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Additions to angiosperm diversity in Bhadrak region of Odisha, India

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ABSTRACT

This paper deals with the list of flowering plants from the Bhadrak district, Odisha, India. A total of 141 taxa (81 native species and 60 exotic species) have been recorded comprising 81 herbs, 22 climbers, 21 trees, and 17 shrubs that are distributed in 115 genera, represented in 48 families, three major clades, and 23 orders as per the APG IV classification. Lamids account for about 33.3% of the taxa. The family Fabaceae is the most species-diverse (14 species), followed by Convolvulaceae (10 species), Acanthaceae (9 species) and Poaceae (7 species). Of the total 141 plant species, most are economically useful as medicinal plants, and others are valuable as edible fruits, ornamentals, and fodders. It is believed that this inventory of angiosperm plant resources of the district provides a comprehensive and updated checklist of the floristic diversity of the Bhadrak district, Odisha.

Figures : 06 References : 42 Table : 01
KEY WORDS : Agricultural rituals, Horistic diversity, Life form composition, Medicinal plants

Introduction

The state of Odisha (81º 43' and 87 º 29' east longitudes and 17º 49' and 22 º 34' north latitude), India, consisting of 30 districts and geographically situated at the head of the Bay of Bengal, has a coastal stretch of around 482 km.It extends over an area of 155,707 sq. km accounting for about 4.87% of the total area of the country.Based on physico-geographical characteristics, the state has been divided into 5 major regions *i.e.*,the coastal plain in the east, the middle mountainous and highlands region, the central plateaus, the western rolling uplands and the major flood plains. The varying climatic condition provides suitable habitats for supporting rich flora and fauna in the region[32].Furthermore, the Eastern Ghat range of hills runs through the heart of Odisha *i.e.,* it starts from north of Similipal and runs through Malkangiri crossing 17 districts of the state harbouring primarily moist deciduous vegetation[7].The state encounters a hot and humid climate round the year with short winters.

As far as the floristic study of the state of Odisha is concerned, it is in scattered form. The reports are available[12,14,15,27,39]. *The Flora of Orissa* work that dealt with 2727 plant species included 2576 species of angiosperms belonging to 159 families.[41] Recently some publications were made on floristic inventory and conservation aspects.[2,3,4,17,18,24,27,28,36,39] A project was initiated to record the occurrence of species to supplement the angiosperm flora of Bhadrak district, Odisha, India.

Materials and Methods

Study site

Bhadrak district (20° 43¢-21° 13¢N and 86° 6¢-87° E) is located in northeast Odisha. It spreads over 2505 km^2 with 1.507 million inhabitants (2011 Census). Rice (*Oryza sativa*) is the major cereal crop cultivated by most of the people of the district. The district is located in the deltaic region close to the Bay of Bengal. Obviously, it has all the features of a coastal climate, *i.e.,* saline weather, the influence of coastal wind,thunder storms

TABLE-1 : List of angiosperm taxa recorded from Bhadrak district, arranged according to the Angiosperm Phylogeny Group Classification IV

Major Clade/ Order	Family / Species	Common Name	Habit	Nativity	Uses
COMMELINIDS					
Arecales	Arecaceae				
	Carpentaria acuminata		Tree	Australia	Ornamental
	Caryota urens		Tree	Native	Ornamental
	Dypsis lutescens		Tree	Mada-gascar	Ornamental
	Licuala grandis		Tree	West America	Ornamental
	Rhapis excelsa		Shrub	China	Ornamental
	Roystonea regia		Tree	Mexico	Ornamental
Commelinales	Commelinaceae				
	Commelina diffusa		Herb	Native	Medicinal
	Cyanotis axillaris		Herb	Native	Medicinal
	Murdannia nudiflora	Kanduli	Herb	Native	Medicinal
	Murdannia spirata		Herb	Native	Fodder
	Murdannia vaginata		Herb	Native	Fodder
Poales	Poaceae				
	Brachiaria mutica	Nardul	Herb	Native	Fodder
	Eragrostis cillianesis		Herb	Native	Fodder
	Eriocaulon cinereum		Herb	Native	Fodder

	Eriochloa procera		Herb	Native	Fodder
	Hymenachne amplexicaulis		Herb	Argentina	Fodder
	Myriostachya wightiana		Herb	Native	Fodder
	Saccharum munja	Anukha	Herb	Native	Ritual
	Xyridaceae				
	Xyris indica		Herb	Native	Medicinal
	Cyperaceae				
	Cyperus corymbosus	Mutha	Herb	Native	Not Known
	Cyperus distans		Herb	Native	Not Known
	Cyperus iria	Swanti	Herb	Tropical America	Not known
Zingiberales	Heliconiaceae				
	Heliconia psittacorum		Herb	South America	Ornamental
	Marantaceae				
	Calathea virginalis		Herb	Tropical America	Ornamental
	Strelitziaceae				
	Ravenala madagascariensis		Tree	Mada-gascar	Ornamental
MONOCOTS					
Alismatales	Araceae				
	Aglaonema commutatum		Herb	Philippines	Ornamental
	Dieffenbachia seguine		Herb	Tropical America	Ornamental
	Epipremnum aureum		Climber	France	Ornamental

	Syngonium podophyllum		Herb	Tropical America	Ornamental
Asparagales	**Amaryillidaceae**				
	Crinum viviparum	Kondai	Herb	Native	Medicinal
	Crinum latifolium	Kuloi basa	Herb	Native	Medicinal
	Zephyranthes carinata		Herb	Mexico	Medicinal
	Asparagaceae				
	Chlorophytum capense		Herb	South Africa	Medicinal
SUPERSROSIDS					
ROSIDS					
Vitales	Vitaceae				
	Cayratia pedata	Pitapotala	Climber	Native	Medicinal
	Cayratia trifolia	Amla lata	Climber	Native	Medicinal
ROSIDS I (FABIDS)					
Fabales	**Fabaceae**				
	Adenanthera pavonina	Manda kaincha	Tree	Native	Medicinal
	Alysicarpus vaginalis		Herb	Native	Fodder
	Canavalia gladiata	Maharada	Climber	Native	Medicinal
	Crotalaria pallida	Junjunka	Herb	Tropical America	Medicinal
	Crotalaria quinquefolia		Herb	Tropical America	Medicinal
	Crotalaria verrucosa		Herb	Tropical America	Medicinal
	Desmodium gangeticum	Soloporni	Herb	Native	Medicinal

	Indigofera astragalina		Herb	Tropical America	Medicinal
	Indigofera linnaei	Lathai	Herb	South America	Medicinal
	Indigofera linifolia	Torki	Herb	South America	Medicinal
	Mucuna monosperma	Baidonka	Climber	Native	Medicinal
	Parkinsonia aculeata		Tree	Tropical America	Medicinal
	Vigna pilosa	Jhikrai	Herb	Native	Medicinal
	Uraria picta	Ishwarjata	Herb	Native	Medicinal
	Polygalaceae				
	Polygala arvensis	Gaighura	Herb	Native	Medicinal
Rosales	Moraceae				
	Ficus benjamina	Pokaha	Tree	Native	Medicinal
	Ficus racemosa	Adambaru	Tree	Native	Ritual/ Medicinal
Cucurbitales	Cucurbitaceae				
	Cucumis melo	Banakakudi	Climber	Native	Edible
	Luffa cylindrica	Pitataradi	Climber	Native	Medicinal
	Mukia maderaspatana	Pahari kakharu	Climber	Native	Medicinal
Malpighiales	Euphorbiaceae				
	Chrozophora rottleri		Herb	Tropical Africa	Medicinal
	Codiaeum variegatum		Shrub	Indonesia	Ornamental
	Drypetes roxburghii	Poichandia	Tree	Native	Medicinal
	Euphorbia milii		Herb	Mada-gascar	Ornamental

	Euphorbia prostrata		Herb	South America	Medicinal
	Micrococca mercurialis		Herb	Native	Medicinal
	Suregada multiflora		Tree	Native	Medicinal
	Clusiaceae				
	Garcinia xanthochymus	Tamala	Tree	Native	Edible
	Passifloraceae				
	Turnera ulmifolia		Herb	Tropical America	Medicinal
	Phyllanthaceae				
	Phyllanthus acidus	Narkoli	Tree	Native	Edible
	Phyllanthus virgatus	Bhuin aonla	Herb	Native	Medicinal
	Sauropus bacciformis	Bila nadia	Herb	Native	Edible
ROSIDS II (MALVIDS)					
Myrtales	Combretaceae				
	Combretum indicum	Madhumalati	Climber	Native	Medicinal
	Lythraceae				
	Ammannia baccifera	Ramdauni	Herb	Native	Medicinal
	Ammannia multiflora		Herb	Native	Fodder
	Melastomataceae				
	Melastoma malabathricum	Korali	Shrub	Native	Medicinal
	Myrtaceae				
	Melaleuca citrina	Buttlebrush	Tree	Australia	Medicinal
Malvales	Malvaceae				

	Hibiscus cannabinus	Kanuriya	Shrub	Native	Ornamental
	Hibiscus schizopetalus	Kata mandar	Shrub	Tropical Africa	Ornamental
	Thespesia lampas	Bankapsi	Tree	Native	Medicinal
	Pterospermum acerifolium	Muchukund	Tree	Native	Medicinal
	Urena lobata	Mota bhindi	Shrub	Tropical America	Medicinal
Brassicales	Salvadoraceae				
	Azima tetracantha		Shrub	Native	Medicinal
Sapindales	Meliaceae				
	Melia azedarach	Mahalimba	Tree	Native	Medicinal
SUPERASTERIDS					
Caryophyllales	Petiveriaceae				
	Rivina humilis		Climber	South America	Edible
	Polygonaceae				
	Polygonum hydropiper		Herb	Native	Medicinal
	Amaranthaceae				
	Alternanthera paronychioides		Herb	Tropical America	Fodder
	Alternanthera philoxeroides	Ghoda madaranga	Herb	Tropical America	Fodder
	Amaranthus tricolor	Neutia	Herb	Native	Edible
	Celosia argentea	Manjur chulia	Herb	Tropical Africa	Medicinal/ Ornamental
	Pupalia lappacea	Kuya-duya	Herb	Native	Medicinal

	Portulacaceae				
	Portulaca grandiflora	Tablegolap	Herb	Argentina	Medicinal/ Ornamental
	Portulaca pilosa		Herb	South America	Medicinal
ASTERIDS					
Ericales	Balsaminaceae				
	Impatiens balsamina	Haragoura	Herb	Tropical America	Medicinal
ASTERIDS I (COMPANULIDS)					
Asterales	Asteraceae				
	Calyptocarpus vialis		Herb	South America	Medicinal
	Sphaeranthus indicus	Bhuinkadamba	Herb	Native	Medicinal
	Sphagneticola trilobata	Bhimraj	Herb	Mexico	Medicinal
Apiales	Apiaceae				
	Foeniculum vulgare	Panmahuri	Herb	Mediter-ranean	Medicinal
	Hydrocotyle sibthorpioides		Herb	Native	Medicinal
ASTERIDS II (LAMIDS)					
Solanales	Convolvulaceae				
	Argyreia cymosa		Climber	Native	Medicinal
	Ipomoea hederifolia	Panikoda	Climber	Tropical America	Medicinal
	Ipomoea indica		Climber	Native	Medicinal
	Ipomoea obscura		Climber	Tropical Africa	Medicinal

	Ipomoea nil	Khami khondo	Climber	North America	Medicinal
	Ipomoea pes-caprae	Kansari nata	Climber	Native	Medicinal
	Ipomoea quamoclit		Climber	Tropical America	Medicinal
	Merremia hederacea		Climber	Native	Medicinal
	Merremia tridentata		Climber	Native	Medicinal
	Hewittia malabarica		Climber	Native	Medicinal
	Hydroleaceae				
	Hydrolea zeylanica	Languliya	Herb	Native	Medicinal
	Solanaceae				
	Nicotiana plumbaginifolia	Hemraj	Herb	Tropical America	Medicinal
	Physalis minima	Tipai	Herb	Tropical America	Medicinal
	Solanum torvum	Kathkoli	Shrub	West Indies	Medicinal
	Sphenocleaceae				
	Sphenoclea zeylanica	Panimaricha	Herb	Native	Medicinal
Lamiales	Acanthaceae				
	Hemigraphis hirta		Herb	Native	Medicinal
	Hygrophila difformis		Herb	Native	Fodder
	Justicia gendarussa	Kalabasanga	Herb	Native	Medicinal
	J. procumbens		Herb	Native	
	Lepidagathis incurva		Herb	Native	Medicinal
	Peristrophe bicalyculata		Herb	Tropical America	Medicinal

	Ruellia tuberosa		Herb	Tropical America	Medicinal
	Thunbergia erecta		Shrub	Tropical Africa	Medicinal
	Rungia pectinata		Herb	Native	Medicinal
	Lamiaceae				
	Anisomeles indica		Herb	Native	Medicinal
	Basilicum polystachyon		Herb	Native	Medicinal
	Clerodendrum thomsoniae		Shrub	Tropical Africa	Ornamental
	Hyptis suaveolens	Ganga tulasi	Herb	Tropical America	Medicinal
	Ocimum americanum	Kapur kanti	Herb	Tropical America	Medicinal
	Lentibulariaceae				
	Utricularia stellaris		Herb	Native	Medicinal
	Scrophulariaceae				
	Lindernia antipoda		Herb	Native	Fodder
	Plantaginaceae				
	Limnophila indica		Herb	Native	Medicinal
	Bignoniaceae				
	Pyrostegia venusta		Climber	Brazil	Medicinal
	Tecoma stans		Tree	Tropical America	Medicinal/ Ornamental
	Verbenaceae				
	Gmelina philippensis		Shrub	Native	Medicinal
	Phyla nodiflora	Gosing	Herb	South America	Medicinal

	Stachytarpheta jamaicensis	Jatia	Herb	Tropical America	Medicinal
Gentianales	Apocyanaceae				
	Allamanda blanchetii		Shrub	Tropical America	Ornamental
	Allamanda cathartica		Shrub	Tropical America	Ornamental
	Carissa carandas	Kerenda koli	Shrub	Native	Edible/ Medicinal
	Carissa spinarum	Anku koli	Shrub	Native	Edible/ Medicinal
	Ichnocarpus frutescens	Madhobi	Shrub	Native	Medicinal
	Telosma pallida	Tokeikundhei	Climber	Native	Edible
	Rubiaceae				
	Benkara malabarica	Phiriki	Shrub	Native	Medicinal
	Dentella repens		Herb	Native	Medicinal
	Mussaenda frondosa		Shrub	Native	Medicinal/ Ornamental
Boraginales	Boraginaceae				
	Cordia myxa	Guanlo	Tree	Native	Ritual/ Medicinal

during monsoons, dust storms in summer and cyclone proneness.

Data collection

To assess the diversity of angiosperms, field surveys were conducted monthly in different seasons (rainy, winter and summer) from July 2016 to July 2020. During field visits, plant samples were collected and photographs of plant species were taken from agricultural lands, wastelands, roadsides, railway tracks, parks, lawns, ponds, river banks and other appropriat places to cover almost whole district in a systematic manner. Information was collected from the respondents, especially the local farmers, elderly people, and local healers through interviews following standard procedures[16,26]. The questionnaire used was a semi-structured type followed by free interviews and informal conversations.Plant species were identified with the help of previous scientific literature[12,41] and with live specimens on the field itself. However, plant samples were identified in the laboratory. During the survey,important taxonomic parameters such as vernacular names, botanical names, flowering time, and family were recorded from the respondents.The ecological parameters noted were the habit and habitat of the species.The economic uses of these species if any were discussed with the local people. The plant list was categorized according to their systematic positions following the APG IV[2] classification system.

Altogether 141 species (81 native species and 60 exotic species) belonging to115 genera distributed in 48 families from 23 orders and three major clades

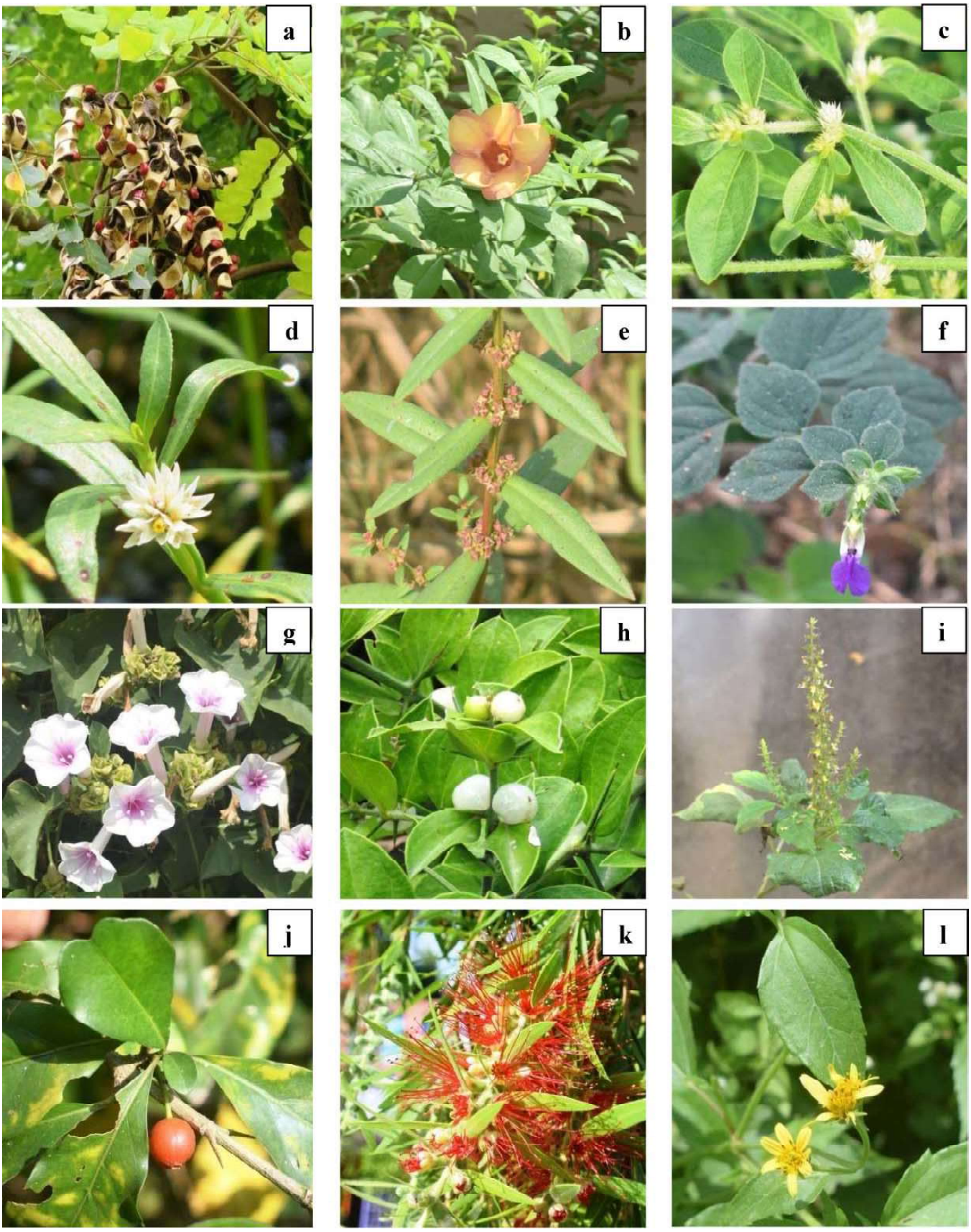

Fig.1:a. ***Adenanthera pavonina*****, b.** ***Allamanda blanchetii*****, c.*****Alternanthera paronichyoides*****, d.*****Alternanthera philoxeroides,* e. *Ammannia baccifera,* f. *Anisomeles indica,* g. *Argyreia cymosa,* h. *Azima tetracantha,* i. *Basilicum polystachyon*, j. *Benkara malabarica,* k. *Callistemon citrinus,* l. *Calyptocarpus vialis*.**

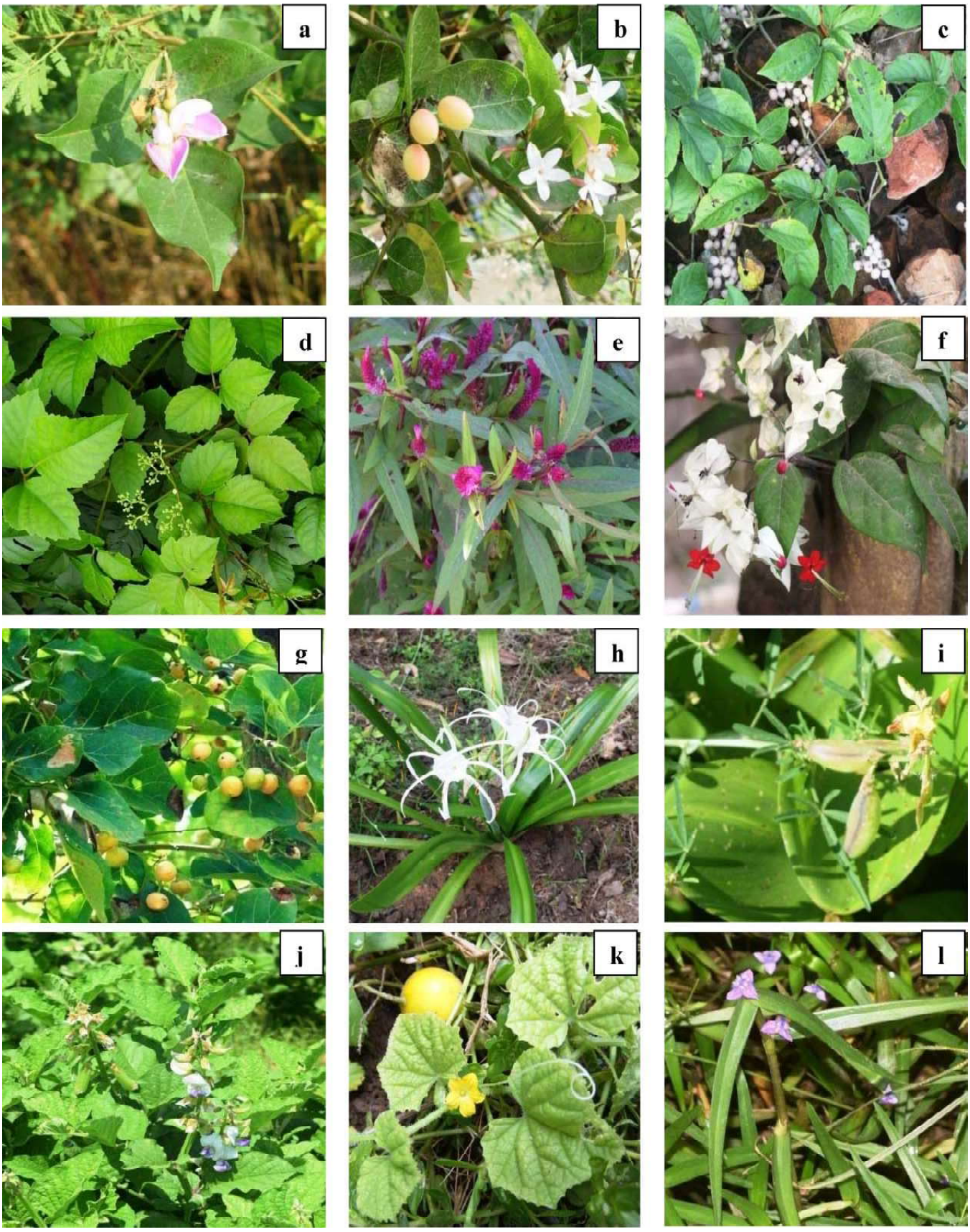

Fig.2: a. *Canavalia gladiata,* b. *Carissa carandas,* c. *Cayratia pedata,* d. *Cayratia trifolia,* e. *Celosia argentea,* f. *Clerodendrum thomsoniae,* g. *Cordia myxa,* h. *Crinum latifolium,* i. *Crotalaria quinguefolia,* j. *Crotalaria verrucosa,* k. *Cucumis melo,* l. *Cyanotis axillaris*.

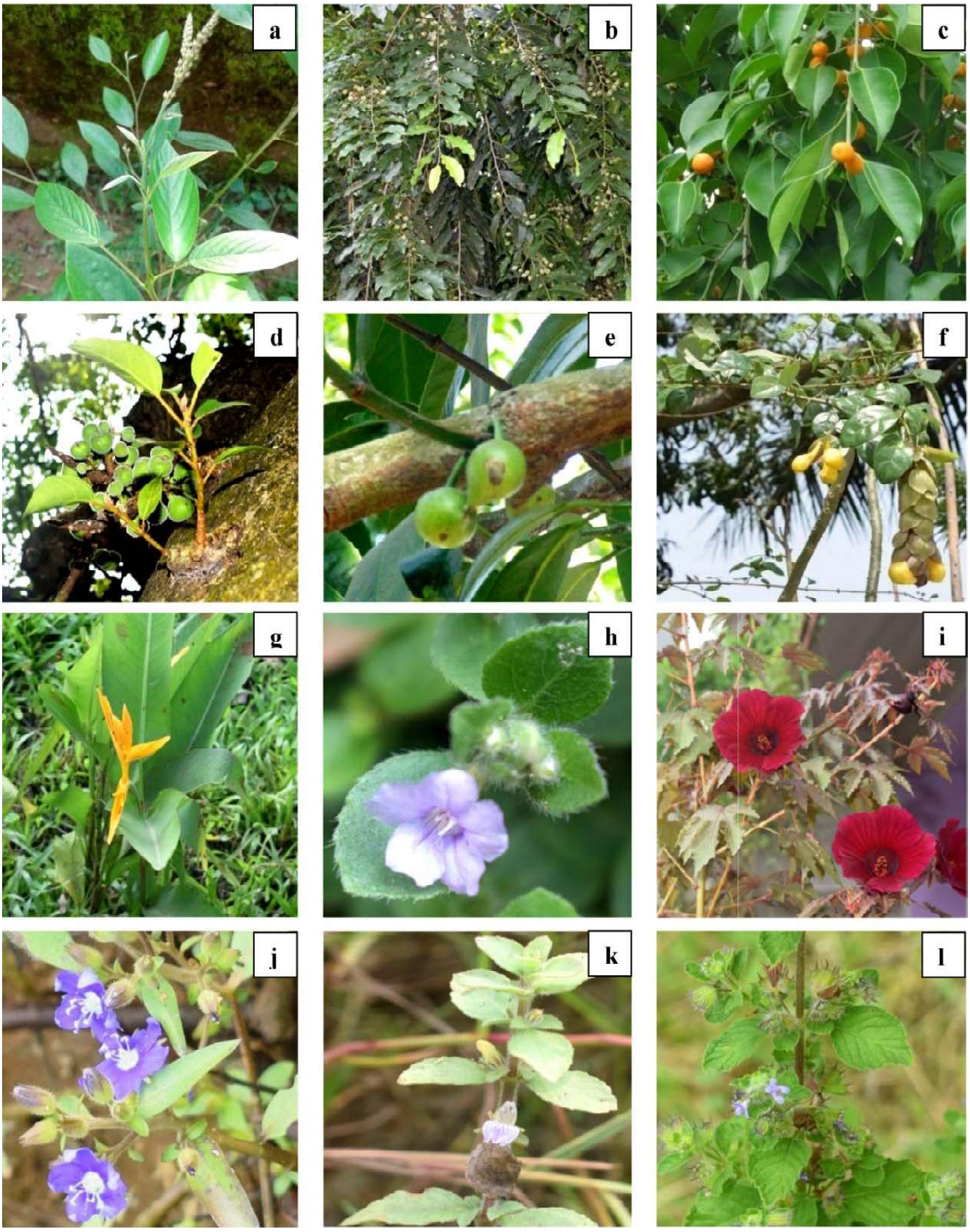

Fig. 3: a. ***Desmodium gangeticum,*** **b.*****Drypetes roxburghii,*** **c.** ***Ficus benjamina,*** **d.** ***Ficus racemosa,*** **e.** ***Garcinia xanthochymus,*** **f.** ***Gmelina philippensis,*** **g.** ***Heliconia psittacorum,*** **h.** ***Hemigraphis hirta,*** **i.** ***Hibiscus cannabinus,*** **j.** ***Hydrolea zeylanica,*** **k.** ***Hygrophila difformis,*** **l.** ***Hyptis suaveolens*****.**

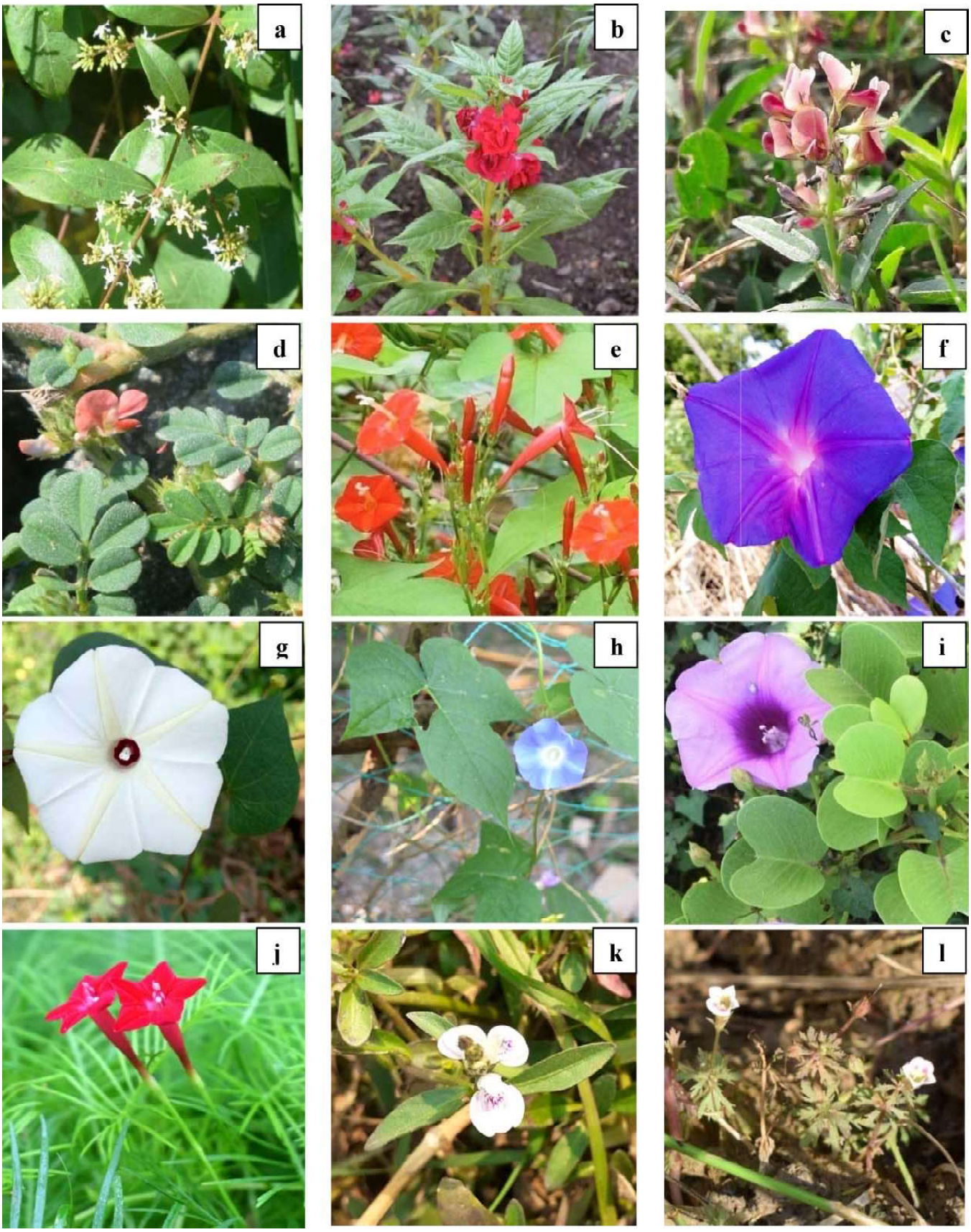

Fig. 4: a. ***Ichnocarpus frutescens,*** **b.** ***Impatiens balsamina,*** **c.** ***Indigofera linnaei,*** **d.** ***Indigofera linifolia,*** **e.** ***Ipomoea hederifolia,*** **f.** ***Ipomoea indica,*** **g.** ***Ipomoea obscura,*** **h.** ***Ipomoea nil,*** **i.** ***Ipomoea pes-caprae,*** **j.** ***Ipomoea quamoclit,*** **k.** ***Justicia procumbens,*** **l.** ***Limnophila indica*****.**

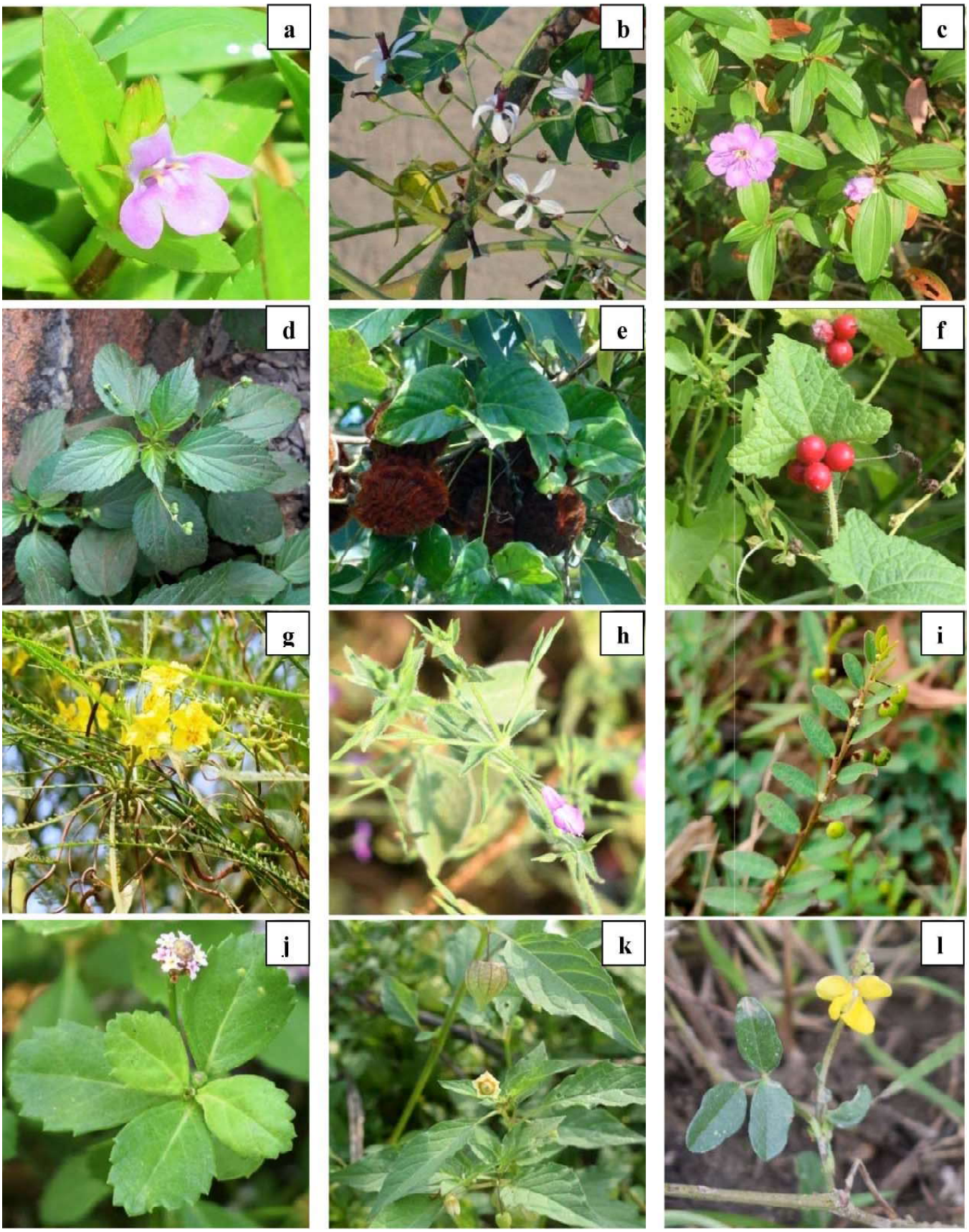

Fig. 5: a. ***Lindernia antipoda,*** **b.** ***Melia azedarach*****, c.** ***Melastoma malabathricum,*** **d.** ***Micrococca mercurialis,*** **e.** ***Mucuna monosperma,*** **f.** ***Mukia maderaspatana,*** **g.** ***Parkinsonia aculeate,*** **h.** ***Peristrophe bicalyculata,*** **i.** ***Phyllanthus virgatus,*** **j.** ***Phyla nodiflora,*** **k.** ***Physalis minima,*** **l.** ***Polygala arvenis*****.**

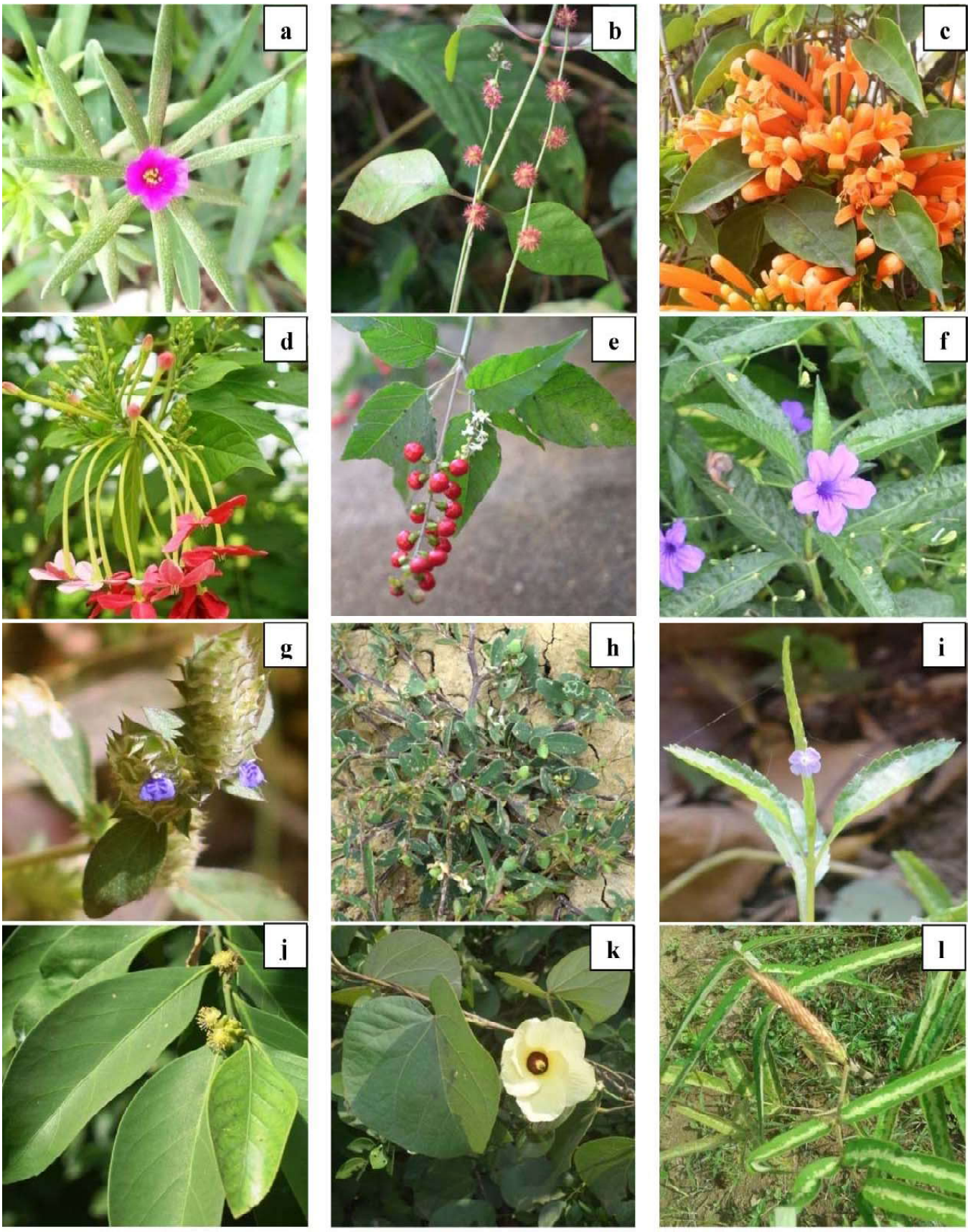

Fig. 6: a. ***Portulaca pilosa,*** **b.** ***Pupalia lappacea,*** **c.** ***Pyrostegia venusta,*** **d.** ***Quisqualis indica,*** **e.** ***Rivinahumilis*** **f.** ***Ruellia tuberosa,*** **g.** ***Rungina pectinata,*** **h.** ***Sauropus bacciformis,*** **i.** ***Stachytarpheta jamaicensis,*** **j.** ***Suregada multiflora,*** **k.** ***Thespesia lampas,*** **l.** ***Uraria picta*****.**

(monocots, superrosids and superasterids) according to Angiosperm Phylogeny Group IV Classification (2016)[23] were recorded during the present study from Bhadrak district (Table 1; Figs. 1-6). Lamids (47 species), Fabids (32 spp.)

Results and Discussion

Commelinids (25 spp.), and Malvids (12 spp.) were the major groups representing a total of 116 taxa that constitute 82.3% of the flora. An analysis of the floristic diversity denoted that the family Fabaceae dominated the flora with 14 species, followed by Convolvulaceae (10 species), Acanthaceae (9 species) and Poaceae 7 species.The predominance of the family Fabaceae is also reported. The dominant genus of the flora was *Ipomoea* (6 spp.). The life form composition analysis showed that herbs dominated the flora of Bhadrak district with a total of 81 species (57.4%), followed by climbers with 22 species (15.6%), trees with 21 species (14.9%) and shrubs with 17 species representing 12.1% of the flora.Worldwide, a good number of plant species are in multipurpose use for instance as food, fodder, medicine, rituals and many more[24]. In the present study, out of 141 species, 63% were used for medicinal purposes. Prominent species among them were *Basilicum polystachyon*, *Commelina diffusa*, *Desmodium gangeticum*, *Euphorbia prostrata*, *Hyptis suaveolens*, *Ipomoea hederifolia L., I. nil*, *I. obscura*, *Ipomoea quamoclit, Suregada multiflora*, *Luffa cylindrica*, *Melia azedarach*, *Phyla nodiflora*, *Physalis minima*, *Sphenoclea zeylanica*. These plants are utilized to cure various ailments such as anthelmintic, anti-inflammatory, asthma, cough, colic and stomach ache, diabetes, eye irritation, conjunctivitis and other eye problems like ophthalmia, fever, gastrointestinal disorders, gynaecology, leprosy, nausea, skin diseases, sores, swellings, ulcers, urinary disorders, rheumatism, wounds, and vomiting. The medicinal properties of the reported plants are also recorded in other studies[7,8,19,21,22,29,35,41]. Similarly, some of the reported species, for instance, *Amaranthus tricolor*, *Carissa carandas*, *Cucumis melo*, *Garcinia xanthochymus*, *Phyllanthus acidus*, *Sauropus bacciformis*, *Telosma pallida* were used for edible purposes. The edible uses of different parts such as leaves, flowers, and fruits of these plants were reported by various scholars[5,9,20,34]. It was observed that 14.2% of recorded species were used for ornamental purposes; examples include, *Aglaonema commutatum*, *Dieffenbachia seguine*, *Epipremnum aureum*, *Licuala grandis* and *Syngonium podophyllum*. My findings in the current investigationare concomitant with previous studies[16,30,33]. Similarly, plant species such as *Alternanthera philoxeroides*, *Alysicarpus vaginalis*, *Brachiaria mutica*, *Lindernia antipoda*, *Myriostachya wightiana*. were used as feed for animals.The line of my results substantiates the earlier studies[10,32]. Plant species like *Saccharum munja* Roxb. and *Cordia myxa* L. have great significance attached to the traditional agricultural rituals of the district. These plants are put by the farmers in the rice field during *Garbhana Sankranti* (*Tula Sankranti*) festival; celebrated on the first day of the solar month of *Kartika*. The name *GarbhanaSankranti* is attributed to the time of fertilization of the rice in the fields. The farmers pray to the goddess Lakshmi, believed to be the authority for the rice plants' wealth, prosperity, and fertility. This creates a linkage between agriculture and the rituals of the district.

Conclusion

The present study makes a significant contribution towards understanding floristic richness in Bhadrak district along with traditional knowledge-based information which can be helpful in providing sustainable utilization of resources.Despite the multipurpose significance, several ongoing anthropogenic factors (urbanization, overexploitation, deforestation, and habitat destruction) play a negative role in the survival of common taxa. Moreover, the recurring natural calamities that occur regularly on the Bay of Bengal coast also affect plant diversity. Biodiversity conservation requires balancing the needs of people and long-term sustenance within the natural habitats, which requires implementation of effective protection measures. It is imperative to develop strategic steps such as the involvement of local communities in management, regular monitoring, awareness programmes and collaborative research for the conservation of the phytodiversity of the region.

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