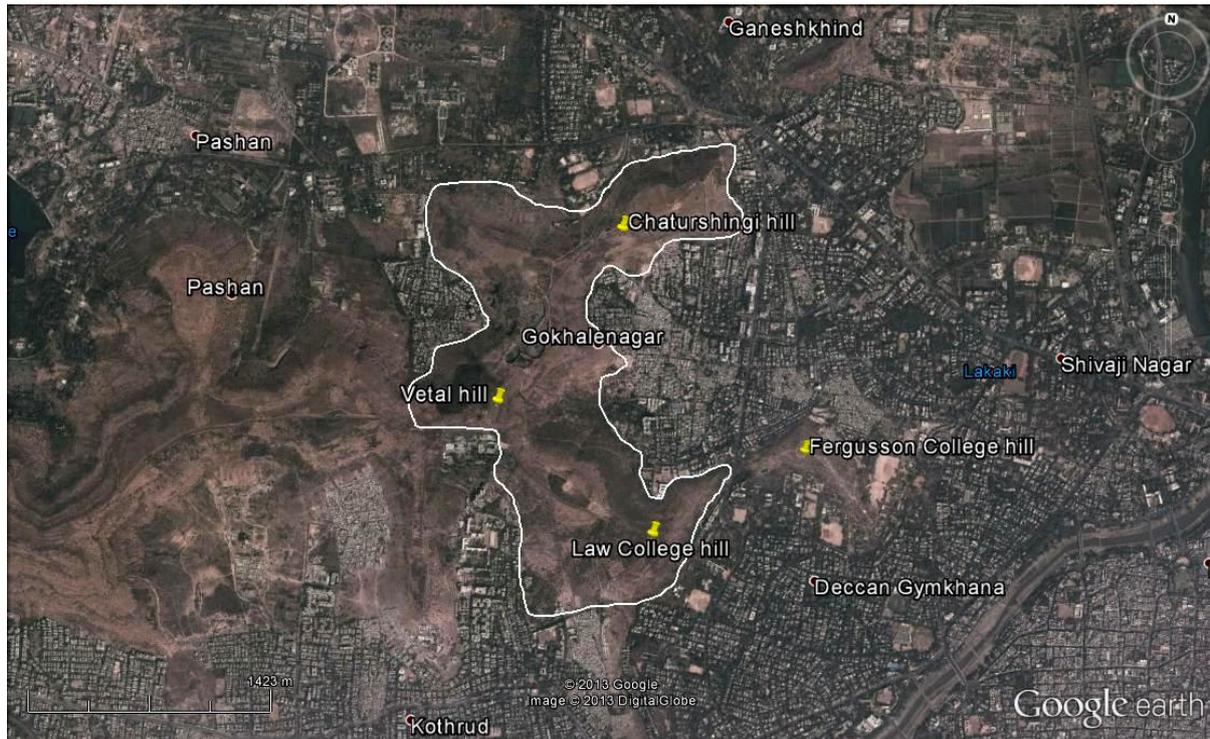


Figure 1: The study area is outlined in white and shows the three hills that are inter-connected.

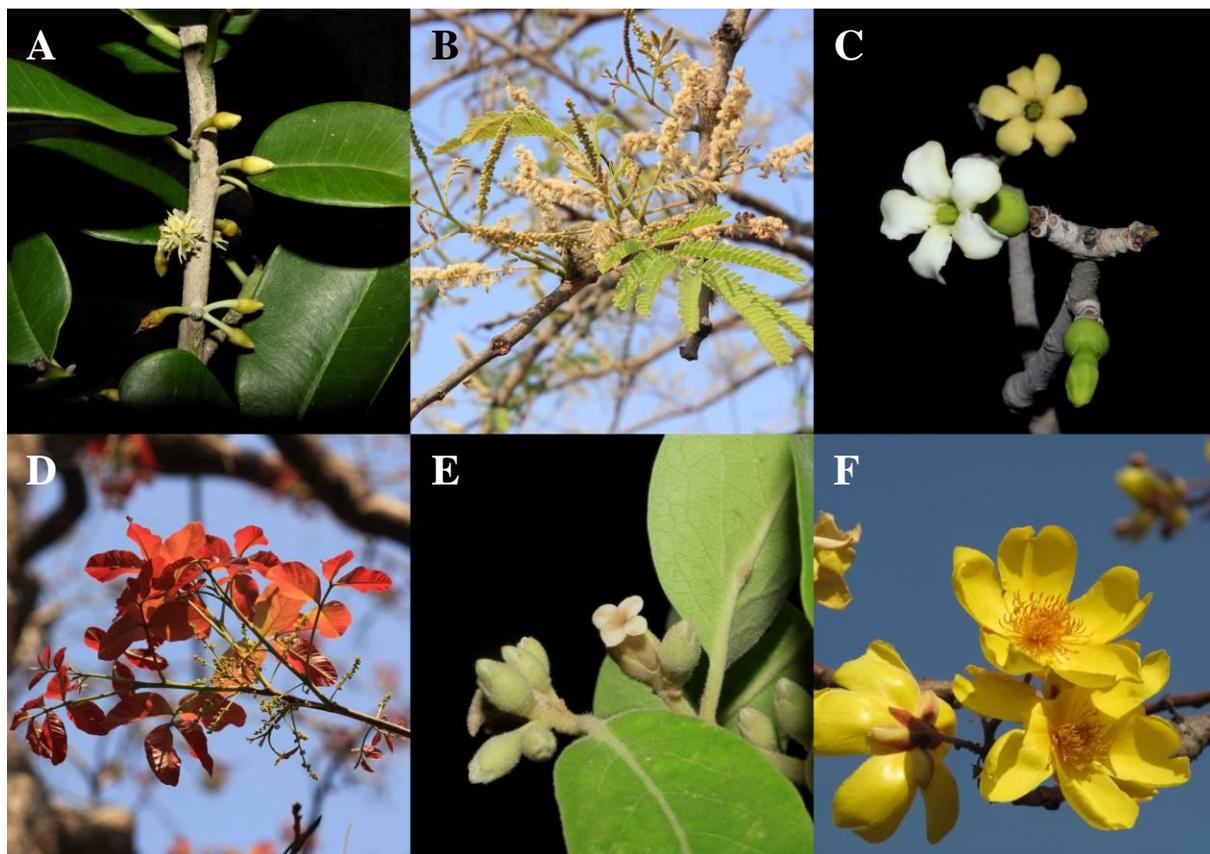


Figure 2: (A) *Manilkara hexandra* (Roxb.) Dubard, (B) *Acacia ferruginea* DC., (C) *Gardenia turgida* Roxb., (D) *Schleicheria oleosa* (Lour.) Oken, (E) *Diospyros melanoxylon* Roxb., (F) *Cochlospermum religiosum* (L.) Alston (photos: A. Nerlekar).

PLATE 4



Figure 3: Herbarium specimen of *Gardenia turgida* Roxb. collected by L.D. Garade on 17 Jun 1902 from Chaturshungi Hill. Courtesy of the Department of Botany, Fergusson College, Pune, India.

PLATE 5



Figure 4: Herbarium specimen of *Schrebera swietenoides* Roxb. collected by L.D. Garade on 17 Jun 1902 from Chaturshungi Hill. Courtesy of the Department of Botany, Fergusson College, Pune, India.