

Angiosperm diversity of the Great Indian Bustard Wildlife Sanctuary: a semi-arid grassland, Maharashtra, India

Jayanthi Janakiraman* and Jeewan Singh Jalal

Botanical Survey of India, Western Regional Centre, 7 Koregaon Road, Pune – 411001, Maharashtra, India

* Corresponding author. E-mail: jayanthi.bsi@gmail.com

Abstract: The Great Indian Bustard Wildlife sanctuary is a semi-arid grassland ecosystem spread over an area of 1,222 km² in the Solapur and Ahmednagar districts of Maharashtra, India. It is an abode of the critically endangered bird, the Great Indian Bustard. A total of 436 plants belonging to 259 genera and 67 families are reported in the present study from the sanctuary, including 22 endemic taxa. Grasses form one of the dominant components of the ecosystem and are represented by about 67 species. The sanctuary is facing severe habitat loss and degradation, posing a threat to its biodiversity. This paper provides a comprehensive documentation of the floristic diversity of the sanctuary. Threats and conservation measures are also discussed.

Key words: inventory, floristics, Nannaj, protected area, Solapur.

INTRODUCTION

Grasslands are a major component of the world's vegetation, covering about 24% (Shantz 1954). They are considered to be a major potential sink for carbon, as grassland soil stores more carbon compared to forest soil (Dinakaran et al. 2011). Grasslands occur in places where temperature, precipitation and physical factors such as soil and drainage combine to create conditions that are too dry for trees to grow. Grasslands have evolved through grazing, drought and periodic fire, and therefore almost all grasslands are maintained by either one or a combination of these factors. They provide habitats for many different animals, birds, insects and lizards, which depend on each other for survival (Allaby 2006; Nancy et al. 2013).

Despite their widespread occurrence, grasslands are shrinking at an alarming rate globally, and are fast becoming one of the most endangered of ecosystems (IUCN 2014). The rapid decline of natural grasslands is due to several reasons. Traditionally, grasslands and

scrub have been considered as “wasteland”. They are prime targets for development projects. About 16% of tropical grasslands have been converted for agriculture or urban development. In forming relatively open areas with low-stature vegetation which intercepts high light intensity, grasslands are also vulnerable to invasive species (Wagner 1989). Their structure and function make them one of the most vulnerable of terrestrial ecosystems to global climate change (Schlesinger 1997; Mooney and Hobbs 2000; Lejeune and Seastedt 2001). Grassland studies are therefore of paramount importance and a pre-requisite for conservation and management of wildlife (Rodgers and Sawarkar 1988; Rahmani 1992).

India has an estimated coverage of grasslands and shrub lands that vary from 3.7 percent to as much as 12 percent of the total area (UNDP 2012). Whyte (1957) has classified Indian grasslands into eight types while Champion and Seth (1968) recognized only three broad categories. The Indian Council of Agricultural Research (ICAR) classified them into five categories, namely *Sehima-Dichanthium* type, *Dichanthium-Cenchrus-Lasiurus* type, *Phragmites-Saccharum-Imperata* type, *Themeda-Arundinella* type and temperate and alpine cover, based on the dominant grass composition (Dabadghao and Shankarnarayan 1973). Based on eco-climatic factors, the Indian grasslands fall under four categories: Himalayan pastures, Terai grasslands, semi-arid grasslands and Shola grasslands. Among these, semi-arid grasslands are found in Western India, Central India and Deccan and are characterized by grassland tracts with patches of thorn forests.

The Bustard Sanctuary comes under the semi-arid grasslands category and is the abode of the Critically Endangered species the Great Indian Bustard [*Ardeotis nigriceps* (Vigors, 1831)] (Birdlife International 2011). This ostrich-like bird occurs in the semi-arid grasslands and deserts of India. It prefers open landscapes, and in particular grassy plains in arid and semi-arid areas interspersed with scrub and low bushes (Rahmani 2006;

Munjpara et al. 2012). It is locally known as “*Maldhok*” in Marathi. Floristic studies in the semi-arid part of Deccan are few when compared to the Western Ghats region of Maharashtra. However, some publications have described areas adjacent to the Bustard Sanctuary (Naik 1979; Pradhan and Singh 1999; Suryavanshi and Bachulkar 2011; Das Das and Singh 2011; Gaikwad et al. 2012; Das Das 2012). No floristic documentation of the Bustard Sanctuary is available to-date, and hence, this study was undertaken with the primary objective of the Botanical Survey of India to explore, inventory and document plant diversity in protected areas of India.

MATERIALS AND METHODS

Study area

The Great Indian Bustard Wildlife Sanctuary (GIB-WLS) was declared a sanctuary *vide* notification No. WLP-1078/72634/FI in 1979 by the Indian Board for Wildlife to protect the critically endangered and endemic bird, the Great Indian Bustard (GIB). It is located in Solapur and Ahmednagar district of Maharashtra and lies between 17°22'17" to 18°54'42" N and 074°23'34" to 076°15'01" E (Figure 1). The sanctuary is spread over an area of ca. 1,222 km². It also includes about 393 villages within its boundary. In general, the terrain of the sanctuary is flat and undulating with an average elevation of 500 to 600 m above mean sea level and covered by a thin mantle of black cotton soil. Apart from black soil, the soil colour varies from reddish brown to coarse grey. The study area comes under the forest types of semi-arid biotope, open scrublands and southern tropical thorn forest (Champion and Seth 1968). The common tree species in this ecosystem are: *Acacia nilotica*, *A. catechu*, *Capparis decidua*, *Senna auriculata*, *Mimosa hamata* and *Ziziphus mauritiana*. The common herbs include *Aeschynomene indica*, *Alysicarpus vaginalis*, *Biophytum sensitivum*, *Cleome viscosa*, *Glossocardia bosvallia*, *Indigofera cordifolia* and *Indigofera linifolia*. The common grasses are *Apluda mutica*, *Chrysopogon fulvus*, *Cymbopogon martini*, *Dichanthium annulatum*, *Heteropogon contortus*, *Ischaemum afrum* and *Setaria pumila*. Factors such as poor soil quality, frequent fire and erosion contribute to the lack of regeneration of the main species and deterioration of native vegetation. The area belongs to the rain shadow region and is prone to annual droughts. June to September is the southwest monsoon season. October and November constitute the post-monsoon or retreating monsoon season. The average annual rainfall in the district is between 550 mm to 650 mm. May is the hottest month with mean daily maximum temperature of 39.9°C and the mean daily minimum of 25.1°C. Grasses form one of the dominant components of the ecosystem. Agriculture is the main occupation of the people in this region. The main crops cultivated include rice, jowar, bajra, pulses, cotton, sugarcane, groundnut,

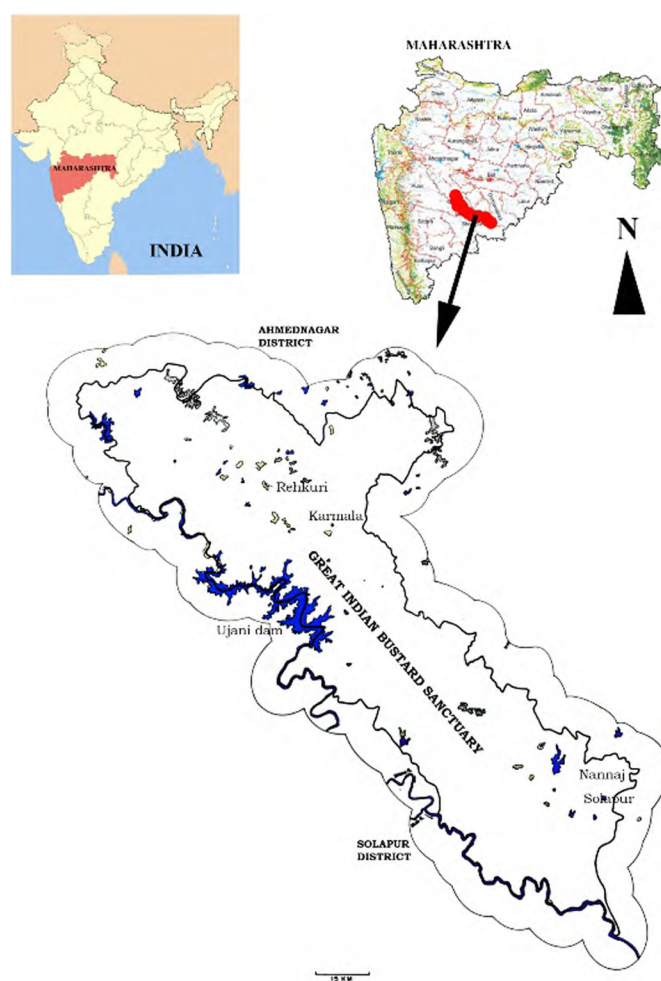


Figure 1. Map showing the study area.

sunflower, turmeric, onion and vegetables such as lady's finger, brinjal, gourds and spinach. Fruits such as grapes and bananas are also cultivated. Plants such as *Parkinsonia aculeata*, *Eucalyptus tereticornis*, *Acacia auriculiformis*, *Dodonaea viscosa*, *Albizia lebbeck*, *Casuarina equisetifolia*, *Duranta repens*, *Gliricidia sepium*, *Azadirachta indica*, etc., are planted near the forest guest houses and along the roadsides.

Data collection

Regular plant exploration tours were undertaken from July 2010 to December 2012. Field trips were organized in different seasons and covered all parts of the study area. In each field trip, the data collected include: habit, habitat, flowering period and local names. Plant samples of all the species were collected from different areas of the sanctuary. The specimens were critically studied for morphological details and for correct identification. Identification was confirmed by consulting standard literature (Cooke 1901; 1908; Naik 1979; Sharma et al. 1996; Pradhan and Singh 1999; Singh and Karthikeyan 2000; Singh et al. 2001; Bhagat et al. 2008; Karthikeyan et al. 2009) and through reference against identified herbarium specimens at Botanical Survey of India, Western

Regional Centre herbarium, Pune (BSI) and Blatter herbarium, Mumbai (BLAT). Web databases such as The Plant List (2013), International Plant Names Index (IPNI 2013), Tropicos, Biodiversity Heritage Library (BHL 2013), Global Biodiversity Information Facility (GBIF 2013) and Kew World Checklist of Selected Plant Families (WCSP 2013) were also consulted for correct nomenclature, author citation and additional information. Author names have been standardised based on Brummitt and Powell (2004). The voucher specimens are deposited at BSI Herbarium Pune, Maharashtra.

RESULTS

Intensive study on the floristic diversity of the Great Indian Bustard Sanctuary resulted in documentation of a total of 436 taxa (Table 1). They belong to 259 genera spread over 67 families. Of these, 317 (73%) taxa belong to dicotyledons and 119 (27%) taxa to monocotyledons (Figure 2). The most dominant families are Poaceae (67 taxa), Fabaceae (41 taxa), Cyperaceae (30 taxa), Asteraceae (29 taxa) and Euphorbiaceae (24 taxa) (Figure 3). Genera such as *Cyperus*, *Euphorbia*, *Ipomoea*, *Senna*, *Acacia* and *Crotalaria* are dominant, possessing greatest species diversity (Figure 4). The flora of the sanctuary is categorized into different life-forms such as trees, shrubs, herbs and climbers in which herbs dominate the flora followed by shrubs and climbers (Figure 5). Trees are poorly represented with only 30 taxa, most of which belong to the genus *Acacia* which is

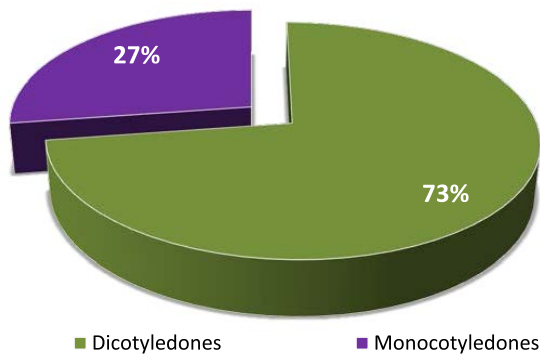


Figure 2. Distribution of dicots and monocots.

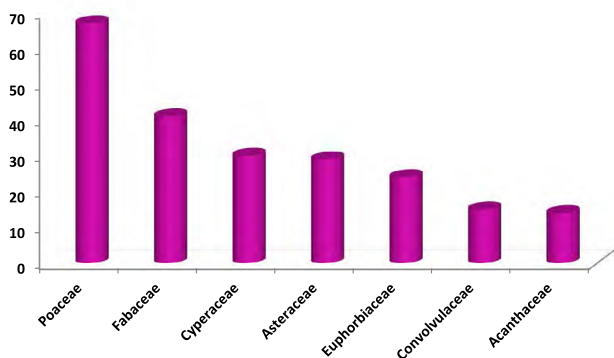


Figure 3. Dominant families of GIBWLS.

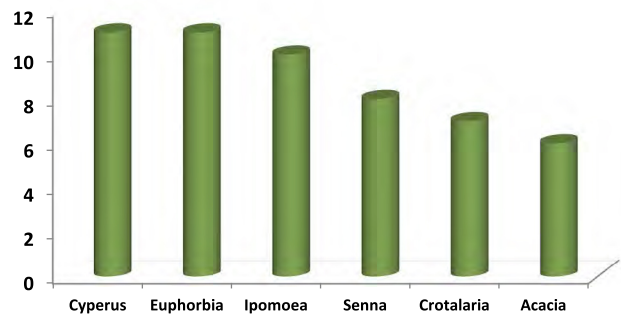


Figure 4. Dominant genera in GIBWLS.

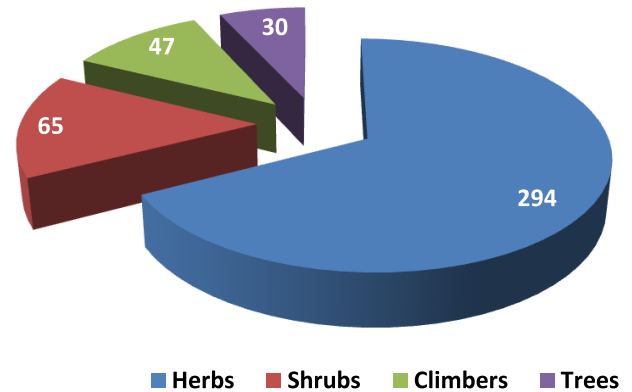


Figure 5. Distribution of life-forms in GIBWLS.

characteristic of the semi-arid ecosystem. Twenty-two endemic taxa were also recorded during the present study: *Cleome simplicifolia*, *Crotalaria filipes*, *Crotalaria vestita*, *Vigna indica*, *Hardwickia binata*, *Dichrostachys cinerea* var. *indica*, *Neonotis montholoni*, *Glossocardia bosvallia*, *Tricholepis radicans*, *Exacum pumilum*, *Hemigraphis urens*, *Euphorbia notopectera*, *Aristida stocksii*, *Isachne borii*, *Iseilema antheophoroides*, *Lophopogon tridentatus*, *Oropetium roxburghianum*, *Oropetium villosulum*, *Sehima sulcatum*, *Spodiopogon rhizophorus*, *Tragus mongolorum* and *Tripogon jacquemontii*.

DISCUSSION

In India, less than one percent of grasslands come under the protected area network, of which 0.24% lies in the semi-arid zone. Some of the protected areas of arid and semi-arid grasslands serve as an important genetic resource in the form of grass and shrub species which are vital for maintaining ecological balance and for food security of the country. These protected areas therefore should not only be considered as key for wildlife conservation, but also as gene banks given that modern cereals have originated from wild grasses (Government of India 2006).

The GIBWLS, which is a grassland ecosystem that accounts for 67 wild grass species and 41 wild legumes, is facing rapid industrialization, conversion of grassland to farmlands and an increase in human population

during the last 30 years. There are also several micro-industries, stone and brick quarries and sugar cane factories located or emerging around the sanctuary's periphery. The cumulative impact of all these land-use pressures has led to severe degradation of habitat, which in turn is leading to a decline in the population of Great Indian Bustard (Dutta et al. 2011). The remaining suitable habitat consists of small and scattered grassland patches protected under the Drought Prone Areas Programme plots, which was introduced by the Central Government. The total aggregate area of these scattered patches is not more than 400 km², with the biggest patch located in the village called Nannaj that lies to the north of Solapur town.

Plantations of trees such as *Gliricidia*, *Azadirachta*, *Eucalyptus* and *Acacia auriculiformis* in the grasslands will adversely affect the habitat's suitability for birds and animals and hence they should be removed. The spread of obnoxious invasive weeds such as *Hyptis suaveolens*, *Parthenium hysterophorus*, *Lantana camara* and *Cassia uniflora* should be controlled and they should be removed from the grassland. Prioritising conservation measures at potential areas such as Nannaj, Mardi, Akolekati, Karamba, Gangevadi, Chapadgaon, Rehkuri and Korti is essential, as these areas harbour several endemic species as well as forming habitat for *Ceropegia bulbosa*; a relatively rare species in the sanctuary.

A total of 22 peninsular endemic species were collected and recorded from these areas during this study. It is observed that 24 grass species have potential fodder value:

Apluda mutica, *Bothriochloa pertusa*, *Cenchrus setigerus*, *Chloris gayana*, *Cynodon dactylon*, *Dactyloctenium aegyptiacum*, *Dichanthium foveolatum*, *Digitaria ternata*, *Echinochloa colonum*, *Eleusine indica*, *Eragrostis pilosa*, *Eragrostis tenella*, *Eragrostis viscosa*, *Heteropogon contortus*, *Melanocentris jacquemontii*, *Oryza sativa*, *Panicum hippothrix*, *Panicum curviflorum*, *Paspalidium flavidum*, *Pennisetum pedicellatum*, *Pennisetum purpureum*, *Sehima ischaemoides*, *Sporobolus indicus* and *Tetrapogon tenellus*. These grasses may be promoted in the sanctuary. Flowers of species such as *Indigofera linifolia*, *Alysicarpus* spp., *Cyanotis fasciculata* and *Chlorophytum tuberosum*, etc. are the main attraction for many beetles and insects. During the study, it was also observed that species such as *Apluda mutica*, *Aristida redacta*, *A. stocksii*, *Echinochloa colona*, *Iseilema antheophoroides*, *Lophopogon tridentatus*, *Melanocentris jacquemontii*, *Oropetium* spp., *Ledebouria hyacinthina*, *Chlorophytum tuberosum*, *Boerhavia diffusa*, *Boerhavia erecta*, *Vigna indica*, *Lepidagathis cristata*, *Spermacoce pusilla*, *Trichodesma indicum*, *Cyanotis fasciculata*, *Ipomoea eriocarpa*, *Indigofera cordifolia*, *Lavandula bipinnata*, etc. support a variety of insects, beetles, and grasshoppers which are the main diet of many grassland birds and animals. Care must be provided to help increase the population of these plant species.

Furthermore, GIS studies should be undertaken for mapping the area to identify the potential grassland patches and level of disturbances in the landscape so as to plan for suitable habitat restoration programmes. Considering this scenario of habitat loss and degradation,

Table 1. List of species in the study area (abbreviations: H= herbs, S= shrubs, C= climbers, T= trees, *= species added based on literature as well as observation in field in vegetative condition.

Taxa	Habit	Flowers	Field No.
Acanthaceae			
<i>Andrographis echinoides</i> (L.) Nees	H	August – September	JJ 198125
<i>Barleria prionitis</i> L.	S	November – December	JJ 199362
<i>Dicliptera paniculata</i> (Forssk.) I. Darbysh.	H	October – December	JJ 199311
<i>Dicliptera verticillata</i> (Forssk.) C.Chr.	H	November – December	JJ 199323
<i>Hemigraphis urens</i> (Roth) J.R.I. Wood	H	November – December	JJ 199389
<i>Hygrophila schulli</i> (Buch.-Ham.) M.R.Almeida & S.M.Almeida	H	November – December	JJ 199361
<i>Justicia diffusa</i> Willd.	H	August – May	*
<i>Justicia japonica</i> Thunb.	H	August – September	JJ 198002
<i>Lepidagathis cristata</i> Willd.	H	August – December	JJ 198158
<i>Lepidagathis trinervis</i> Nees	H	November – May	*
<i>Ruellia patula</i> Jacq.	H	July – August	JJ 199257
<i>Ruellia prostrata</i> Poir.	H	July – August	JJ 199405
<i>Rungia elegans</i> Dalzell & A. Gibson	H	November – December	JJ 199360
<i>Rungia repens</i> (L.) Nees	H	August – September	JJ 198148
Agavaceae			
<i>Agave americana</i> L.	H	October – December	JJ 199491
Aizoaceae			
<i>Trianthema portulacastrum</i> L.	H	September – October	JJ 198277
Amaranthaceae			
<i>Achyranthes aspera</i> L.	H	October – December	JJ 198052
<i>Aerva javanica</i> (Burm. f.) Juss.	H	October – December	JJ 199467
<i>Alternanthera pungens</i> Kunth	H	September – December	JJ 198222

Continued

Table 1. Continued.

Taxa	Habit	Flowers	Field No.
<i>Alternanthera sessilis</i> (L.) R. Br. ex DC.	H	August – December	JJ 198131
<i>Alternanthera tenella</i> Colla	H	August – December	JJ 198172
<i>Amaranthus spinosus</i> L.	H	July – December	JJ 199239
<i>Amaranthus viridis</i> L.	H	August – December	JJ 198270
<i>Celosia argentea</i> L.	H	July – October	JJ 198205
<i>Digera muricata</i> (L.) Mart.	H	August – October	JJ 198255
<i>Gomphrena serrata</i> L.	H	August – September	JJ 198054
<i>Pupalia lappacea</i> (L.) Juss.	H	August – September	JJ 198254
Anacardiaceae			
<i>Rhus mysorensis</i> G. Don	S	July – December	JJ 199288
Apiaceae			
<i>Centella asiatica</i> (L.) Urb.	H	September – October	JJ 199412
Apocynaceae			
<i>Catharanthus pusillus</i> (Murr.) G. Don	H	September – October	JJ 198193
<i>Catharanthus roseus</i> (L.) G. Don	S	September – December	JJ 199477
Araceae			
<i>Colocasia esculenta</i> (L.) Schott.	H	July – December	JJ 199490
Arecaceae			
<i>Borassus flabellifer</i> L.	T	March – June	*
<i>Phoenix sylvestris</i> (L.) Roxb.	T	March – June	*
Aristolochiaceae			
<i>Aristolochia bracteolata</i> Lam.	H	July – September	JJ 199254
Asclepiadaceae			
<i>Asclepias curassavica</i> L.	H	October – February	JJ 199471
<i>Calotropis gigantea</i> (L.) R. Br.	S	Almost throughout the year	JJ 199235
<i>Calotropis procera</i> (Aiton.) R. Br.	S	Almost throughout the year	JJ 198401
<i>Caralluma adscendens</i> (Roxb.) R. Br.	H	July – September	JJ 198063
<i>Ceropegia bulbosa</i> Roxb.	C	August – September	JJ 198119
<i>Dregea volubilis</i> (L.f.) Benth. ex Hook.f	C	August – October	JJ 198141
<i>Marsdenia sylvestris</i> (Retz.) Pl. Forst.	C	July – October	JJ 199258
<i>Pentstemon capensis</i> (L. f.) Bullock	C	July – October	JJ 199283
<i>Pergularia daemia</i> (Forssk.) Choiv.	C	August – September	JJ 198132
<i>Secamone emetica</i> (Retz.) R. Br.	C	July – August	JJ 199255
<i>Tylophora indica</i> (Burm. f.) Merr.	C	August – September	JJ 199478
Asteraceae			
<i>Acanthospermum hispidum</i> DC.	H	September – October	JJ 198179
<i>Ageratum conyzoides</i> L.	H	September – December	JJ 194802
<i>Anaphalis subdecurrens</i> (DC.) Gamble	H	September – December	JJ 198296
<i>Bidens biternata</i> (Lour.) Merr. & Sherff.	H	September – December	JJ 198098
<i>Blainvillea acmella</i> (L.) Philipson	H	September – December	JJ 198134
<i>Blumea axillaris</i> (Lam.) DC.	H	October – December	JJ 199320
<i>Blumea lacera</i> (Burm. f.) DC.	H	August – December	JJ 199315
<i>Blumea oxyodonta</i> DC.	H	October – December	JJ 199335
<i>Caesulia axillaris</i> Roxb.,	H	September – October	JJ 198062
<i>Cyanthillium cinereum</i> (L.) H. Rob.	H	September – October	JJ 198110
<i>Cyathocline purpurea</i> (Buch.-Ham. ex D. Don) O. Ktze.	H	October – December	JJ 199316
<i>Dicoma tomentosa</i> Cass.	H	October – December	JJ 198088
<i>Echinops echinatus</i> Roxb.	H	October – December	JJ 199327
<i>Eclipta prostrata</i> (L.) L.	H	August – October	JJ 198221
<i>Emilia sonchifolia</i> (L.) DC.	H	September - October	JJ 198109
<i>Flaveria trinervia</i> (Spreng.) C. Mohr.	H	July – August	JJ 199297
<i>Glossocardia bosvallia</i> (L. f.) DC.	H	September – October	JJ 198015
<i>Goniocaulon indicum</i> (Klein ex Willd.) Clarke	H	November – December	JJ 199388
<i>Grangea maderaspatana</i> (L.) Poir.	H	July – August	JJ 199223
<i>Lagascea mollis</i> Cav.	H	August – September	JJ 199215
<i>Launaea procumbens</i> (Roxb.) Ramayya & Rajagopal	H	August – September	JJ 199295
<i>Parthenium hysterophorus</i> L.	H	August – September	JJ 198212
<i>Pluchea lanceolata</i> (DC.) C.B. Clarke	S	October – December	JJ 199400
<i>Pseudognaphalium luteo-album</i> (L.) Hillard & B.L. Burt.	H	September – December	JJ 199352
<i>Pulicaria wightiana</i> C. B. Clarke	H	August – September	JJ 198021

Continued

Table 1. Continued.

Taxa	Habit	Flowers	Field No.
<i>Sphaeranthus indicus</i> L.	H	November – December	JJ 199371
<i>Tricholepis radicans</i> (Roxb.) DC.	H	September – October	JJ 198051
<i>Tridax procumbens</i> L.	H	September – October	JJ 198020
<i>Xanthium indicum</i> Koen.	S	October – December	JJ 198163
Bignoniaceae			
<i>Dolichandrone falcata</i> (Wall. ex DC.) Seem.	T	August – September	JJ 198171
Boraginaceae			
<i>Coldenia procumbens</i> L.	H	July – August	JJ 199222
<i>Cordia dichotoma</i> Forst. f.	T	July – August	JJ 199248
<i>Cordia sinensis</i> Lam.	T	July – August	JJ 199287
<i>Heliotropium bracteatum</i> R. Br.	H	September – October	JJ 198070
<i>Heliotropium indicum</i> L.	H	Frequently throughout the year	JJ 199472
<i>Heliotropium ovalifolium</i> Forssk.	H	July – September	JJ 199232
<i>Heliotropium supinum</i> L.	H	October – December	JJ 199381
<i>Trichodesma indicum</i> (L.) Lehm.	H	August – September	JJ 198091
<i>Trichodesma zeylanicum</i> (Burm. f.) R. Br.	H	August – September	JJ 198188
Brassicaceae			
<i>Brassica juncea</i> (L.) Czern.	H	June – October	JJ 199476
<i>Thlaspi arvensis</i> L.	H	July – August	JJ 199298
Cactaceae			
<i>Opuntia elatior</i> Mill.	S	August – September	*
Caesalpinaceae			
<i>Bauhinia racemosa</i> Lam.	T	June – August	JJ 198197
<i>Caesalpinia bonduc</i> (L.) Roxb.	S	July – December	JJ 199236
<i>Chamaecrista mimosoides</i> (L.) Greene	H	September – October	JJ 198049
<i>Hardwickia binata</i> Roxb.,	T	August – December	JJ 199246
<i>Senna alata</i> (L.) Roxb.	S	July – December	JJ 199475
<i>Senna auriculata</i> (L.) Roxb.	S	Almost throughout the year	JJ 198031
<i>Senna italica</i> Mill.	S	July – August	JJ 199281
<i>Senna obtusifolia</i> (L.) H.S. Irwin & Barneby	S	September – October	JJ 199402
<i>Senna occidentalis</i> (L.) Link	S	August – December	JJ 198113
<i>Senna sophera</i> (L.) Roxb.	S	July – August	JJ 199289
<i>Senna tora</i> (L.) Roxb.	S	July – August	JJ 199406
<i>Senna uniflora</i> (Mill.) H.S. Irwin & Barneby	S	September – December	JJ 198030
Capparaceae			
<i>Capparis decidua</i> (Forssk.) Edgew.	T	July – August	JJ 199201
<i>Capparis divaricata</i> Lam.	S	July – December	JJ 198196
<i>Capparis grandis</i> L.f.	T	April – August	JJ 199275
<i>Cleome chelidonii</i> L. f.	H	July – October	JJ 199221
<i>Cleome gynandra</i> L.	H	July – October	JJ 198263
<i>Cleome simplicifolia</i> (Cambess.) Hook. f. & Thoms.	H	July – September	JJ 198013
<i>Cleome viscosa</i> L.	H	July – September	JJ 198286
Caryophyllaceae			
<i>Polycarpha corymbosa</i> (L.) Lam.	H	August – September	JJ 198012
Casuarinaceae			
<i>Casuarina equisetifolia</i> L.	T	August – October	JJ 199500
Colchicaceae			
<i>Iphigenia indica</i> (L.) Kunth	H	July – September	JJ 198147
Commelinaceae			
<i>Commelina benghalensis</i> L.	H	July – September	JJ 199489
<i>Commelina diffusa</i> Burm.f.	H	July – September	JJ 198059
<i>Commelina erecta</i> L.	H	July – September	JJ 199284
<i>Commelina forskalaei</i> Vahl	H	July – September	JJ 199488
<i>Commelina caroliniana</i> Walter	H	July – September	JJ 198252
<i>Cyanotis axillaris</i> (L.) D. Don ex Sweet	H	July – September	JJ 198237
<i>Cyanotis cristata</i> (L.) D. Don	H	July – September	JJ 198032
<i>Cyanotis fasciculata</i> (B. Heyne ex Roth) Schult. & Schult. f.	H	August – September	JJ 198008
Convolvulaceae			
<i>Argyreia cymosa</i> (Roxb.) Sweet	C	November – December	JJ 199344
<i>Convolvulus arvensis</i> L.	C	July – August	JJ 199292

Continued

Table 1. Continued.

Taxa	Habit	Flowers	Field No.
<i>Evolvulus alsinoides</i> (L.) L.	H	July – September	JJ 198016
<i>Ipomoea aquatica</i> Forssk.	H	July – September	JJ 199480
<i>Ipomoea cairica</i> (L.) Sweet	C	July – September	JJ 199365
<i>Ipomoea carnea</i> Jacq.	S	July – October	JJ 198279
<i>Ipomoea eriocarpa</i> R. Br.	C	November – December	JJ 199379
<i>Ipomoea hederifolia</i> L.	C	November – December	JJ 199309
<i>Ipomoea nil</i> (L.) Roth	C	August – September	JJ 198229
<i>Ipomoea obscura</i> (L.) Ker Gawl	C	September – December	JJ 198235
<i>Ipomoea grandifolia</i> (Dammer) O'Donell	C	September – December	JJ 198168
<i>Ipomoea sindica</i> Stapf	C	September – December	JJ 199466
<i>Ipomoea violacea</i> L.	C	September – December	JJ 199345
<i>Merremia emarginata</i> (Burm.f.) Hallier f.	H	September – December	JJ 198267
<i>Rivea hypocrateriformis</i> (Desr.) Choisy	C	July – December	JJ 198124
Cucurbitaceae			
<i>Citrullus colocynthis</i> (L.) Schrad.	C	July – October	JJ 199306
<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai	C	July – October	JJ 199413
<i>Coccinia grandis</i> (L.) Voigt.	C	September - December	JJ 198187
<i>Corallocarpus epigaeus</i> (Rottler) Benth. & Hook. f.	C	September – October	JJ 198181
<i>Cucumis prophetarum</i> L.	C	September – December	JJ 199299
<i>Cucumis sativus</i> L.	C	September – December	JJ 198180
<i>Diplocyclos palmatus</i> (L.) C. Jeffrey	C	September – December	JJ 198118
<i>Momordica charantia</i> L.	C	July – October	JJ 199213
<i>Momordica cymbalaria</i> Hook.f.	C	July – August	JJ 199261
<i>Momordica dioica</i> Roxb. ex Willd.	C	July – October	JJ 199245
<i>Mukia maderaspatana</i> (L.) M. Roem.	C	September – October	JJ 198024
Cuscutaceae			
<i>Cuscuta reflexa</i> Roxb.	C	December – January	JJ 199274
Cyperaceae			
<i>Bulbostylis barbata</i> (Rottb.) C.B. Clarke	H	September – October	JJ 198042
<i>Cyperus alulatus</i> J. Kern	H	July – December	JJ 198066
<i>Cyperus compressus</i> L.	H	July – December	JJ 198283
<i>Cyperus difformis</i> L.	H	July – December	JJ 198206
<i>Cyperus digitatus</i> Roxb.	H	July – December	JJ 198215
<i>Cyperus distans</i> L. f.	H	August – October	JJ 198217
<i>Cyperus exaltatus</i> Retz.	H	August – December	JJ 199396
<i>Cyperus iria</i> L.	H	July – December	JJ 198036
<i>Cyperus nutans</i> var. <i>eleusinoides</i> (Kunth) R.W. Haines	H	July – December	JJ 198248
<i>Cyperus pilosus</i> Vahl	H	July – September	JJ 198096
<i>Cyperus rotundus</i> L.	H	July – December	JJ 198214
<i>Cyperus tenuispica</i> Steud.	H	August – October	JJ 198097
<i>Eleocharis atropurpurea</i> (Retz.) J. Presl. & C. Presl.	H	November – December	JJ 199319
<i>Eleocharis geniculata</i> (L.) Roem. & Schult.	H	August – December	JJ 198101
<i>Fimbristylis complanata</i> (Retz.) Link	H	July – October	JJ 198093
<i>Fimbristylis dichotoma</i> (L.) Vahl	H	July – December	JJ 198292
<i>Fimbristylis ferruginea</i> (L.) Vahl	H	August – October	JJ 198219
<i>Fimbristylis ovata</i> (Burm. f.) J. Kern	H	August – October	JJ 198294
<i>Fimbristylis quinqueangularis</i> (Vahl) Kunth	H	September – October	JJ 198089
<i>Fimbristylis tenera</i> Schult.	H	September – October	JJ 198041
<i>Fuirena cuspidata</i> (Roth) Kunth	H	August – October	JJ 198246
<i>Kyllinga brevifolia</i> Rottb.	H	August – September	JJ 198035
<i>Lipocarpa squarrosa</i> (L.) Goetgheb.	H	August – September	JJ 198203
<i>Mariscus squarrosus</i> (L.) C.B. Clarke	H	August – September	JJ 198037
<i>Pycnus flavidus</i> (Retz.) T. Koyama	H	August – September	JJ 198218
<i>Pycnus polystachyos</i> (Rottb.) P. Beauv.	H	August – September	JJ 199493
<i>Schoenoplectiella lateriflora</i> (J.F. Gmel) Lye	H	July – September	JJ 199395
<i>Schoenoplectiella roylei</i> (Nees) Lye	H	September – October	*
<i>Schoenoplectiella supina</i> (L.) Lye	H	July – September	JJ 199397
<i>Scleria parvula</i> Steud.	H	July – September	JJ 198284
Eriocaulaceae			
<i>Eriocaulon quinqueangulare</i> L.	H	August – September	JJ 198202

Continued

Table 1. Continued.

Taxa	Habit	Flowers	Field No.
Euphorbiaceae			
<i>Acalypha indica</i> L.	H	August – September	JJ 198149
<i>Chrozophora rottleri</i> (Geiseler) A. Juss.ex Spreng.	H	August – September	JJ 199427
<i>Croton bonplandianus</i> Baill.	H	August – October	JJ 198264
<i>Euphorbia antiquorum</i> L.	S	July – September	*
<i>Euphorbia cristata</i> B. Heyne ex Roth	H	July – September	JJ 198161
<i>Euphorbia heterophylla</i> L.	H	August – September	JJ 198157
<i>Euphorbia heyneana</i> Spreng.	H	November – December	JJ 199384
<i>Euphorbia hirta</i> L.	H	August – September	JJ 198011
<i>Euphorbia hypericifolia</i> L.	H	July – August	JJ 198010
<i>Euphorbia indica</i> Lam.	H	August – September	JJ 198274
<i>Euphorbia notopectera</i> Boiss.	H	August – September	JJ 198071
<i>Euphorbia prostrata</i> Aiton	H	August – September	JJ 199229
<i>Euphorbia thymifolia</i> L.	H	August – September	JJ 198275
<i>Euphorbia tirucalli</i> L.	S	December – February	JJ 199414
<i>Flueggea leucopyrus</i> Willd.	S	July – December	JJ 198067
<i>Jatropha curcas</i> L.	S	December – February	JJ 199249
<i>Jatropha gossypifolia</i> L.	S	July – October	JJ 199207
<i>Phyllanthus amarus</i> Schumach. & Thonn.	H	July – October	JJ 198128
<i>Phyllanthus debilis</i> Klein ex Willd.,	H	August – December	JJ 199429
<i>Phyllanthus maderaspatensis</i> L.	H	August – December	JJ 198005
<i>Phyllanthus reticulatus</i> Poir.	S	July – October	JJ 198200
<i>Phyllanthus simplex</i> Retz.	H	July – October	JJ 199216
<i>Ricinus communis</i> L.	S	October – December	JJ 194803
<i>Tragia plukenetii</i> Radcl.-Sm.	H	August – October	JJ 198154
Fabaceae			
<i>Abrus precatorius</i> L.	C	Almost throughout the year	JJ 199390
<i>Aeschynomene indica</i> L.	S	September – October	JJ 198231
<i>Alysicarpus glumaceus</i> (Vahl) DC.	H	September – October	JJ 198173
<i>Alysicarpus heyneanus</i> Wight & Arn.	H	July – September	JJ 199322
<i>Alysicarpus monilifer</i> (L.) DC.	H	July – September	JJ 199451
<i>Alysicarpus scariosus</i> (Rottl. ex Spreng.) Graham ex Thwaites	H	September – October	JJ 199394
<i>Alysicarpus tetragonolobus</i> Edgew.	H	September – October	JJ 198085
<i>Alysicarpus vaginalis</i> (L.) DC. var. <i>nummularifolius</i> Miq.	H	September – October	JJ 198009
<i>Butea monosperma</i> (Lam.) Taub.	T	February – March	*
<i>Canavalia africana</i> Dunn	C	July – December	JJ 199343
<i>Canavalia ensiformis</i> (L.) DC.	C	July – December	JJ 199457
<i>Crotalaria calycina</i> Schrank	H	September – October	JJ 198153
<i>Crotalaria filipes</i> Benth	H	September – October	JJ 198256
<i>Crotalaria hebecarpa</i> (DC.) Rudd	H	September – December	JJ 198086
<i>Crotalaria juncea</i> L.	H	November – December	JJ 199399
<i>Crotalaria orixensis</i> Willd.	H	September – October	JJ 198162
<i>Crotalaria pallida</i> Aiton.	H	July – October	JJ 199473
<i>Crotalaria vestita</i> Baker	H	September – October	JJ 198122
<i>Desmodium dichotomum</i> (Willd.) DC.	H	September – October	JJ 198174
<i>Desmodium gangeticum</i> (L.) DC.	S	September – October	JJ 199447
<i>Desmodium heterocarpon</i> (L.) DC.	S	September – October	JJ 198129
<i>Desmodium triflorum</i> (L.) DC.	H	July – September	JJ 199497
<i>Erythrina variegata</i> L.	T	March – April	JJ 194804
<i>Indigofera coerulea</i> Roxb.	S	July – August	JJ 199296
<i>Indigofera cordifolia</i> B. Heyne ex Roth	H	September – December	JJ 198018
<i>Indigofera linifolia</i> (L.f.) Retz.	H	September – December	JJ 198025
<i>Indigofera prostrata</i> Willd.	H	August – October	*
<i>Indigofera tinctoria</i> L.	S	July – October	JJ 199291
<i>Indigofera trifoliata</i> L.	H	September – December	JJ 198190
<i>Lablab purpureus</i> (L.) Sweet	C	July – September	JJ 199356
<i>Rhynchosia capitata</i> (B. Heyne ex Roth) DC.	C	September – December	JJ 198198
<i>Rhynchosia minima</i> (L.) DC.	C	September – December	JJ 198120
<i>Stylosanthes fruticosa</i> (Retz.) Alston	S	September – October	JJ 198092
<i>Stylosanthes viscosa</i> (L.) Sw.	S	September – October	JJ 198258

Continued

Table 1. Continued.

Taxa	Habit	Flowers	Field No.
<i>Tephrosia purpurea</i> (L.) Pers.	S	September – October	JJ 198022
<i>Tephrosia senticososa</i> (L.) Pers.	S	September – December	JJ 198192
<i>Tephrosia villosa</i> (L.) Pers.	S	July – October	JJ 198226
<i>Vigna aconitifolia</i> (Jacq.) Morechal	C	August – September	JJ 198167
<i>Vigna indica</i> T.M. Dixit, K.V. Bhat & S.R. Yadav	C	August – September	JJ 198019
<i>Vigna trilobata</i> (L.) Verdc.	C	August – September	JJ 198164
<i>Zornia gibbosa</i> Span.	H	August – September	JJ 198001
Gentianaceae			
<i>Canscora diffusa</i> (Vahl) R. Br.	H	August – September	JJ 198220
<i>Enicostema axillare</i> (Lam.) Raynal	H	August – September	JJ 198073
<i>Exacum pumilum</i> Griseb.	H	August – September	JJ 198106
Geraniaceae			
<i>Monsonia senegalensis</i> Guill. & Perr.	H	July – August	JJ 199293
Hydrocharitaceae			
<i>Ottelia alismoides</i> (L.) Pers.	H	October – December	JJ 199354
Lamiaceae			
<i>Hyptis suaveolens</i> (L.) Poit.	H	July – September	JJ 198210
<i>Lavandula bipinnata</i> (Roth) Kuntze	H	August – September	JJ 198105
<i>Leonotis nepetifolia</i> (L.) R. Br.	S	November – December	JJ 199358
<i>Leucas aspera</i> (Willd.) Link	H	July – October	JJ 198244
<i>Leucas lavandulifolia</i> Sm.	H	July – October	JJ 198175
<i>Leucas longifolia</i> Benth.	H	July – October	JJ 198057
<i>Ocimum tenuiflorum</i> L.	H	July – October	JJ 198100
<i>Orthosiphon pallidus</i> Royle ex Benth.	H	July – September	JJ 198151
Lentibulariaceae			
<i>Utricularia bifida</i> L.	H	November – December	JJ 199375
Liliaceae			
<i>Aloe vera</i> (L.) Burm.f.	H	December – March	JJ 199492
<i>Asparagus racemosus</i> Willd.	C	October – February	JJ 199286
<i>Chlorophytum laxum</i> R. Br.	H	July – September	JJ 199285
<i>Chlorophytum tuberosum</i> (Roxb.) Baker	H	July – September	JJ 199252
<i>Ledebouria hyacinthina</i> (L.f.) Jessop	H	July – September	JJ 199217
Lobeliaceae			
<i>Lobelia alsinoides</i> Lam.	H	August – October	JJ 199376
Lythraceae			
<i>Ammannia baccifera</i> L.	H	November – December	JJ 198241
<i>Ammannia multiflora</i> Roxb.	H	September – October	JJ 198076
Malvaceae			
<i>Abutilon hirtum</i> (Lam.) Sweet	S	July – October	JJ 199270
<i>Abutilon indicum</i> (L.) Sweet	S	August – December	JJ 198230
<i>Abutilon pannosum</i> (G. Forst.) Schtdl.	S	September – December	JJ 198183
<i>Hibiscus caesius</i> Garcke	H	October – December	JJ 199359
<i>Hibiscus lobatus</i> (Murray) Kuntze.	H	December – January	JJ 199280
<i>Malachra capitata</i> (L.) L.	S	December – January	JJ 199462
<i>Malvastrum coromandelianum</i> (L.) Garcke	S	July – September	JJ 198160
<i>Sida acuta</i> Burm. f.	S	September – December	JJ 198261
<i>Sida rhombifolia</i> L.	S	October – December	JJ 194805
<i>Sida spinosa</i> L.	S	September – December	JJ 198289
<i>Thespesia populnea</i> (L.) Sol. ex Correa	T	August – December	JJ 194806
Martyniaceae			
<i>Martynia annua</i> L.	H	August – September	JJ 198115
Menispermaceae			
<i>Cocculus hirsutus</i> (L.) W. Theob.	C	Frequently throughout the year	JJ 198199
<i>Tinospora cordifolia</i> (Willd.) Miers ex Hook. f. & Thoms	C	July – October	JJ 198201
Mimosaceae			
<i>Acacia campbellii</i> Arn.	T	August – December	JJ 199329
<i>Acacia catechu</i> (L.f.) Willd.	T	August – October	JJ 198194
<i>Acacia eburnea</i> (L.f.) Willd.	T	September – December	JJ 194807
<i>Acacia leucophloea</i> (Roxb.) Willd.	T	September – December	JJ 198058
<i>Acacia nilotica</i> subsp. <i>cupressiformis</i> (J.L. Stewart) Ali & Faruqui	T	August – December	JJ 194808

Continued

Table 1. Continued.

Taxa	Habit	Flowers	Field No.
<i>Acacia nilotica</i> subsp. <i>indica</i> (Benth.) Brenan	T	September – October	JJ 198140
<i>Acacia tomentosa</i> Willd.	T	September – December	JJ 199273
<i>Dichrostachys cinerea</i> var. <i>indica</i> Brenan & Brummit	S	August – December	JJ 199237
<i>Leucaena leucocephala</i> (Lam.) de Wit	T	August – December	JJ 194809
<i>Mimosa hamata</i> Willd.	S	August – December	JJ 198099
<i>Mimosa pudica</i> L.	H	August – December	JJ 194810
<i>Pithecellobium dulce</i> (Roxb.) Benth.	T	February – June	JJ 199455
<i>Prosopis juliflora</i> (Sw.) DC.	T	February – June	JJ 194811
Molluginaceae			
<i>Glinus lotoides</i> L.	H	August – September	JJ 199240
<i>Mollugo nudicaulis</i> Lam.	H	September – October	JJ 198028
<i>Mollugo stricta</i> L.	H	September – December	JJ 199393
Moraceae			
<i>Ficus benghalensis</i> L.	T	February – June	JJ 194812
<i>Ficus hispida</i> L. f.	T	July – August	JJ 194813
<i>Ficus microcarpa</i> L. f.	T	July – August	JJ 199272
<i>Ficus racemosa</i> L.	T	July – August	JJ 199250
<i>Ficus religiosa</i> L.	T	July – August	JJ 194814
Nyctaginaceae			
<i>Boerhavia erecta</i> L.	H	September – October	JJ 199421
<i>Boerhavia diffusa</i> L.	H	September – October	JJ 198077
<i>Mirabilis jalapa</i> L.	H	Frequently throughout the year	JJ 199486
Onagraceae			
<i>Ludwigia hyssopifolia</i> (G.Don) Exell	H	September – October	JJ 198211
Oxalidaceae			
<i>Biophytum sensitivum</i> (L.) DC.	H	September – October	JJ 198033
<i>Oxalis corniculata</i> L.	H	Almost throughout the year	JJ 199366
Papaveraceae			
<i>Argemone mexicana</i> L.	H	Almost throughout the year	JJ 198300
Passifloraceae			
<i>Passiflora foetida</i> L.	C	August – December	JJ 194815
Pedaliaceae			
<i>Sesamum laciniatum</i> Klein. ex Willd.	H	August – September	JJ 198023
<i>Sesamum indicum</i> L.	H	August – September	JJ 198146
Periploceae			
<i>Cryptolepis buchananii</i> Roem. & Schult.	S	July – September	JJ 198233
<i>Cryptostegia grandiflora</i> R. Br.	S	July – September	JJ 198056
<i>Hemidesmus indicus</i> (L.) Schult.	C	July – September	JJ 199479
Plumbaginaceae			
<i>Plumbago zeylanica</i> L.	S	September – October	JJ 198232
Poaceae			
<i>Alloteropsis cimicina</i> (L.) Stapf.	H	July – September	JJ 198127
<i>Andropogon pumilus</i> Roxb.	H	July – December	JJ 198133
<i>Apluda mutica</i> L.	H	September – December	JJ 198170
<i>Aristida adscensionis</i> L.	H	September – December	JJ 199348
<i>Aristida funiculata</i> Trin. & Rupr.	H	September – December	JJ 199494
<i>Aristida hystrix</i> L. f.	H	September – December	JJ 198139
<i>Aristida redacta</i> Stapf.	H	September – December	JJ 198108
<i>Aristida setacea</i> Retz.	H	September – December	JJ 199495
<i>Aristida stocksii</i> (Hook. f.) Domin	H	July – December	JJ 198040
<i>Arundinella tuberculata</i> Munro ex Lisboa	H	September – November	*
<i>Arundo donax</i> L.	H	September – November	JJ 199334
<i>Bothriochloa pertusa</i> (L.) A. Camus	H	September – December	JJ 198029
<i>Brachiaria distachya</i> (L.) Stapf.	H	September – November	JJ 198117
<i>Brachiaria eruciformis</i> (Sm.) Griseb.	H	July – September	JJ 198165
<i>Brachiaria ramosa</i> (L.) Stapf.	H	July – September	JJ 198176
<i>Cenchrus setigerus</i> Vahl	H	July – September	JJ 198184
<i>Chionachne gigantea</i> (J. Koenig) Veldkamp	H	July – September	JJ 198259
<i>Chloris gayana</i> Kunth ex Stapf	H	July – September	JJ 198135
<i>Chrysopogon fulvus</i> (Spreng.) Chiov.	H	August – September	JJ 198143

Continued

Table 1. Continued.

Taxa	Habit	Flowers	Field No.
<i>Coix lacryma-jobi</i> L.	H	July – September	JJ 199368
<i>Cymbopogon martini</i> (Roxb.) S. Watson	H	July – October	JJ 198265
<i>Cynodon dactylon</i> (L.) Pers.	H	August – October	JJ 199224
<i>Dactyloctenium aegyptiacum</i> (L.) Willd.	H	August – October	JJ 198260
<i>Dactyloctenium aristatum</i> Link	H	August – October	JJ 198048
<i>Dichanthium foveolatum</i> (Delile) Roberty	H	August – October	JJ 198185
<i>Digitaria ciliaris</i> (Retz.) Koeler	H	August – October	JJ 198044
<i>Digitaria stricta</i> Roth ex Roem. & Schult.	H	August – October	JJ 198081
<i>Digitaria ternata</i> (A. Rich.) Stapf.	H	September – December	JJ 199496
<i>Dinebra retroflexa</i> (Vahl) Panz.	H	August – October	JJ 198269
<i>Echinochloa colonum</i> (L.) Link	H	August – September	JJ 198046
<i>Eleusine indica</i> (L.) Gaertn.	H	July – September	JJ 198227
<i>Eragrostiella bifaria</i> (Vahl)	H	July – September	JJ 198111
<i>Eragrostiella brachyphylla</i> (Stapf) Bor	H	July – September	JJ 198043
<i>Eragrostis gangetica</i> (Roxb.) Steud	H	September – October	JJ 198112
<i>Eragrostis pilosa</i> (L.) P. Beauv.	H	September – October	JJ 198045
<i>Eragrostis tenella</i> (L.) P. Beauv. ex Roem. & Schult.	H	August – October	JJ 198268
<i>Eragrostis unioides</i> (Retz.) Nees ex Steud.	H	August – October	JJ 199382
<i>Eragrostis viscosa</i> (Retz.) Trin.	H	September – October	JJ 199336
<i>Heteropogon contortus</i> (L.) P. Beauv. ex Roem. & Schult.	H	September – October	JJ 198079
<i>Heteropogon triticeus</i> (R. Br.) Stapf ex Craib	H	September – October	JJ 199370
<i>Isachne borii</i> Hemadri	H	September – October	*
<i>Ischaemum afrum</i> (J.F. Gmel.) Dandy	H	July – September	JJ 198186
<i>Iseilema antheperoides</i> Hack.	H	September – October	JJ 198026
<i>Hackelochloa granularis</i> (L.) Kuntze	H	September – October	JJ 198014
<i>Lophopogon tridentatus</i> (Roxb.) Hack.	H	August – October	JJ 198038
<i>Melanocenchris jacquemontii</i> Jaub. & Spach	H	August – October	JJ 198039
<i>Oropetium roxburghianum</i> (Steud.) S.M. Phillips	H	August – September	JJ 199226
<i>Oropetium thomaeum</i> (L. f.) Trin.	H	August – September	JJ 198126
<i>Oropetium villosulum</i> Stapf ex Bor	H	August – September	JJ 199419
<i>Oryza sativa</i> L.	H	July– September	JJ 198285
<i>Panicum hippothrix</i> K.Schum. ex Engl.	H	July – October	JJ 199498
<i>Panicum curviflorum</i> Hornem	H	September – October	JJ 198087
<i>Paspalidium flavidum</i> (Retz.) A. Camus	H	August – October	JJ 198027
<i>Pennisetum pedicellatum</i> Trin.	H	July – September	JJ 199499
<i>Pennisetum purpureum</i> Schumach.	H	July – September	JJ 199271
<i>Sehima ischaemoides</i> Forssk.	H	July – October	JJ 198137
<i>Sehima sulcatum</i> (Hack.) A. Camus	H	July – October	JJ 199392
<i>Setaria intermedia</i> Roem. & Schult.	H	July – September	JJ 198136
<i>Setaria pumila</i> (Poir.) Roem. & Schult.	H	July – October	JJ 198047
<i>Spodiopogon rhizophorus</i> (Steud.) Pilg.	H	July – October	*
<i>Sporobolus coromandelianus</i> (Retz.) Kunth	H	July – October	*
<i>Sporobolus indicus</i> (L.) R. Br.	H	July – October	JJ 199452
<i>Tetrapogon tenellus</i> (J. Koenig ex Roxb.) Chiov.	H	July – October	JJ 198225
<i>Themeda laxa</i> (Andersson) A. Camus	H	July – December	JJ 199369
<i>Tragus mongolorum</i> Ohwi	H	July – October	JJ 198074
<i>Tripogon bromoides</i> Roth	H	July – October	JJ 199437
<i>Tripogon jacquemontii</i> Stapf	H	July – October	JJ 198249
Polygalaceae			
<i>Polygala arvensis</i> Willd.	H	July – September	JJ 198034
<i>Polygala erioptera</i> DC. Prodr.	H	August – September	JJ 198084
Polygonaceae			
<i>Antigonon leptopus</i> Hook. & Arn.	C	Almost throughout the year	JJ 199487
<i>Persicaria glabra</i> (Willd.) M. Gomez	H	August – September	JJ 199453
<i>Polygonum plebeium</i> R. Br.	H	July – September	JJ 199227
Pontederiaceae			
<i>Eichhornia crassipes</i> (Mart.) Solms	H	Almost throughout the year	*
Portulacaceae			
<i>Portulaca oleracea</i> L.	H	July – September	JJ 198017
<i>Portulaca tuberosa</i> Roxb.	H	July – September	JJ 198204
<i>Portulaca quadrifida</i> L.	H	August – September	JJ 199430

Continued

Table 1. Continued.

Taxa	Habit	Flowers	Field No.
Rhamnaceae			
<i>Ziziphus mauritiana</i> Lam.	S	September – December	JJ 198068
<i>Ziziphus xylopyrus</i> (Retz.) Willd.	S	August – December	JJ 199386
Rubiaceae			
<i>Benkara malabarica</i> (Lam.) Tirveng.	S	June – October	JJ 198223
<i>Dentella repens</i> (L.) J.R. Forst. & G. Forst.	H	July – August	JJ 199225
<i>Kohautia aspera</i> (B. Heyne ex Roth) Bremek.	H	August – November	*
<i>Morinda pubescens</i> J.E. Sm.	T	Almost throughout the year	JJ 198055
<i>Neanotis montholonii</i> (Hook. f.) W.H. Lewis	H	September – October	JJ 198159
<i>Oldenlandia corymbosa</i> L.	H	September – October	JJ 198240
<i>Oldenlandia diffusa</i> (Willd.) Roxb.	H	September – October	JJ 199468
<i>Oldenlandia umbellata</i> L.	H	August – December	*
<i>Spermacoce articularis</i> L.f.	H	September – October	JJ 198064
<i>Spermacoce pusilla</i> Wall.	H	September – October	JJ 198003
Santalaceae			
<i>Santalum album</i> L.	T	August – October	JJ 198114
Sapindaceae			
<i>Cardiospermum halicacabum</i> L.	C	Almost throughout the year	JJ 198130
Scrophulariaceae			
<i>Bacopa monnieri</i> (L.) Wettst.	H	July – August	JJ 199290
<i>Limnophila heterophylla</i> (Roxb.) Benth.	H	November – December	JJ 199374
<i>Lindernia antipoda</i> (L.) Alston	H	November – December	JJ 199483
<i>Lindernia ciliata</i> (Colsm.) Pennell	H	November – December	JJ 199378
<i>Lindernia crustacea</i> (L.) F. Muell.	H	November – December	JJ 199484
<i>Sopubia delphinifolia</i> D. Don	H	August – September	JJ 198061
<i>Stemodia viscosa</i> Roxb.	H	November – December	JJ 199373
<i>Striga asiatica</i> (L.) Kuntze	H	August – September	JJ 198006
<i>Striga densiflora</i> (Benth.) Benth	H	August – September	JJ 198004
<i>Striga gesnerioides</i> (Willd.) Vatke	H	August – September	JJ 198069
<i>Verbascum chinense</i> (L.) Santapau	H	July – August	JJ 199230
Solanaceae			
<i>Datura innoxia</i> Mill.	H	September – December	JJ 198278
<i>Datura metel</i> L.	H	September – December	JJ 199481
<i>Datura ferox</i> L.	H	August – September	JJ 199409
<i>Physalis angulata</i> L.	H	July – August	JJ 198182
<i>Solanum erianthum</i> D. Don	S	July – August	JJ 199247
<i>Solanum incanum</i> L.	S	July – September	JJ 199211
<i>Solanum americanum</i> Mill.	S	July – October	JJ 199482
<i>Solanum virginianum</i> L.	S	July – October	JJ 199214
Tiliaceae			
<i>Corchorus fascicularis</i> Lam.	H	September – December	JJ 198065
<i>Corchorus olitorius</i> L.	H	September – December	JJ 198121
<i>Corchorus trilocularis</i> L.	H	September – December	JJ 198243
<i>Grewia tenax</i> (Forssk.) Fiori	S	April – September	*
<i>Grewia villosa</i> Willd.	S	August – December	JJ 199326
<i>Triumfetta malabarica</i> Koen. ex Rottb.	S	September – October	JJ 198155
Typhaceae			
<i>Typha angustifolia</i> L.	H	July – September	JJ 199367
Verbenaceae			
<i>Clerodendrum phlomidis</i> L. f.	S	July – December	JJ 199253
<i>Lantana camara</i> L.	S	Frequently throughout the year	JJ 199485
<i>Phyla nodiflora</i> (L.) Greene	H	July – August	JJ 199219
<i>Vitex negundo</i> L.	S	July – September	JJ 199206
Vitaceae			
<i>Cissus amottiana</i> Shetty & P. Singh	S	Irregularly throughout the year	JJ 198224
<i>Cissus quadrangularis</i> L.	C	Almost throughout the year	JJ 194816
Zygophyllaceae			
<i>Balanites aegyptiaca</i> (L.) Delile	S	July – December	JJ 198266
<i>Tribulus terrestris</i> L.	H	July – December	JJ 198007

coupled with high probability of extinction of bustards in the near future, the Ministry of Environment and Forests (MoEF), Government of India, has included the Great Indian Bustard under the Species recovery component of the Centrally Sponsored Scheme – Integrated Development of Wildlife Habitats (CSS-IDWH). In this programme, a task force is constituted to prepare an action plan to conserve bustards and their habitats. Hence, this documentation study is important in providing the floristic diversity of the bustard habitat, to continue habitat specific conservation measures.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. Paramjit Singh, Director, Botanical Survey of India for encouragement and for providing all the facilities and Dr. D. K. Singh, Additional Director for constant support. Sincere thanks to Shri. M. K. Rao, Chief Conservator of Forests, Pune, forest department officials and staff for granting permission and necessary help during the field tours. Our sincere thanks to Mrs. Anne Dayanandan, for critically reviewing the manuscript for language correction and to Dr. P. Dayanandan (Professor, retired), Madras Christian College for providing valuable suggestions. Thanks are due to anonymous reviewers for their valuable comments.

LITERATURE CITED

- Allaby, M. 2006. Biomes of the earth: grasslands. New York: Chelsea House Publishers. 257 pp.
- Bhagat, R., V.B. Shimpale, G.G. Potdar and R.B. Deshmukh. 2008. Flora of Baramati. Baramati: Rani B. Bhagat, A/P-Hol (8-Phata). 450 pp.
- BHL. [2013]. Biodiversity Heritage Library. Accessed at <http://www.biodiversitylibrary.org>, 25 May 2013.
- BirdLife International. 2011. Threatened birds of Asia. The BirdLife International Red Data Book. Cambridge, UK. 3038 pp.
- Brummitt, R.K. and C.E. Powell. 2004. Authors of plant names. Kew: Royal Botanic Gardens. 740 pp.
- Champion, H.G. and S.K. Seth. 1968. A revised survey of the forest types of India. New Delhi: Manager of Publications. 404 pp.
- Cooke, T. 1901. The flora of the Presidency of Bombay. Vol. 1. London: Tailor and Francis. 645 pp.
- Cooke, T. 1908. The flora of the Presidency of Bombay. Vol. 2. London: Tailor and Francis. 1083 pp.
- Dabodghao, P.M. and K.A. Shankaranarayan. 1973. The grass cover of India. New Delhi: Indian Council of Agricultural Research. 713 pp.
- Das Das, S.K. and N.P. Singh. 2006. Additions to the flora of Ahmednagar district (Maharashtra). Journal of Economic and Taxonomic Botany 30(3): 595–602.
- Das Das, S.K. and N.P. Singh. 2012. Floristic diversity and conservation of Ujani Wetlands (Maharashtra). Dehra Dun: Bishen Singh Mahendra Pal Singh. 302 pp.
- Das Das, S.K. 2012. A contribution to the flora of Solapur District Maharashtra, India. Nelumbo 54: 157–162.
- Dinakaran, J., N. Mehta and N.S.R. Krisnaya. 2011. Soil organic carbon dynamics in two functional types of ground cover (grasses and herbaceous) in the tropics. Current Science 101(6): 776–783.
- Dutta, S., A.R. Rahmani and Y.V. Jhala. 2011. Running out of time? The Great Indian Bustard *Ardeotis nigriceps*—status, viability, and conservation strategies. European Journal of Wildlife Research 57: 615–625. doi: 10.1007/s10344-010-0472-z
- Gaikwad, S.P., R.D. Gore and K.U. Garad. 2012. Additions to the flora of Marathwada region of Maharashtra, India. Journal of Threatened Taxa 4(4): 2515–2523. <http://threatenedtaxa.org/viewPDFFile.asp?fname=0283526iv122515-2523.pdf&typ=jnl&Imonth=4&Iyear=2012>
- GBIF. 2013. Global Biodiversity Information Facility. Accessed at <http://www.gbif.org>, 20 July 2013.
- Government of India. 2006. Report of the Task Force on Grasslands and Deserts. New Delhi: Planning Commission. 32 pp.
- IUCN. 2014. World Commission on Protected Areas – Temperate Grasslands Specialist Group. International Union for the Conservation of Nature. Accessed at http://www.iucn.org/about/work/programmes/gpap_home/gpap_biodiversity/gpap_wcpabiodiv/gpap_grasslands, 30 October 2014.
- Karthikeyan, S., M. Sanjappa and S. Moorthy. 2009. Flowering plants of India: dicotyledons. Volume I. Kolkata: Botanical Survey of India. 365 pp.
- WCSP. 2013. World checklist of selected plant families. Royal Botanic Gardens, Kew. 2013. Accessed at <http://apps.kew.org/wcsp/>, 18 May 2013.
- Lejune, K.D. and T.R. Seastedt. 2001. *Centaurea* species: the forb that won the west. Conservation Biology 15(6): 1568–1574. doi: 10.1046/j.1523-1739.2001.00242.x
- Mooney, H.A. and R.J. Hobbs. 2000. Invasive species in a changing world. Washington, D.C.: Island Press. 457 pp.
- Munjpara, S.B., C.N. Pandey and B. Jethva. 2012. Habitat use by the Great Indian Bustard *Ardeotis nigriceps* (Gruiformes: Otidae) in breeding and non-breeding seasons in Kachchh, Gujarat, India. Journal of Threatened Taxa 5(2): 3654–3660. doi: 10.11609/JoTT.02757.3654-60
- Naik, V.N. 1979. The flora of Osmanabad. Aurangabad: Venus Publishers. 466 pp.
- Nancy, D., K. Kowalkowski and C. Throp (eds.). 2013. Grasslands—habitat survival. London: Capstone Global Library Ltd. 32 pp.
- Pratibha, P. 2005. National parks and sanctuaries in Maharashtra. Volume I. Mumbai: Bombay Natural History Society. 212 pp.
- Pratibha, P. 2005. National parks and sanctuaries in Maharashtra. Volume 2. Mumbai: Bombay Natural History Society. 531 pp.
- Pradhan, S.G. and N.P. Singh. 1999. Flora of Ahmednagar District (Maharashtra). Dehra Dun: Bishen Singh Mahendra Pal Singh. 339 pp.
- Rodgers, W.A. and V.B. Sawarkar. 1988. Vegetation management in wildlife protected areas in India. Aspects of Applied Biology 16: 407–422.
- Rahmani, A.R. 1992. Threatened fauna of Indian Grasslands; pp. 143–151, in: K.P. Singh and J.S. Singh (eds.). Tropical ecosystems: ecology and management. New Delhi: Wiley Eastern Ltd.
- Rahmani, A. R. 2006. Need to start Project Bustards. Mumbai: Bombay Natural History. 20 pp.
- Schlesinger, W.H. 1997. Biogeochemistry: an analysis of global change. San Diego: Academic Press. 588 pp.
- Sharma, B.D., S. Karthikeyan and N.P. Singh (eds.). 1996. Flora of Maharashtra state. Monocotyledones. Calcutta: Botanical Survey of India. 794 pp.
- Shantz, H.L. 1954. The place of grasslands in the Earth's cover of vegetation. Ecology 35(2): 143–145. doi: 10.2307/1931110
- Singh, N.P. and S. Karthikeyan (eds.). 2000. Flora of Maharashtra state—*Dicotyledones*. Volume I. Kolkata: Botanical Survey of India. 898 pp.
- Singh, N.P., P. Lakshminarasimhan, S. Karthikeyan and P.V. Prasanna. 2001. Flora of Maharashtra state—*Dicotyledones*. Volume II. Kolkata: Botanical Survey of India. 1080 pp.
- Suryavanshi, R. and M. Bachulkar. 2011. Arboreal flora of Solapur

Corporation. Journal of Botanical Research 2(1): 8–16.
 IPNI. 2013. The international plant names index. Accessed at <http://www.ipni.org/>, 20 June 2013.
 The Plant List. 2010. Version 1. Accessed at <http://www.theplantlist.org/>, 18 May 2013.
 Tropicos. 2013. Tropicos. Missouri Botanic Garden. Accessed at <http://www.tropicos.org/>, 25 June 2013.
 UNDP. 2012. Fast facts on India's biodiversity, part 2—ecosystems and habitats. United Nations Development Programme. Accessed at <http://www.in.undp.org/>, 6 January 2015.
 Wagner, F.H. 1989. Grazers, past and present; pp. 151–162, in: L.F. Huenneke and H. Mooney (eds.). grassland structure

and function: California annual grassland. Dordrecht, The Netherlands: Kluwer Academic Publishers.
 Whyte, R.O. 1957. The grassland and fodder resources of India. Indian Council of Agricultural Research Sciences Monograph 22: 1–437.

Authors' contribution statement: JJ collected the data and JJ and JSJ wrote the text and made analysis.

Received: December 2013

Accepted: January 2014

Editorial responsibility: Paul A. Egan



Figure 6. View of different habitats in Great Indian Bustard Wildlife sanctuary. **A:** View of core area at Nannaj. **B:** Clumps of grass dominated by *Cybopogon* spp. **C:** Population of *Cyanotis fasciculata* amidst grasses. **D:** Seasonal lake inside the sanctuary showing scrub vegetation. **E:** View of rocky plateau inside the sanctuary. **F:** Herd of Black-buck population during monsoon season.



Figure 7. Different views of the sanctuary during dry season. **A:** View of grassland at Mardi. **B:** View at Karmala. **C:** View at Chapadgoan. **D:** View at Nannaj. **E:** View at Korti. **F:** View at Rehkuri.



Figure 8. Legumes of the sanctuary. **A:** *Crotalaria calycina*. **B:** *C. filipes*. **C:** *C. hebecarpa*. **D:** *C. juncea*. **E:** *C. pallida*. **F:** *Desmodium heterocarpon*. **G:** *D. triflorum*. **H:** *Indigofera coerulea*. **I:** *I. cordifolia*. **J:** *I. linifolia*. **K:** *I. tinctoria*. **L:** *I. trifoliata*.



Figure 9. *Senna* and *Acacia* species found in the sanctuary. **A:** *Senna italica*. **B:** *S. occidentalis*. **C:** *S. sophora*. **D:** *S. uniflora*. **E:** *Acacia campbellii*. **F:** *A. catechu*. **G:** *A. eburnea*. **H:** *A. leucophloea*. **I:** *A. nilotica*. **J:** *A. tomentosa*.



Figure 10. “Morning glories” recorded from the sanctuary. **A:** *Convolvulus arvensis*. **B:** *Evolvulus alsinoides*. **C:** *Ipomoea cairica*. **D:** *I. carnea*. **E:** *I. eriocarpa*. **F:** *I. grandifolia*. **G:** *I. hederifolia*. **H:** *I. nil*. **I:** *I. obscura*. **J:** *I. sindica*-in flower. **K:** *I. sindica* – in fruit. **L:** *I. violacea*.



Figure 11. Sedges of the sanctuary. **A:** *Cyperus compressus*. **B:** *C. difformis*. **C:** *C. digitatus*. **D:** *C. iria*. **E:** *C. nutans* var. *eleusinoides*. **F:** *C. rotundus*. **G:** *Eleocharis geniculata*. **H:** *Fimbristylis ferruginea*. **I:** *Fuirena cuspidata*. **J:** *Kyllinga brevifolia*. **K:** *Lipocarpa squarrosa*. **L:** *Mariscus squarrosus*.



Figure 12. Grasses of the sanctuary. **A:** *Apluda mutica*. **B:** *Hackelochloa granularis*. **C:** *Lophopogon tridentatus*. **D:** *Melanocenchris jacquemontii*. **E:** *Oropetium roxburghianum*. **F:** *Sehima ischaemoides*. **G:** *Themeda laxa*. **H:** *Tragus mongolorum*. **I:** *Pennisetum purpureum*