Phytology

A synoptic account of flora of Jessore Wildlife Sanctuary in Banaskantha district, Gujarat, India

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Abstract

The investigation was carried out in order to explore the existing floristic composition in Jessore Wildlife Sanctuary (JWS) forest area of Banaskantha district, Gujarat. The study has been undertaken to bring out a scientific and comprehensive account of the flora of the forest. The vegetation was arid to semiarid and dry deciduous, thorny scrub type. The present paper deals with 737 wild plant species (including 14 subspecies and 54 varieties) belonging to 424 genera and 113 families of angiosperms plants. Among them, 597 species of Dicotyledons and 140 species of Monocotyledons are encountered. Among 113 families, Papilionaceae, Poaceae, Asteraceae, Acanthaceae and Cyperaceae are the most dominant family.

Keywords: Jessore Wildlife Sanctuary (JWS), Flora, Banaskantha, Gujarat

Introduction

Jessore an historic high hill of the district Banaskantha is an important hill of the Aravalli series situated in the north western part of the district. The Jessore Wildlife Sanctuary derives its name from of this hill and adjoining areas was constituted as a Wildlife Sanctuary in May, 1978 (GHKH-65-78-WLP-2077-62041-P Dt. 6.5.1978) for the purpose of protection, propagation and development of Wildlife and its environment.

Botanically, the area of the sanctuary has not yet been completely explored. Several taxonomists did continue to survey the forest area and many new records for North Gujarat were added at regularly intervals, such as, "Plants of Northern Gujarat" (Sexton & Sedgwick, 1918; Saxton, 1922) [31, 32] and "A contribution to the Flora of North Gujarat" (Yogi, 1970) [37]. Two forest ranges such as Ambaji and Danta of district Banaskantha were explored for floristic study by (Ant, 2001; Patel, 2001; Patel, 2003; Patel, 2003; Dabgar, 2009) [3, 25, 23, 26, 12] respectively. GUIDE (2007) [1] has published a list of plant species recorded in different forest types of North Gujarat Region, Gujarat. Amirgadh range forest of Banaskantha district was explored by (Patel, 2008) [24]. A draft report on Biodiversity study on Jessore Wildlife Sanctuary has been prepared by GEER Foundation, Gandhinagar (2010) [2]. After regularly interval many botanists, researchers, taxonomist and scientists (Meena, 2012; Patel, 2011; Patel, 2012; Patel, 2012) [16, 22, 20, 21] of different colleges, universities and institutes have been worked on flora/floristic diversity of Banaskantha district as well as Jessore Wildlife Sanctuary or its adjoining area. Exhaustive and detailed account on the biological diversity of Gujarat has been published by (Raghavan *et al.*, 1981; Bole & Pathak, 1988; Pilo *et al.*, 1996; Pandey & Singh, 1999, Singh & Parabia, 2003; Meena & Pandey, 2004; Meena, 2012; Patel, 2013) [29, 7, 28, 19, 35, 18, 17, 27]. Therefore, though it is an important document it is not a comprehensive one to be considered as the flora of JWS.

Study area

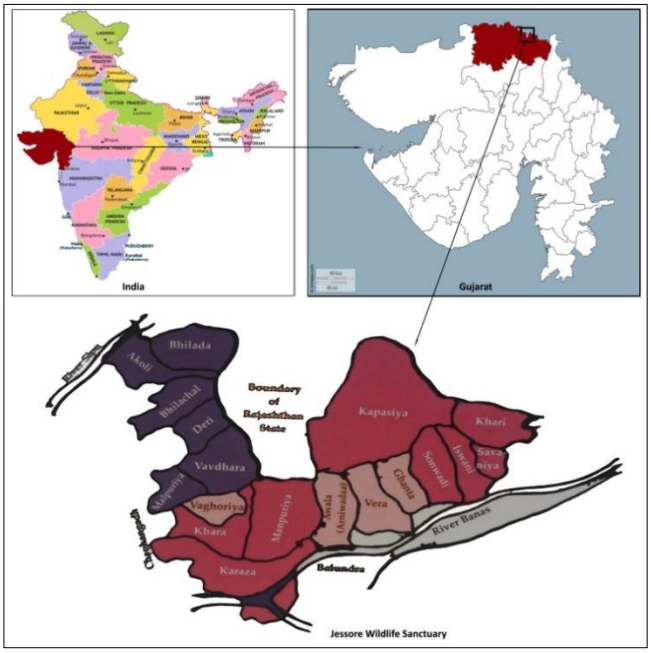

Fig 1: Map showing location of study area

JWS forest area is a part of Amirgadh and Dantivada talukas of Banaskantha district. The total area of the Sanctuary is 180.66 sq km. covering 18 villages of Dantivada and Amirgadh talukas of Banaskantha district and lies between $24^{0}12'$ to $24^{0}31'$ N latitude and $72^{0}18'$ to $73^{0}37'$ E longitude. Jessore, Jairaj, Chotila and Sevania are the major hills of the area. In addition, Karja, Kedarnath, Gadhgajano, Duko, Ishwani, etc. are hill in the study area. The highest peak is the Jessore with a height of around 3350 ft. (1021 m) above mean sea level. Location of the

study area is given in Figure 1. The floral diversity of Jessore Wildlife Sanctuary can be broadly classified as Tropical Deciduous Forests and Tropical Thorn Forests. According to the revised classification of forest types (Champion & Seth, 1966, 2005) [9], the Sanctuary can be classified into Type 5A/C3–Southern Dry Mixed Deciduous Forests of Tropical Dry Deciduous Group and Type 6B/C1–Desert Thorn Forest of the subgroup 6B of Tropical Thorn Forests. JWS forest in Banaskantha district of NGR is one of them, in spite of its flourishing vegetation remain unexplored taxonomically and still needs to explore detailed study of the JWS forest area.

Materials and methods

Botanical collection is the foundation of all the researchers in plant sciences. The entire area was divided in to various routes, tracks. Frequent field trips were conducted in all seasons during 2009-2013 at regular intervals to different areas of the Jessore Wildlife Sanctuary forest area for observation and collection of plant species. Specimens were collected mostly at flowering and fruiting stages and properly processed for herbarium by using the standard herbarium methods recommended by (Santapau, 1955; Jain and Rao, 1977) [30, 15]. After the specimen was pressed, dried and poisoned it was affixed on a mounting sheet. For the purpose of identification, after studying the character of the plant, checked them with the help of available literature (Cooke, 1958; Shah, 1978; Abraham & Vatsala, 1981; Chakravarty, 1982; Singh, 1983; Shetty & Singh, 1987, 1991, 1993; Bhandari, 1995; Cook, 1996; Jagtap & Singh, 1999) [11, 33, 4, 8, 36, 34, 6, 10, 14] and finally confirmed after having carefully compared with earlier identified plants of the species with the help of authentic herbaria. Restricted plant species were located with the help of GPS. The families are arranged according to Bentham and Hooker's classification (1862-83) except in a few cases in which Hutchinson's (1959) concept regarding splitting of the families is followed. All voucher specimens deposited in Hari Aum Foundation, Gandhinagar. Some important plants are featured in photographs (Fig. 2, 3, 4).

Results and discussion

Results of the study are presented under two categories: (i) forest vegetation and (ii) floristic diversity. The forest vegetation cover comprises overall vegetation, forest types, their distribution in the sanctuary and composition of each type with details of vegetation stratification; while the complete angiospermic diversity is presented under the second categories.

(I) Forest vegetation

As per the GEER Foundation draft report on Biodiversity study of JWS, the forest range occupies diverse forest types. The floral diversity can be broadly classified as Group 5- Tropical Dry Deciduous Forests and Group 6- Tropical Thorn Forests of the Champion and Seth's revised classification of the forest types (2005). As per the detailed classification, the area can be classified in the type 5A/C3 i.e., Southern Tropical Dry Deciduous Forests/ Southern Dry Mixed Deciduous Forest of Tropical Dry Deciduous Forest group and Desert Thorn Forest (Type 6B/C1) of the group 6B-Northern Tropical Thorn Forest of Tropical Thorn Forest Group.

Southern dry mixed deciduous forests

The top canopy and under storey are not very well defined in the forests of the region under study. The main species are *Acacia chundra* (Roxb. Ex Rottl.) Willd., *Aegle marmelos* (L.) Corr., *Albizia lebbeck* (L.) Bth., *A. procera* (Roxb.) Bth., *Anogeissus latifolia* (Roxb.) Wall ex Bedd., *A. pendula* Edgew., *Boswellia serrata* Roxb., *Butea monosperma* (Lam.) Taub., *Cassia fistula* L., *Dendrocalamus strictus* Nees, *Derris indica* (Lam.) Bennet, *Diospyros melanoxylon* (Roxb.), *Emblica officinalis* Gaertn., *Erythrina suberosa* Roxb., *Ficua benghalensis* L., *F. racemose* L., *Holoptelea integrifolia* (Roxb.) Planch., *Lannea coromandelica* (Houtt.) Merrill, *Miliusa tomentosa* (Roxb.) Sinclair, *Mitragyna parvifolia* (Roxb.) Korth., *Phoenix sylvestris* (L.) Roxb., *Sterculia urens* Roxb., *Syzygium cumini* (L.) Skeels, *Tamarindus indica* L., *Tectona grandis* L. f., *Terminalia arjuna* (Roxb.) W. & A., *T. bellirica* (Gaertn.) Roxb., *T. crenulata* Roth., *Wrightia tinctoria* R. Br., *W. tomentosa* R. & S., *Zizyphus mauritiana* Lam. and *Z. xylopyra* (Retz.) Willd. The major species of the lower canopy are *Adhatoda vasica* (L.) Nees, *Alangium salvifolium* (L.f.) Wang., *Balanites aegyptiaca* (L.) Del., *Capparis sepiaria* L., *Carissa congesta* Wt., *Dichrostachys cinerea* (L.) W. & A., *Flacourtia indica* (Burm f.) Merr., *Helecteres isora* L., *Holarrhena antidysenterica* (L.) Wall, *Vitex negundo* L. and Zizyphus nummularia (Burm f.) W. & A. The grasses include *Aristida funiculate* Trin & Rupr., *Cenchrus biflorus* Roxb., *C. ciliaris* L. Mant., *Cynodon dactylon* (L.) Pers., *Dicanthium annulatum* (Forsk.) Stapf and *Heteropogon controtus* (L.) P. Beauv etc. Within this subgroup, following major forests pockets are found in the region under study.

(a) Boswellia serrata forests

It is most common in middle reaches of the hills particularly in Khata Amba, Kedarnath, Ghata, Awala, Chauhangadh, Umbaripani, Khara, and Manpuriya areas. Its main associates are *Boswellia serrata* Roxb., *Anogeissus pendula* Edgew., *Butea monosperma* (Lam.) Taub., *Diospyros melanoxylon* Roxb., *Wrightia tinctoria* R. Br., etc.

(b) *Anogeissus pendula* forests

The lower reaches of some hills particularly the southern and western slopes especially Vera, Ghata, Chauhangadh, Gadhgajano, and Awala areas consist of this type of forest with associates like *Butea monosperma* (Lam.) Taub., *Dichrostachys cinerea* (L.) W. & A., *Diospyros melanoxylon* Roxb., *Wrightia tinctoria* R. Br., *Zizyphus nummularia* (Burm f.) W & A., etc.

(c) *Butea* forests

In some foothill and moister climates, the *Butea* forest is observed. Particularly in Taleti, Ghanta, Khata Amba, Ishwani (awala), Manpuriya and Vera areas of the region under study. *Butea monosperma* (Lam.) Taub. Is commonly with *Boswellia*

serrata Roxb., *Diospyros melanoxylon* Roxb., *Anogeissus pendula* Edgew., etc.

(d) *Lannea* forests

In the middle to higher reaches of hills particularly between Taleti and Kedarnath, Thorpani, Khata Amba, Umaripani and Doshi Dungar areas of the region under study, *Lannea* is commonly found with *Aegle marmelos* (L.) Corr., *Anogeissus latifolia* (Roxb.) Wall ex. Bedd., *Butea monosperma* (Lam.) Taub., *Boswellia serrata* Roxb., *Diospyros melanoxylon* Roxb., etc.

(e) Mixed forests

There are some good dense forests areas representative of the past habitat condition found particularly in Ghata, Khalu, some part behind Kedarnath, Khisiyo, Munijini Kutiya and Doshi Dungar.

(f) *Bamboo* forests

Bamboo is observed in the Jessore Lake, Khalu and Kedarnath and Manpuriya of the Sanctuary area.

(g) *Prosopis* forests

A considerable part of mixed forest of *Butea monosperma* (Lam.) Taub., *Acacia chundra* (Roxb. Ex Rottl.) Willd., *Anogeissus* sps. has been invaded with the *Prosopis chilensis* (Molina) Stuntze growth in patches. The hills in Khara (Lukho dungar) and Manpuriya area are totally invaded by the *Prosopis* sps. in addition, the lands of Kapasiya, Sonwadi, Dabhela, Taleti and Waghodiya area are occupied by the *Prosopis* sps.

Desert thorn forest

This type of vegetation merges imperceptibly with the Southern Dry Mix Deciduous Forest. Due to heavy biotic pressure on the plains, the floral diversity in the flat lands and the foothills has suffered the most and the biotic interventions with afforestation and invansion of thorny species has converted the plain land into thorn forest. In such areas, the canopy differentiation is quite difficult. The main tree species of this type are:

Acacia chundra (Roxb. Ex Rottl.) Willd., *A. leucophloea* (Roxb.) Willd., *A. Senegal* (L.) Willd., *Anogeissus pendula* Edgew., *Butea monosperma* (Lam.) Taub., *Prosopis chilensis* (Molina) Stuntze, *Zizyphus mauritiana* Lam. and *Zizyphus nummularia* (Burm f.) W. & A. The undergrowth is represented by *Balanites aegyptiaca* (L.) Del., *Capparis decidua* (Forsk.) Edgew., *C. sepiaria* L., *Cassia auriculata* L., *Dichrostachys cinerea* (L.) W. & A. along with grasses like *Cenchrus*, *Heteropogon*, *Dicanthium* etc.

***Acacia Senegal* (L.) willd forest**

The predominant parts are Arniwada, Awala, Chauhangadh, Khara and Manpuriya area with interspersed small patches in Deri and Bhilda. The associates are *Anogeissus pendula* Edgew., and *Zizyphus nummularia* (burm f.) W. & A. the group of forests is prevalent mostly in south western parts of the region under study.

(II) Floristic diversity

The investigation was carried out in order to explore the existing floristic composition in JWS forest area of Banaskantha district. The vegetation was arid to semiarid and dry deciduous, thorny scrub type. The Study revealed that the presence of 737 wild plant species (including 14 subspecies and 54 varieties) belonging to 424 genera and 113 families of angiosperms were studied. Saxton & Sedgwick (1918) [31], Yogi, D.V. (1970) [37], Shah, G.L. (1978) [33], Patel, K.C. (2003) [23], Patel, R.S. (2003) [26], North Gujarat Region (NGR) Report (2007) and Patel, K.M. (2008) [24], have listed most abundant families available in their areas. A similar list of dominant families for comparative study for the present area is given in Table-1.

Table 1: Dominant families for comparative study for the JWS Forest area

Sr. No.	Family	1	2	3	4	5	6	7	8
1	Papilionaceae	55	77	194	36	43	70	56	75
2	Poaceae	257	132	241	22	34	88	43	65
3	Asteraceae	197	42	89	22	25	40	36	46
4	Acanthaceae	108	27	69	17	20	22	24	32
5	Cyperaceae	86	50	108	6	17	22	27	31
6	Euphorbiaceae	91	35	63	14	20	33	26	30
7	Convolvulaceae	24	31	52	14	14	29	22	29
8	Cucurbitaceae	27	23	33	8	15	22	15	21
9	Amaranthaceae	23	17	26	12	10		17	20

1) Saxton & Sedgwick (1918) [31], 2) Yogi, D.V. (1970) [37], 3) Shah, G.L. (1978) [33], 4) Patel, K.C. (2003) [23], 5) Patel, R.S. (2003) [26], 6) North Gujarat Region (NGR) Report (2007), 7) Patel, K.M. (2008) [24], 8) Present Study (2013)

Fig 2: a. *Antirrhinum orontium* L; **b.** *Argemone ochroleuca* Sweet; **c.** *Cardamine trichocarpa* Hochst ex Rich; **d.** *Ceropegia bulbosa* Roxb.; **e.** *Cleome monophylla* L.; **f.** *Corallocarpus conocarpus* (Dalz. & Gibs) Cl.; **g.** *Gnaphalium luteo-album* L.; **h.** *Habenaria furcifera* Lindl; **i.** *Indigofera glandulosa* Roxb. ex Willd.

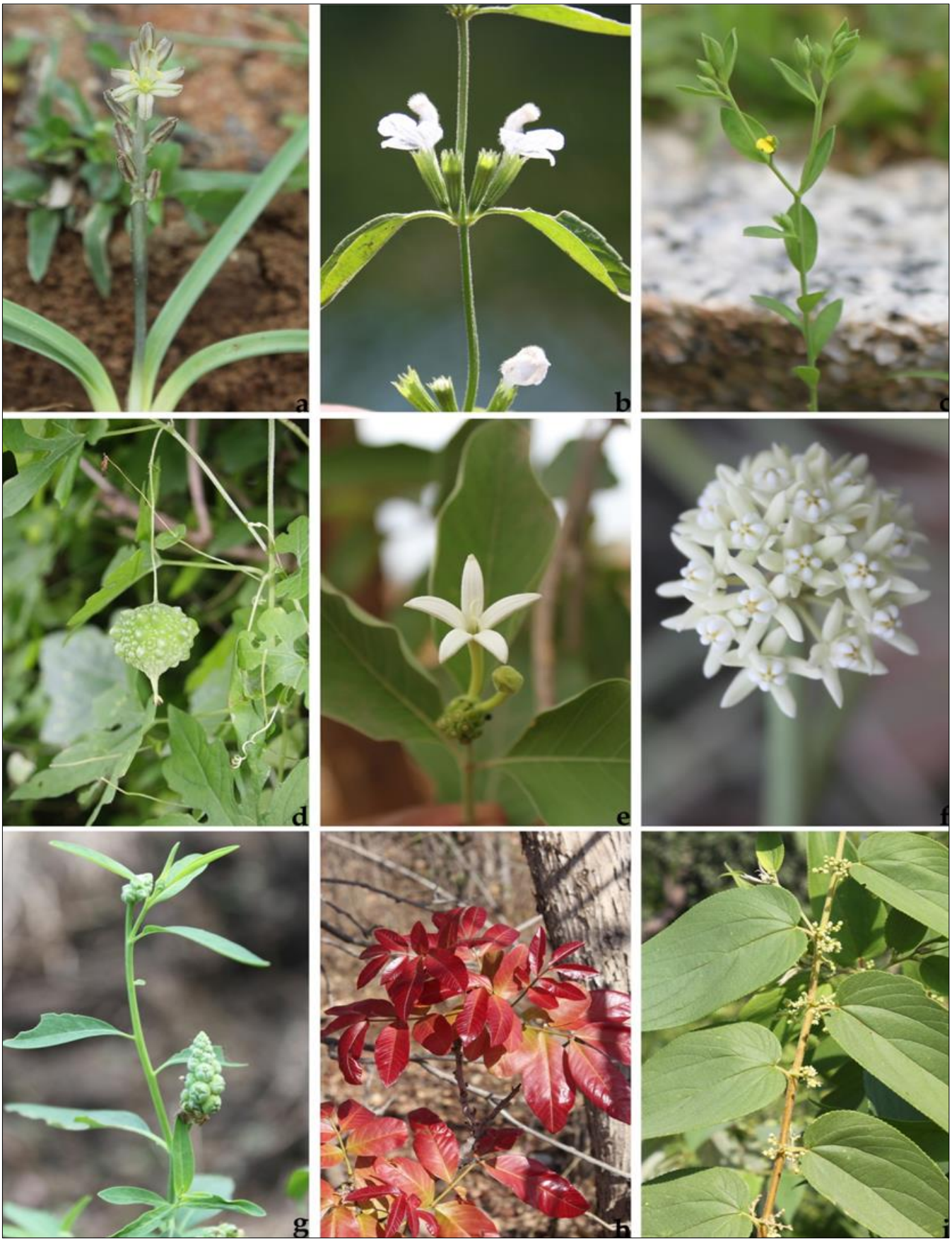

Fig 3: a. *Iphigenia indica* (L.) A. Gray; **b.** *Leucus biflora* R. Br.; **c.** *Linum mysurense* Heyne ex Benth.; **d.** *Momordica charantia* L. var. muricata; **e.** *Morinda tomentosa* Heyne ex Roth; **f.** *Sarcostemma acidum* (Roxb.) Voigt; **g.** *Sphenoclea zeylanica* Gaertn. Oken.; **h.** *Schleichera oleosa* (Loin.); **i.** *Trema orientalis* (L.) Bl.

Fig 4: a. *Ctenolepis cerasiformis* (Stocks.) Hk.f.; **b.** *Dalechampia scandens* L. var. *cordofana* (Hochst. ex A.Rich.) Muell.-Arg.; **c.** *Girardinia zeylanica* Decne.; **d.** *Gloriosa superba* L.; **e.** *Lepidagathis cuspidata* Nees.; **f.** *Stylosanthes mucronata* Willd. **g.** *Striga gesneroides* (Willd.) Vatke; **h.** *Vernonia anthelmintica* (L.) Willd.; **i.** *Vigna vexillata* (L.) A. Rich.

The Synoptic view of number of families, genera, species, sub-species and varieties are enumerated in the percentage is given in Table-2.

Table 2: Synoptic view of number of families, genera, species, sub-species and varieties

Class	Sub class	Series	Families	Genera	Species	Sub species	Var.
Dicotyledonae	Polypetalae	Thalamiflorae	19	49	87	0	2
		Disciflorae	17	30	38	0	1
		Calyciflorae	15	72	158	8	23
		Total	51	151	283	0	26
	Gamopetalae	Inferae	3	44	60	1	1
		Superae	4	6	7	0	1
		Bicarpellatae	24	98	170	1	6
		Total	31	148	237	2	8
	Monochlamydae		10	37	77	0	7
	Total		92	336	597	10	41
	%age		81	79	81	71	76
Monocotyledonae			21	88	140	4	13
	%age		19	21	19	29	24
Grand Total			113	424	737	14	54

Table 3: Dominant genera

Genera	Species
Cyperus	18
Ipomoea	16
Indigofera	11
Cassia	10
Euphorbia	9
Ficus	9
Acacia	8
Heliotropium	7
Sida	7
Tephrosia	7

Among 113 families, Papilionaceae is the dominant and leading family, species wise (more than 25) followed by Poaceae, Asteraceae, Acanthaceae, Cyperaceae, Euphorbiaceae and Convolvulaceae (Figure.-5). Out of 424 genera the dominant genera with their number of species (more than 25) are given in Table.-3. The ratio of species belonging to Monocotyledones to Dicotyledones is 1:4.26, of genera 1:3.82 and family 1:4.38. Herbs are dominated followed by trees, grasses & sedges, climbers & twiners, shrubs & under shrubs, parasites & semi-parasites, epiphyte and insectivorous (Figure.-6). The abundance of wild plants was classified in following 5 arbitrary classes on the basis of their visual occurrence (presence) in the no. of tracks out of the surveyed 11 tracks. The criteria for classification are based upon visual occurrence of the species in the no. of tracks are given in Table-4. Out of recorded total 737 wild plant species maximum 44% are found as common, whereas minimum 3% as very common. However, occasional and rare species each found 15% whereas 23% plant species are as not common. The visual occurrence of wild plant species of area is given in Figure-5.

Table 4: Showing classification of abundance of wild plants

Class	Criteria number of tracks in which the plant species recorded/observed	No. of recorded wild plant species
Very common	> 9 tracks	21
Common	8-9 tracks	322
Not common	6-7 tracks	169
Occassional	3-5 tracks	112
Rare	< 3 tracks	113
Total		737

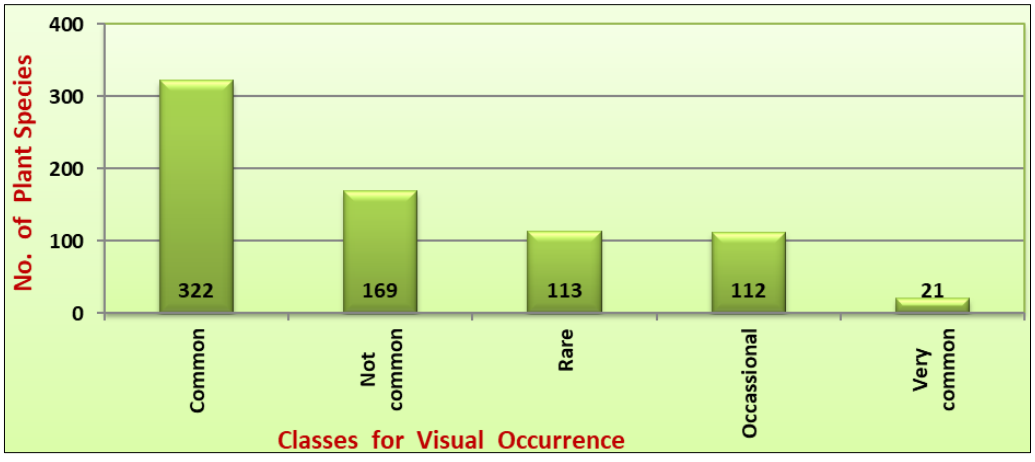

Fig 5: Visual occurrence of plant species

There are 17 plant species are reported / listed during present study, but these species are not reported / listed in the Flora of Gujarat State (Table-5).

Table 5: Plant species are not listed/reported in Gujarat State flora

Scientific Name	Family
Acacia nilotica (L.) Del. subsp. *astringens*	Mimosaceae
Acacia tortalis (Forssk.) Hayne	Mimosaceae
Albizia lebbeck (L.) Bth. var. *rostrata*	Mimosaceae
Anogeissus sericea Brandis var. *nummularia*	Combretaceae
Antirrhinum orontium L.	Scrophulariaceae
Argemone ochroleuca Sweet	Papaveraceae
Butea monosperma var. *lutea* (Witt.) Maheshwari.	Papilionaceae
Ceropegia bulbosa Roxb. var. *lushii* (Grah.) Hook. f.	Asclepiadaceae
Cucumis sativus L. var *sativus*	Cucurbitaceae
Eulophia herbacea Lindl.	Orchidaceae
Gnaphalium luteo-album L. subsp. *affine*	Asteraceae
Momordica charantia L. var. *muricata*	Cucurbitaceae
Schoenoplectus lacustris (L.) Palla,	Cyperaceae
Striga gesneroides (Willd.) Vatke var. *minor* Santapau	Scrophulariaceae
Stylosanthes mucronata Willd.	Papilionaceae
Teramnus labialis (L.f.) Spreng. var. *mollis*	Papilionaceae
Wrightia dolichocarpa Bahadur et Bennet	Apocynaceae

Butea monosperma var. *lutea* (Witt.) Maheshwari and *Commiphora wightii* (Arn.) Bhandari are Threatened plant species in Gujarat IUCN Red Data Book, 2000.

Fig 6: *Butea monosperma* var. *lutea* (Witt.) Maheshwari and *Commiphora wightii* (Arn.) Bhandari

The 26 tree species recorded from the JWS forest area are also given as regionally threatened (as mentioned in Gujarat State Biodiversity Conservation Strategy and Action Plan, Published by Forest Dept., Gujarat State. October-2005) are given in Table-6.

Table 6: Regionally threatened plant species

Name of species	Family
Acacia nilotica (L.) Del. subsp. *indica* (Bth.) Brenan	Mimosaceae
Anogeissus sericea Brandis var. *sericea*	Combretaceae
Casearia elliptica Willd.	Flacourtiaceae
Cassine glauca (Rottb.) O.Ktze	Ehretiaceae
Dalbergia lanceolaria L.	Papilionaceae
Dalbergia latifolia Roxb.	Papilionaceae
Dalbergia volubilis Roxb.	Papilionaceae
Ehretia laevis Roxb.	Ehretiaceae
Eriolaena stocksii Hk. f &Th.	Sterculiaceae

Ficus arnottiana Miq.	Moraceae
Firmiana colorata (Roxb.) R.Br.	Moraceae
Hymenodictyon excelsum (Roxb.) Wall.	Rubiaceae
Kydia calycina Roxb.	Malvaceae
Limonia acidissima L.	Rutaceae
Manilkara hexandra (Roxb.) Dub.	Sapotaceae
Moringa concanensis Nimmo	Moringaceae
Ougeinia oojeinensis (Roxb.) Hochreut.	Bignoniaceae
Pterocarpus marsupium Roxb. var. *acuminatus* Prain	Papilionaceae
Schleichera oleosa (Lour.) Oken.	Sapindaceae
Schrebera swietenioides Roxb.	Oleaceae
Sterculia urens Roxb.	Sterculiaceae
Stereospermum suaveolens (Roxb.) DC.	Bignoniaceae
Streblus asper Lour.	Moraceae
Syzygium heyneanum Wall. ex W. & A.	Myrtaceae
Tecomella undulata (Sm.) Seem.	Bignoniaceae
Zizyphus glabrata Heyne ex Roth	Rhamnaceae

The 8 plant species like *Ammania desertorum* Blatt. & Hallb., *Anogeissus sericea* Brandis var. *nummularia*, *Blumea bovei* (DC.) Vatke, *Citrullus colocynthis* (L.) Schrad, *Commiphora wightii* (Arn.) Bhandari, *Corallocarpus conocarpus* (Dalz. & Gibbs) CB Clarke, *Gloriosa superba* L. and *Heliotropium rariflorum* Stocks which have been recorded as "Rare and Endangered Plants and Animals of Gujarat" published by Gujarat Ecological Commission (2003) are also recorded during the present study in JWS forest area. The checklist of plant species reported from JWS Forest area with Scientific name, Family and Habit are given in Table- 7.

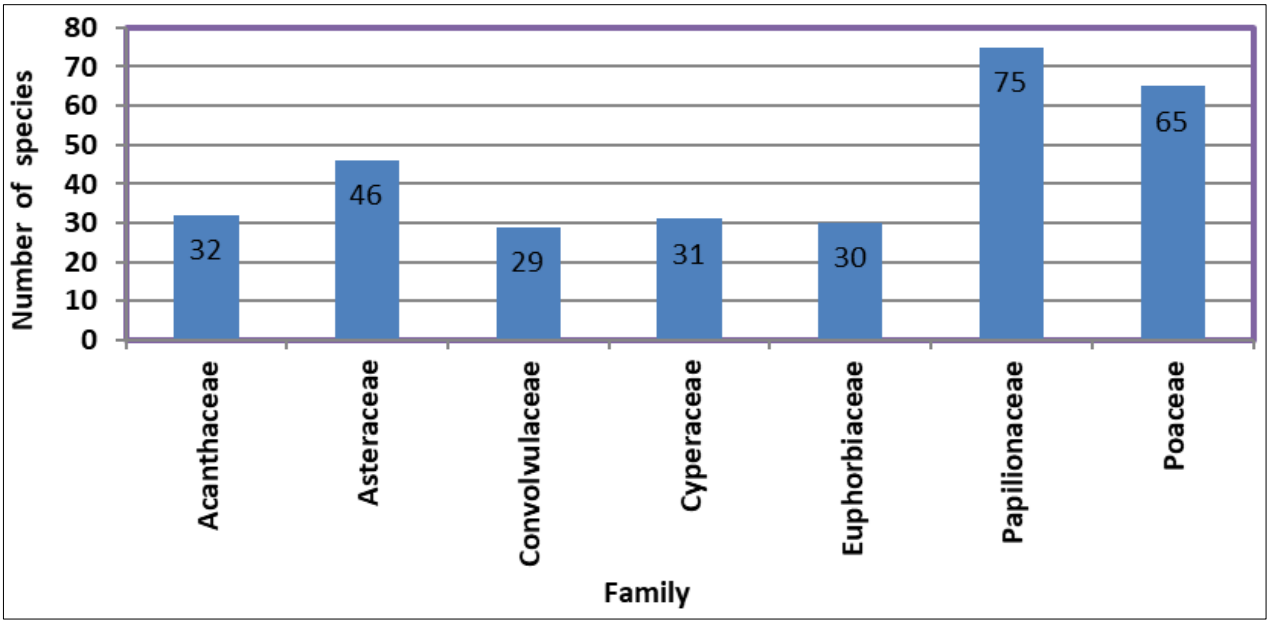

Fig 5: Dominant families with their number of species

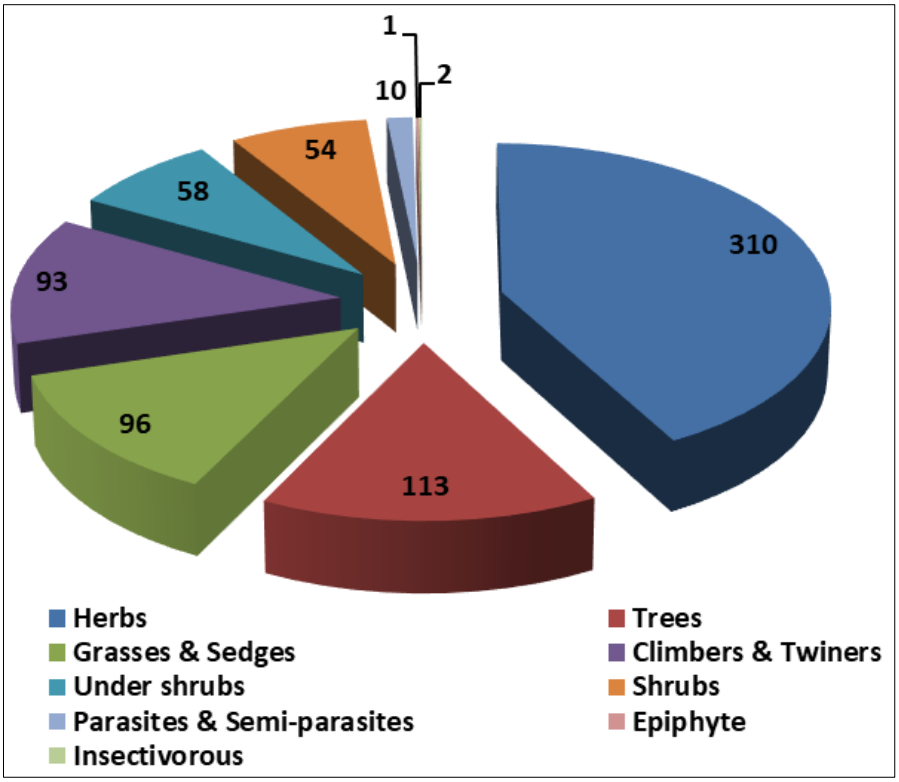

Fig 6: Distribution of species according to life-forms

Conclusion

During present investigation we observed that the Floristic vegetation is very much affected by local activities and their natural regeneration prevented due to heavy cuttings, grazing, anthropological pressure, exotic weeds, tourism activities and severe drought are the main factors for the loss of Phyto diversity of the Sanctuary. Jessore Wildlife Sanctuary is a paradise for medicinal plants wealth. Ecosystem complexity of the Sanctuary is being changed now a days because of human interference. The influence of industrialization, over population, loss of potential habitat, climatic changes etc., have altered the vegetation pattern of the area. This has definitely affected flora adversely. There is urgent need to aware the peoples about the plant biodiversity and its important in their daily routine life. We do not know the effects of the new introductions over native vegetation yet. The data presented in this work are original and first hand. It is hoped that it will contribute in preparation of flora. Consequently, Sanctuary is facing a lot of threat, particularly the rare and threatened plant species. So, there is an urgent need of conservation to preserve such types of hotspot of the States for protect and conserve this species for the future generation.

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