Bangladesh J. Plant Taxon. **27**(1): 85–101, 2020 (June)

AN ANNOTATED CHECKLIST OF WEED FLORA IN ODISHA, INDIA

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Keywords: Bhadrak district; Diversity; Ecosystem services; Traditional medicines; Weed.

Abstract

This study consolidated our understanding on the weeds of Bhadrak district, Odisha, India based on both bibliographic sources and field studies. A total of 277species of weed taxa belonging to 198 genera and 65 families are reported from the study area. About 95.7% of these weed taxa are distributed across six major superorders; the Lamids and Malvids constitute 43.3% with 60 species each, followed by Commenilids (56 species), Fabids (48 species), Companulids (23 species) and Monocots (18 species). Asteraceae, Poaceae, and Fabaceae are best represented. Forbs are the most represented (50.5%), followed by shrubs (15.2%), climber (11.2%), grasses (10.8%), sedges (6.5%) and legumes (5.8%). Annuals comprised about 57.5% and the remaining are perennials. As per Raunkiaer classification, the therophytes is the most dominant class with 135 plant species (48.7%).The use of weed for different purposes as indicated by local people is also discussed. This study provides a comprehensive and updated checklist of the weed speciesof Bhadrak district which will serve as a tool for conservation of the local biodiversity.

Introduction

India, a country with heterogeneous landforms, shows great variation from one region to another in respect of climate, altitude and vegetation.The country has 60 agroeco-subregions and each agro-eco-subregion has been divided into agro-eco-units at the district level for developing long term land use strategies (Gajbhiye and Mandal, 2006). Climatic, edaphic and biotic factors prevailing in each of the agro-ecological regions influence the formation of vegetation of that area (Rao *et al.*, 2014).The diversity of native flora is an important component of ecosystems that has a primary role in protecting the environmental stability of a region (Cunningham *et al*., 2015). DeWet and Harlan (1975) classified plants of nature into three categories: i) wild plants (which grow naturally outside the human disturbed habitat), ii) domesticates/ crops (which are artificially propagated and often require cultivation and care by humans in order to grow and make use of environmental resources), and iii) weeds (which thrive in habitats that are continuously disturbed by humans).

The terms weed, invader and colonizer have often been used in a conflicting way. The distinctions between them are quite subtle and result from differing viewpoints. According to Rejmanek (1995), weeds interfere with human land use; colonizers are successful at establishing following disturbance; and invaders are species introduced into their non-native habitat. There is substantial overlap among these terms. A plant may be considered as only one of these, or it may be included in all of thesecategories. Many varying definitions have been developed for weeds, depending on each particular situation where they occur and the plants involved. Thomas *et al.*

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(2002) stated that a weed as a plant growing where it is not desired, or a plant out of place. According to Barbara *et al.* (2003), a weed is a native or introduced (alien) species that has a perceived negative ecological or economic effect on agricultural or natural systems. Navas (1991) defined a weed as "a plant that form populations that are able to enter cultivated habitats,markedly disturbed or occupied by man, and potentially depress or displace the resident plant populations which are deliberately cultivated or are of ecological and/or aesthetic interest".

A weed is only a weed under specific circumstances, that the inclusion of a plant into this category is arbitrarily based on human perceptions and that a specific plant species will not always be considered a weed (Crawley, 1997b).Weeds have some pinpointing characters, such as short seed dormancy, high seed germination rate, environmental plasticity, high seedling growth and reproductive capacity, short life cycle, self-compatibility, efficient and well organized methods of seed dispersal, allelopathy and tolerance to abiotic and biotic stresses (El-Sheikh, 2013a).Furthermore, weeds are able to survive and grow in different ecological habitats, with their occurrence being very sensitive to changes in agricultural practices (Fried *et al.*, 2010). Due to these reason weeds are becoming dominant all over the world (Holm *et al.*, 1997). Moreover, the current climate change and natural calamities (cyclones, storms and associated floods) have emerged as the greatest ecological challenge of the 21st century which will affect prevalence of weed species, their distribution and dispersal to invade new ecosystems (Kang and Banga, 2013; Singh *et al.*, 2011). In addition, the effect of human mediated processes on weed species composition cannot be overlooked (Hyvonen, 2007).Those plants which are susceptible to a particular kind of disturbance decrease in number or even disappear (Bergmeier, 2006).

Negative connotations are commonly invoked by the term weed, when referring to biodiversity assets (Martin-Fores *et al.*, 2017).Indeed, since the beginning of crop production weeds have represented a serious constraint to worldwide agriculture, as when left uncontrolled they can cause severe economic losses by reducing detrimentally crop yield and quality (Travlos *et al*., 2018).Weed growth represents a major source of inefficiency, diverting scarce resources (nutrients, water, sunlight and labour) for cultivated crops (Nyarko and Datta, 1993).They can significantly influence crop disease incidence by acting as vectors or reservoirs of plant pathogens (Wisler and Norris, 2005).Weeds infestation also slow down harvesting operation, increase the cost of production, decrease excellence of fertile lands and germination capability of crops seed due to the phytotoxins or allelochemicals and reduce the market value of crops (Algandaby and Salama, 2016).

However, the benefits of weeds are less well understood.Weeds may increase crop growth under certain circumstances. For example, in some dry areas of India, three ‘weeds’ (*Arnebia hispidissima* (Lehm.) DC., *Borreria articularis* (L.f.) Williams and *Celosia argentea*) increase the growth of millet (bajra, *Pennisetum typhoideum*) (Bhandari and Sen, 1979). Weeds form the basis of the agro-ecosystem food web and provide various ecosystem services, such as provisioning of food, medicine, prevention of soil erosion, and livestock feed (Bastiaans *et al.* 2000; Yamaguchi and Umemoto, 1996). Therefore, it is of a vital importance for every country to keep a record of the diversity and distribution of its weeds, and identify whether they are native or exotic/introduced/ aliens/ invader. Potentially serious new weeds are often overlooked until they are widely naturalized and having harmful impact on agricultural production and environment (Waterhouse, 2003).Thus, there is an urgent need to carry out floristic surveys, especially in regions where the flora is not well documented. Fair amount of studies are encountered to document the weed flora of India (Bhattacharjya and Sarma, 2016; Tiwari *et al.*, 2016; Sinha and Banerjee, 2018). However, very little is known about weed flora of Odisha (Mallick *et al.*, 2015).To date, published information is not available on weed plant communities of Bhadrak district of Odisha, India. The main aim of the presented research is to provide the baseline

information on composition and distribution of weed communities prevailing in the Bhadrak region.

Materials and Methods

Study area

Odisha is the ninth largest state of India by area and the eleventh largest by population. It is located in the east coast of India (17.48º – 22.34º N and 81.24º – 87.29º E) with the Bay of Bengal forming its eastern and south eastern frontiers. The entire territory lies in the tropical zone as a result of which high temperature is recorded particularly during April-May. However, the sea exercises a moderating influence over the climate of the coastal belt whereas the hill tracts experience an extreme climate.The forest found in this region is tropical moist deciduous (Champion and Seth, 1968).

Bhadrak district (20° 43′–21° 13′N and 86° 6′–87° E) is located in Northeast Odisha. It spreads over 2505 km^2 having 1.507 million inhabitants (2011 Census). Four other districts namely Balasore, Kendrapara, Jajpur and Koenjher surround Bhadrak district while a part is bounded by the Bay of Bengal. Three distinct annual seasons are the rainy (mid June to mid October), winter (mid October to February) and summer (March to mid June) season. The maximum and minimum temperatures range from 37.4°C to 17.7°C respectively and the annual average rainfall is approximately 1428mm.It is characterized by periodic earth tremors, thunder storms in the rains and dust storms in April and May. The district covers about 1.61 % of the total land area of the state and contributes 3.59 % of the state's population. About 86.66 % of the inhabitants are villagers and the people are engaged in agricultural practices as their primary occupation.

Data collection

Extensive field surveys (June 2015- May 2018) were carried out to document and enlist the weed flora in diverse habitats following established and standard procedures (Martin, 1995). The information on the weed plants was obtained through questionnaires, complemented by free interviews and informal conversations (Martin, 1995). The information regarding the weed species has been gathered mostly from local farmers, elderly and knowledgeable persons. Personal interviews and group discussions carried out in the local language revealed specific information about the plants, which were further compared and authenticated by crosschecking (Cunningham, 2001).During field study, the economic uses of these species if any were discussed with the local people.Weeds were identified with available regional floras (Saxena and Brahmam 1996).The plant species are enumerated and arranged as per Angiosperm Phylogeny Group III Classification (APG III, 2009). The lifeforms of plant species were recognized through Raunkiaer (1934) classification. The voucher specimens were deposited in the herbarium of the Department of Botany, Chandbali College, Chandbali. The weed plants were represented alphabetically according to their scientific names, local name if any, family, habit, life span, life form, and uses.

Results and Discussion

Two hundred and seventy seven species belonging to 198 genera of 65 flowering plant families were recorded in the study area, representing ten superorders and thirty orders as per APG III classification (Table 1). Among the reported plants, 43.3% of the taxa were recorded from the superorder Lamids and Malvids (each with 60 species), 20.2% from superorder commelinids, 17.3% from Fabids, and 8.3% from superorder Companulids. Order Poales, Carylophyllales, Lamiales, Sonales, Asterales, Fabales, Malvales and Malphigiales accounted for about 75% of the species in the district. Twenty seven families are only represented by one species; examples include Capparaceae, Molluginaceae, Oxalidaceae, Papaveraceae and Vitaceae.The largest family

Table 1. List of weed flora recorded from Bhadrak district, arranged according to the Angiosperm Phylogeny Group Classification III.

Superorder/Order	Family/Species	Common name	Habit	Life span	Life form	Uses
EARLY ANGIOSPERMS						
Nymphaeales	**Nymphaeaceae**					
	Nymphaea nouchali Burm. f.	Kain	Forb	P	Hyd	M, E
	Nymphaea pubescens Willd.	Rangakain	Forb	P	Hyd	E
	Euryale ferox Salisb.	Kanta Padma	Forb	P	Hyd	M
MAGNOLIIDS						
Piperales	**Aristolachiaceae**					
	Aristolochia indica L.	Balbolena	Climber	p	Cry	M
	Piperaceae					
	Peperomia pellucida (L.) Kunth		Forb	A	Hem	M
Laurales	**Lauraceae**					
	Cassytha filiformis L.	Nirmuli	Climber	P	Ph	M
MONOCOTS						
Alismatales	**Alismataceae**					
	Sagittaria sagittifolia L.		Forb	P	Hyd	E
	Aponogetonaceae					
	Aponogeton natans (L.) Engl. & Krause	Jhechu	Forb	P	Hyd	E
	Aponogeton undulatus Roxb.		Forb	P	Hyd	E
	Araceae					
	Alocasia macrorrhizos (L.) G.Don.	Badasaru	Forb	P	Cry	E
	Amorphophallus paeoniifolius (Dennst.)Nicolson	Olua	Forb	P	Cry	E
	Caladium bicolor (Aiton) Vent.		Forb	A	Cry	NK
	Colocasia esculenta (L.) Schott.	Saru	Forb	A	Hyd	M, E
	Pistia stratiotes L.	Borajhanji	Forb	P	Hyd	M
	Hydrocharitaceae					
	Hydrilla verticillata (L. f.) Royle.	Chingudiadala	Forb	P	Hyd	M
	Ottelia alismoides (L.) Pers.	Panikundri	Forb	P	Hyd	M, E
	Vallisneria natans (Lour.) Hara		Forb	A	Hyd	E
	Lemnaceae					
	Wolffia globosa (Roxb.) Hatog.& Plas		Forb	A	Hyd	E
Pandanales	**Pandanaceae**					
	Pandanus fascicularis Lam.	Kia	Shrub	P	Ph	BF
	Pandanus foetidus Roxb.	Lunikia	Shrub	P	Ph	Biofencing
Liliales	**Colchicaceae**					
	Gloriosa superba L.	Ognisikha	Climber	A	Cr	M
Asparagales	**Amaryillidacea**e					
	Crinum asiaticum L.	Arsa	Forb	P	Cr	M, E
	Asparagaceae					BF
	Agave americana L.	Baramasi	Shrub	P	Ph	BF
	Sansevieria roxburghiana Schult. & Schult. f.	Muruga	Forb	P	Ph	

COMMELINIDS						
Commelinales	**Commelinaceae**					
	Aneilema vaginatum (L.) R.Br.		Forb	A	Ch	FD
	Commelina benghalensis L.	Kansiri	Forb	A	Ch	M
	Commelina difusa Burm.f.		Forb	A	Ch	M
	Cyanotis axillaris (L.) Schult. & Schult. f.		Forb	A	Ch	FD
	Murdannia nudiflora (L.) Brenan	Kanduli	Forb	A	Ch	FD
	Pontederiaceae					
	Eichhornia crassipes (Mart.)Solms	Bilatidala	Forb	P	Hyd	NK
	Monocharia hastata (L.)Solm		Forb	**A**	Hyd	E
Poales	**Poaceae**					
	Brachiaria reptans (L.) Garde. & Hubb.		Grass	A	Ch	FD
	Chloris barbata Sw.		Grass	P	Hem	FD
	Chrysopogon aciculatus (Retz.) Trin.	Guguchia	Grass	P	Cr	M
	Coix lacryma-jobi L.	Gargara	Grass	A	Th	FD
	Cynodon dactylon (L.) Pers.	Duba	Grass	P	Hem	M,R
	Dactyloctenium aegyptium (L.) Willd.	Kakhuriya	Grass	A	Hem	FD
	Digitaria cilliaris Retz. Koeler		Grass	A	Ch	FD
	Echinochloa colona (L.) Link	Swanghas	Grass	A	Th	E
	Echinochloa crusgalli (L.) P. Beauv.	Dhera	Grass	A	Th	E
	Eleusine indica (L.) Gaertn.	Anamandia	Grass	A	Hem	FD
	Eragrostis ciliata (Roxb.)Nees		Grass	P	Cr	FD
	Eragrostis gangetica (Roxb.) Steud.	Kankra chare	Grass	A	Cr	FD
	Heteropogon contortus (L.) P. Beauv.	Dauria	Grass	P	Cr	FD
	Imperata cylindrica (L.) Raeusch.	Chhana ghas	Grass	P	Hem	FD
	Isachne globosa (Thunb.) Kuntze		Grass	A	Th	FD
	Ischaemum rugosum Salisb.	Tuli	Grass	A	Hem	FD
	Leptochloa chinensis (L.) Nees	Bhuru	Grass	A	Hem	FD
	Oplismenus burmanii (Retz.) P. Beauv.	Kanguria	Grass	A	Th	FD
	Oryza rufipogon Griff.	Balunga	Grass	P	Th	FD
	Panicum psilopodium Trin.		Grass	A	Th	FD
	Panicum repens L.	Reda	Grass	P	Th	FD
	Paspalum distichum L.		Grass	P	Th	FD
	Phragmites karka (Retz.) Trin.ex Steud.	Noto	Grass	A	Th	FD
	Saccharum spontaneum L.	Kashatundi	Grass	P	Hel	FD
	Setaria intermedia Roem. & Schult.		Grass	A	Th	FD
	Setaria pumila (Poir.) Roem. & Schult.	Sial legunda	Grass	A	Th	FD
	Setaria verticillata (L.) P. Beauv.		Grass	A	Th	FD
	Sporobolus indicus (L.) R. Br.	Kankra chara	Grass	P	Th	NK
	Vetiveria zizanioides (L.) Nash.	Bena	Grass	P	Th	AR
	Xyridaceae					
	Xyris indica L.		Grass	A	Th	FD

	Cyperaceae					
	Bulbostylis barbata (Roxb.) C.B.Cl.		Sedge	A	Th	FD
	Cyperus alopecuroides Rottb. Descr.	Hensuati	Sedge	P	Th	AR
	Cyperus brevifolius (Rottb.)Hassk.		Sedge	P	Cr	FD
	Cyperus castaneus Willd.		Sedge	A	Th	FD
	Cyperus compressus L.		Sedge	A	Hel	FD
	Cyperus difformis L.	Swonli	Sedge	A	Ch	FD
	Cyperus iria L.		Sedge	A	Ch	FD
	Cyperus rotundus L.	Mthaghas	Sedge	P	Hem	M
	Eleocharis acutangula (Roxb.) Schult. & Schult.		Sedge	P	Cr	NK
	Eleocharis dulcis (Burm. f.) Henschef		Sedge	A	Cr	NK
	Fimbristylis dichotoma (L.) Vahl		Sedge	A	Ch	FD
	Fimbristylis ferruginea (L.) Vahl		Sedge	P	Hem	FD
	Fimbristylis miliacea (L.) Vahl		Sedge	A	Hem	FD
	Fimbristylis ovata (Burm.f.) J Kern.		Sedge	A	Hem	FD
	Fuirena ciliaris (L.) Roxb.		Sedge	A	Th	FD
	Kylinga nemoralis (J.R. & G. Forst) Dandy ex Hutch. & Dalz.		Sedge	P	Th	NK
	Scirpus articulatus L.	Kanri	Sedge	A	Hem	NK
	Scirpus grossus L.	Santara	Sedge	P	Cr	NK
	Typhaceae					
	Typha angustata Bory. & Chaub	Hangla	Forb	P	Ph	M
CORE EUDICOTS						
Proteales	**Nelumbonaceae**					
	Nelumbo nucifera Gaertn.	Padma	Forb	P	Hyd	E
Ranunculales	**Menispermaceae**					
	Cissampelos pareira L.	Akanbindi	Climber	P	Ch	M
	Tiliacora racemosa Colebr.	Kalajati noi	Climber	P	Ch	NK
	Tinospora cordifolia (Willd.)Hook.f. & Thomson	Guluchilata	Climber	P	Ch	M
	Papaveraceae					
	Argemone mexicana L.	Kantakusuma	Forb	A	Th	M,E
ROSIDS						
Vitales	**Vitaceae**					
	Cissus quadrangularis L.	Hadabhanga	Shrub	P	Th	M
FABIDS						
Zygophyllales	**Zygophyllaceae**					
	Tribulus terrestris L.	Gokhara	Forb	P	Ch	M
Oxalidales	**Oxalidaceae**					
	Oxalis corniculata L.	Ambiliti	Forb	P	Cr	M, E
Malpighiales	**Euphorbiaceae**					
	Acalypha indica L.		Forb	A	Th	NK
	Chrozophora rottleri (Geisel.) Juss.		Forb	A	Th	NK
	Croton sparsiflorus Morong	Nandababuli	Forb	P	Th	M
	Euphorbia hirta L.	Harharika	Forb	A	Th	M
	Euphorbia heterophyla L.		Forb	A	Th	NK
	Euphorbia thymifolia L.	Patrasiju	Shrub	P	Th	BF
	Euphorbia tirucalli L.	Dangulisiju	Shrub	P	Th	BF

	Euphorbia tithymaloides L.		Shrub	P	Th	BF
	Jatropha curcas L.	Jara	Shrub	P	Ph	M
	Jatropha gossypiifolia L.	Baigaba	Shrub	P	Th	M
	Synadenium grantii Hook f.		Shrub	P	Th	BF
	Tragia involucrata L.	Bichhuati	Forb	A	Ph	M
	LINACEAE					
	Linum usitatissimum L.		Forb	A	Th	M
	Phyllanthaceae					
	Breynia vitis-idaea (Burm. f.) Fischer	Pohalakuli	Shrub	P	Th	BF
	Phyllanthus amarus Schum. &Thonn.	Bhui anla	Forb	A	Th	M
	Phyllanthus urinaria L.	Bhuiamla	Forb	A	Th	M
	Violaceae					
	Hybanthus enneaspermus (L.) F. Muell.	Madan mastak	Forb	A	Ch	M
Fabales	**Fabaceae**					
	Abrus precatorius L.	Kaincha	Legume	A	Ph	M
	Aeschynomene indica L.	Sola	Legume	A	Cr	FD
	Aeschynomene aspera L.	Sola	Legume	A	Cr	AR
	Alysicarpus monilifer (L.) DC.		Legume	A	Th	FD
	Alysicarpus vaginalis (L.) DC.		Legume	A	Th	FD
	Caesalpinia bonduc (L.) Roxb.	Gilo	Climber	P	Ph	M
	Caesalpinia crista L.	Nantei	Climber	P	Ph	NK
	Cassia absus L.		Forb	A	Th	NK
	Cassia alata L.		Shrub	P	Ph	M
	Cassia occidentalis L.	Kalachakunda	Forb	P	Ph	M
	Cassia tora L.	Chakunda	Forb	P	Th	M
	Crotalaria juncea L.	Chanapata	Legume	A	Th	M
	Crotalaria spectabilis Roth.	Jhumka	Legume	P	Th	FD
	Crotalaria prostrata Rottl. ex Willd.	Jhumka	Legume	P	Th	FD
	Desmodium triflorum (L.)DC.	Kaansisna	Legume	A	Th	FD
	Indigofera linnaei Ali		Legume	P	Th	FD
	Melilotus indica (L.) All.	Bana methi	Legume	A	Th	FD
	Mimosa pudica L.	Lajakuli	Legume	P	Th	M
	Mucuna pruriens (L.) DC.	Baidanka	Climber	A	Th	M
	Neptunia oleracea Lour.		Legume	A	Hyd	M
	Smithia conferta J.E. Sm.	Sanomungo	Legume	A	Th	FD
	Tephrosia purpurea (L.) Pers.	Banakolathi	Legume	P	Th	M
	Vigna trilobata (L.) Verdc.		Legume	A	Cr	FD
Cucurbitales	**Cucurbitaceae**					
	Benincasa hipsida (Thunb) Cogn.	Panikakharu	Climber	A	Ph	E
	Coccinia indica Wight & Arn.	Kunduri	Climber	A	Ph	E
	Luffa acutangula (L.) Roxb.	Pitataradi	Climber	A	Ph	M
	Trichosanthes cucumerina. L.	Banapotala	Climber	A	Th	E
	Trichosanthes tricuspidata Lour.	Mahakal	Climber	P	Th	NK
Rosales	**Urticaceae**					
	Urticularia stelaris L.f.	Bhaturia dala	Forb	A	Hyd	NK

MALVIDS						
Myrtales	**Onagraceae**					
	Ludwigia adscendens (L.) H. Hara	Jagal	Forb	A	Hyd	M,E
	Ludwigia hyssopifolia (G.Don)		Forb	A	Hyd	M, E
	Ludwigia octovalvis (Jacq.) Raven		Forb	A	Hyd	M
	Ludwigia perennis L.	Latkera	Forb	A	Hyd	FD
	Lythraceae					
	Ammannia baccifera L.	Ramdauni	Forb	A	Th	FD
	Ammannia multiflora Roxb.		Forb	A	Th	FD
	Rotala indica (Willd.) Koehne		Forb	A	Th	FD
Brassicales						
	Brassicaceae					
	Brassica juncea (L.) Czern. & Coss.	Raisorisha	Forb	A	Th	E
	Cleomaceae					
	Cleome gynandra L.	Arakasago	Forb	A	Th	M
	Cleome monophylla L.	Rangasorish	Forb	A	Th	NK
	Cleome rutidosperma DC.		Forb	A	Th	M
	Cleome viscosa L.	Anasorisho	Forb	A	Th	M
	Capparaceae					
	Capparis zeylanica L.	Asadua	Shrub	P	Ph	M
Sapindales	**Sapindaceae**					
	Cardiospermum halicacabum L.	Kanphuta	Climber	A	Th	M
Malvales	**Malvaceae**					
	Abutilon indicum (L.) Sweet	Pedipedika	Shrub	A	Ph	M
	Corchorus aestuans L.	Bananalita	Forb	A	Th	M
	Corchorus olitorius L.		Forb	A	Th	NK
	Corchorus tridens L.		Forb	A	Th	NK
	Corchorus trilocularis L.		Forb	A	Th	NK
	Hibiscus sabdariffa L.	Khatakaunria	Shrub	A	Th	E
	Hibiscus vitifolius L.		Shrub	A	Th	NK
	Malachra capitata (L.) L.		Forb	P	Th	NK
	Malvaviscus arboreus Cav.	Lankamandar	Shrub	P	Th	NK
	Melochia corchorifolia L.	Telpuri	Forb	A	Th	NK
	Pavonia zeylanica (L.) Cav.		Forb	A	Ch	NK
	Sida acuta Burm.f.	Sunakhadika	Forb	A	Th	M
	Sida cordata (Burm. f.) Borss. Waalk.	Bisiripi	Forb	A	Th	M
	Sida cordifolia L.	Bisiripi	Shrub	A	Th	M
	Sida rhombifolia L.	Sahabeda	Shrub	A	Th	M
	Sida spinosa L.	Bajramuli	Forb	A	Th	FD
	Triumfetta rhomboidea Jacq.		Shrub	P	Th	NK
	Urena lobata L.		Shrub	A	Ph	NK
Saxifragales	**Crassulaceae**					
	Bryophyllum pinnatum (Lam.) Oken.	Amarpoi	Forb	P	Ch	NK
Caryophyllales	**Aizoaceae**					
	Sesuvium portulacastrum (L.) L.	Godabani	Ferb	P	Th	BF
	Trianthema portulacastrum L.	Purinisaga	Forb	A	Th	M
	Polygonaceae					
	Antigonon leptopus Hook. & Arn.		Climber	P	Th	M
	Polygonum barbatum L.	Nara	Forb	A	Th	E

	Polygonum glabrum Willd	Bihongi	Forb	A	Th	E
	Polygonum plebeium R.Br.	Muthisaga	Forb	A	Th	M,E
	Molluginaceae					
	Glinus oppositifolius (L.) A.DC.	Pitasaga	Forb	A	Th	M,E
	Amaranthaceae					
	Achyranthes aspera L.	Apamaranga	Forb	A	Th	M
	Aerva lanata (L.) Juss. ex Sch.	Paunsia	Forb	A	Th	FD
	Alternanthera philoxeroides (Mart) Griseb.	Ghodamadaranga	Forb	P	Hyd	FD
	Alternanthera sessilis (L.)R.Br.ex DC.	Madranga	Forb	P	Hyd	M,E
	Amaranthus gangeticus L.	Nalikosala	Forb	A	Th	E
	Amaranthus viridis L.	Leutia	Forb	A	Th	E
	Amaranthus spinosus L.	Kantaneutia	Forb	A	Th	M, E
	Celosia argentea L.	Chulia	Forb	A	Ch	M
	Chenopodium album L.	Bathuasaga	Forb	A	Th	E
	Gomphrena serrata L.		Forb	A	Th	M
	Suaeda maritima (L.) Dumort.		Forb	A	Th	NK
	Portulacaceae					
	Portulaca oleracea L.	Badabalbaula	Forb	A	Ch	M, E
	Portulaca quadrifida L.	Balbaula	Forb	A	Ch	E
	Nyctaginaceae					
	Boerhavia diffusa L.	Puruni	Forb	P	Th	M, E
	Mirabilis jalaba L.	Chandrakanta	Forb	A	Th	M
	Bougainvillea spectabilis Willd.	Kagajaphula	Shrub	P	Th	BF
	Cactaceae					
	Opuntia stricta (Haw.) Haw. var. *dillenii* (Ker Gawl.) L. D. Benson	Nagapheni	Shrub	P	Ph	M, BF
	Pilosocereus arrabidae (Lem.) Byles & G.D.Rowley	Deulisiju	Shrub	P	Ph	BF
	Plumbaginaceae					
	Plumbago zeylanica L.	Chintamani	Forb	P	Th	M
LAMIDS						
Gentianales	**Apocynaceae**					
	Calotropis gigantea R. Br.	Dhala-arakha	Shrub	P	Ph	M
	Calotropis procera (Aiton)W.T. Aiton	Arakha	Shrub	P	Ph	M
	Cathranthus roseus (L.) G. Don.	Sadabihari	Forb	P	Th	M
	Gymnema sylvestre (Retz.) R.Br.ex Schult.	Gurmari	Climber	P	Th	M
	Pergularia daemia (Forssk.) Chiov.	Uturudi	Climber	P	Th	M
	Rubiaceae					
	Dentella repens (L.) J.R. & Forst.		Forb	A	Th	BF
	Hedyotis corymbosa (L.) Lam.	Jarjati	Forb	A	Ch	M
	Spermacoce articularis L.f.	Solaganthi	Forb	A	Ch	FD
Lamiales	**Acanthaceae**					
	Andrographis paniculata (Burm.f.) Wall.ex. Nees	Bhuinnimba	Forb	A	Th	M
	Acanthus ilicifolius L.	Harkanch	Shrub	P	Hel	M
	Barleria prionitis L.	Daskeraanta	Shrub	P	Ch	

	Hygrophila auriculata Heine.	Koelekha	Forb	P	Ch	M
	Justicia gendarussa Burn.f.	Kalabasanga	Forb	P	Ch	M
	Ruellia prostrata Poir.		Forb	P	Th	NK
	Rungia pectinata (L.) Nees		Forb	A	Th	NK
	Lamiaceae					
	Clerodendrum inerme (L.) Gaertn.	Chinyanrhi	Shrub	P	Ph	M
	Clerodendrum indicum (L.) Kuntze	Nagri	Shrub	P	Ph	M
	Clerodendrum philippinum Schauer.	Dilbari	Shrub	P	Ph	BF
	Clerodendrum phlomoides L. f.	Donkari	Shrub	P	Ph	M
	Hyptis suaveolens (L.) Poit.		Forb	A	Ph	NK
	Leucas aspera (Willd.) Link	Gaiso	Forb	P	Ch	M
	Ocimum canum Sims		Forb	P	Th	M
	Martyniaceae					
	Martynia annua L.	Baghanakhi	Shrub	A	Th	NK
	Scrophulariaceae					
	Bacopa monnieri (L.) Pennell	Brahmi	Forb	A	Ch	M, E
	Lindernia antipoda (L.) Alston		Forb	A	Th	FD
	Lindernia crustacea (L.)F.v.Muell.		Forb	A	Th	NK
	Plantaginaceae					
	Mecardonia procumbens (Mills.) Small		Forb	A	Ch	NK
	Scoparia dulcis L.	Chirarita	Forb	P	Ch	NK
	Pedaliaceae					
	Pedalium murex L.	Gokara	Forb	A	Th	M
	Sesamum indicum L.	Khasa	Forb	A	Ch	M
	Verbenaceae					
	Duranta repens L.	Bilatikanta	Shrub	P	Ph	BF
	Lantana camara L.	Gandhagauria	Shrub	P	Ph	M
	Lippia javanica (Burn.f) Spreng	Naguari	Forb	P	Ch	M
	Phyla nudiflora (L.) Greene		Forb	A	Th	FD
Solanales	**Convolvulaceae**					
	Argyreia nervosa (Burm. f.) Boj.	Mundanoi	Climber	A	Ph	NK
	Cuscuta reflexa Roxb.	Nirmuli	Climber	A	Hem	M
	Evolvulus alsinoides (L.) L.	Bichhamalia	Forb	P	Th	M
	Evolvulus nummularius (L.) L.		Forb	P	Th	NK
	Ipomoea alba L.	Kunjalata	Climber	P	Th	NK
	Ipomoea aquatica Forssk.	Kalamasaga	Climber	A	Hyd	M, E
	Ipomoea carnea Jacq.	Amari	Shrub	P	Cr	BF
	Ipomoea hederifolia L.		Climber	A	Th	NK
	Ipomoea marginata (Desr.)Verdc.		Climber	A	Th	NK
	Ipomoea mauritiana Jacq.	Bhuinkakharu	Climber	A	Ph	NK
	Ipomoea obscura Ker.-Gawl.		Climber	P	Th	M
	Ipomoea pes-tigridis L.		Climber	A	Th	NK
	Ipomoea quamocit L.		Climber	P	Th	M
	Merremia tridentata (L.) Hall. f.		Climber	A	Th	FD
	Merremia hederacea (Burm. f.) Hall.		Climber	A	Th	NK

	Hydroleaceae					
	Hydrolea zeylanica (L.) Vahl	Languliya	Forb	A	Hyd	FD
	Sphenocleaceae					
	Sphenoclea zeylanica Gaertn.	Panimircho	Forb	A	Hyd	FD
	Solanaceae					M
	Datura metel L.	Kaladudura	Shrub	P	Ph	M
	Datura stramonium L.	Dudura	Shrub	A	Ph	M
	Physalis minima L.		Forb	P	Ph	M
	Solanum nigrum L.	Tutguna	Shrub	A	Ph	M
	Solanum surattense Burm. f.	Beji-begun	Forb	P	Th	M
	Solanum torvum Sw.		Shrub	P	Ph	M
	Solanum trilobatum L.	Nabhiankuri	Shrub	A	Ph	NK
	Solanum viarum Dunal	Bhegibaigan	Shrub	P	Ph	M
Boraginales	**Boraginaceae**					
	Heliotropium indicum L.	Hatisundha	Forb	A	Th	M
CAMPANULIDS						
Asterales	**Asteraceae**					
	Acanthospermum hispidum DC.		Forb	A	Th	M
	Ageratum conyzoides L.	Poksunga	Forb	A	Th	M
	Bidens pilosa L.		Forb	A	Th	M
	Blumea membranacea Wall. ex DC.	Poksunga	Forb	A	Th	NK
	Chromolaena odorata (L.) King & Rob.		Forb	P	Th	NK
	Echinops echinatus Roxb.		Forb	A	Ch	NK
	Eclipta prostrata (L.) L.	Bhrungaraj	Forb	A	Th	M, E
	Emila sonchifolia (L.) DC.	Sarkara	Forb	A	Ch	NK
	Enydra fluctuans Lour.	Hidmichi	Forb	A	Cr	M, E
	Gnaphalium polycaulon Pers.		Forb	A	Th	NK
	Grangea maderaspatana (L.) Poir.	Painjari	Forb	A	Ch	NK
	Mikania micrantha Kunth		Climber	A	Ph	NK
	Parthenium hysterophorus L.		Forb	A	Th	NK
	Sonchus oleraceus L.		Forb	A	Th	NK
	Sphaeranthus indicus L.	Bhuikadamba	Forb	A	Th	NK
	Spilanthes paniculata Wall. ex DC.		Forb	A	Ch	FD
	Synedrella nodiflora (L.) Gaertn.		Forb	A	Th	NK
	Tridax procumbens L.	Bisalyakarani	Forb	P	Th	M
	Vernonia cinerea (L.) Less.	Poksunga	Forb	A	Th	M
	Xanthium indicum J.Koenig. ex Roxb.		Shrub	A	Ch	NK
	Menyanthaceae					
	Nymphoides hydrophylla (Lour.) Kuntze		Forb	P	Hyd	E
	Nymphoides indicum (L.) Kuntze		Forb	P	Hyd	E
Apiales	**Apiaceae**					
	Centella asiatica (L.) Urb.	Thalkudi	Forb	P	Hem	M,E

Abbreviations: A: Annual, P: Perennial, Ch: Chamephyte, Cr: Cryptophyte, Hem: Hemicryptophyte, Ph: Phanerophyte, Tel: Helophytes, Hyd: Hydrophyte, Th: Therophyte, M: Medicine, E: Edible, BF: Biofencing, FD: Fodder, R: Ritual, AR: Artifact, NK: Not known.

was Poaceae represented by 29 species while the Fabaceae and Asteraceae were represented by 23 and 20 species, respectively. Habit analysis revealed that forbs were the most represented (50.5%), followed by shrubs (15.2%), climbers (11.2%), grasses (10.8%), sedges (6.5%) and legumes (5.8%). The Therophytes was the most dominant class with 135 plant species (48.7%) followed by Phanerophytes with 40 species (14.5%), Chemaephytes with 36 species (13.0%), Hydrophytes with 28 species (10.1%), Cryptophytes with 20 species (7.2%), Hemicryptophytes with 15 species (5.4%),and helophytes having three species (1.1%) respectively. Annuals were the most represented (57.7%) than the perennials (42.3%).

Many weeds were used by local communities as food, fodder, traditional medicines and other purposes. Out of 277, about 41% of the species were used for the treatment of various ailments, such as diabetes, gastrointestinal disorders, fever, gynaecology, cardiovascular disorders, skin diseases, rheumatism, and dental caries. Prominent among them were *Andrographis paniculata*, *Bacopa monnieri*, *Catharanthus roseus*, *Centella asiatica*, *Glinus oppositifolius*, *Gymnema sylvestre*, *Ipomoea aquatica*, *Oxalis corniculata*, *Solanum surattense* and *Tridax procumbens*. Many weeds (27.5%) were collected by the farmers for domestic animal feed. Examples include *Alternanthera philoxeroides*, *Echinochloa crusgalli*, *Hydrolea zeylanica, Polygonum glabrum* and *Spermacoce articularis.*Similarly, 12.4% of the reported plant species were used for edible purposes, for instance *Alternanthera sessilis, Colocasia esculenta*, *Glinus oppositifolius, Ipomoea aquatica* and *Oxalis corniculata*. Weeds like *Aeschynomene aspera*, *Cyperus alopecuroides*, and *Vetiveria zizanioides* were used for various household purposes. Likewise, a variety of plant species were used for biofencing pupose. Examples include, *Bougainvillea spectabilis*, *Clerodendrum inerme*, *Duranta repens*, *Euphorbia tirucalli*, *Ipomoea carnea*, *Jatropha curcas* and *Pandanus fascicularis.* Some of the plants like *Cynodon dactylon* and *Desmostachya bipinnata*, were used for various rituals by the inhabitants of the district.

Many factors such as increasing atmospheric temperature and CO_2 level, variation in rainfall pattern and climate change are regarded as important indicator of weed species distribution in a geographical area (Patterson *et al.*, 1999; Rodenburg *et al.*, 2011). For instance, *Datura stramonium*, which needs high temperature for profuse growth (Cavero *et al.*, 1999) and *Setaria viridis* requires warmer conditions germinated later in the (August) season (Dekker, 2003), would become a more competitive candidate under the climate change scenarios. A recent study indicated that *Setaria viridis* would be a problematic weed in maize-based cropping systems elsewhere, through synchrony with maize emergence, which is probably due to stimulation by increased temperature (Peters and Gerowitt, 2014). Under such a scenario, the distribution and prevalence of weeds will be problematic in crop ecosystems.

The total number of weed species reported in the present study (277 species) is significantly higher compared with those found in Nalbari district, Assam, India (217 species; Bhattacharjya and Sarma, 2016), Sundargarh District, Odisha, India (174 species; Mallick *et al.*, 2015), Spain (175 species; Cirujeda *et al.*, 2011) but lower than the species reported from Central Europe (381 species; Lososova *et al.*, 2008) and Greece (278 species; Damanakis, 1983).The botanical families with greater representation are the Poaceae, followed by Asteraceae and Fabaceae. The present report draws support from earlier studies (Radosevich and Holt, 1984; Pullaiah, 2015).The predominance of herbaceous plants **(**forbs 140 species; grasses 30 species and sedges 18 species**)** found in this study is also reported by Irwin *et al.* (2015).Present study revealed the predominance of annual weed species over the perennial ones which is similar to the conclusion of Bergmeier (2006). The dominant life forms in biological spectrum of a region indicate the phytoclimate of that region (Thakur, 2015). The present observation indicates a higher percentage of the Therophytes (49.1%) which is in accordance with the studies of Bhattacharjya and Sarma (2016).

In this study *Boerhavia diffusa* is found abundantly in cultivated fields, waste lands, roadsides, pathways and gardens. Low (1991) reported that, *B. diffusa* is found in dry sandy nature of soils. Abeywardana and Hettiarachchi (2001) concluded that *B. diffusa* is a common weed present in sandy areas, while Chopra (1969) stated that *B. diffusa* grows all over the warmer region up to 2000m an altitudinal range of Himalaya and grows easily in fields following the rainy time of year and in wastelands. In the present study, *Commelina benghalensis* is present in abundance that exposed moderate moist condition. Kaul *et al.* (2002) stated that *C. benghalensis* requires moist soil condition for establishment and after establishment it can also survive dry condition. *Achyranthes aspera* is commonly found in the district. Smith (1981) reported that *A. aspera* grow from sea level up to 900 m. Similarly, *Chenopodium album* is found mainly in crop fields. Glemnitz *et al.*, (2000) reported *Chenopodium album* from agricultural fields throughout Europe independently of climatic conditions. Some weeds are causing great concern in many parts of this district. *Ageratum conyzoides* is expanding at an alarming rate, especially in agricultural fields, road sides and even gardens. The weed is harmful to native species and has become a problem in agroecosystems (Negi and Hajra, 2007). *Eichornia crassipes* is of most nuisance as it causes hindrance by choking all possible water bodies and reducing their utility (Cilliers, 1991). Similarly, *Lantana camara* is spreading fast all over the district due to its better competitive ability and allelopathic effect (Sundaram and Hiremath, 2012). *Mikania micrantha* which is a fast growing species, is covering the habitats of the district and suppressing the growth of agricultural crops as well as natural vegetation through competition and allelopathic effects (Huang *et al.*, 2009). *Parthenium hysterophorus*, a dominant weed of the study area, especially in wastelands, roadsides, railway tracks and foot paths, is an aggressive colonizer spreading rapidly suppressing native herbaceous flora. This weed is reported to be allergenic causing respiratory problems, dermatitis and asthma (Raghubanshi *et al.*, 2005).

A number of weeds reported from the study area (40.8%) are used by local people in traditional medicines for their primary health care. For instance, burned root ashes of *Achyranthes aspera* L. are applied topically to reduce the pain of the skin infected with worms as well as to expel the dead worms out. Warmed leaves of *Amaranthus spinosus* are applied locally to cure boils and burns. Fresh leaf paste of *Argemone mexicana* is applied topically to treat eczema. Decoction of whole plant of *Boerhavia diffusa* is used to treat leucorrhoea. Juice of *Cynodon dactylon* is used to stop nose bleeding. Latex of *Euphorbia hirta* is effective for healing of wounds. *Glinus oppositifolius* is used either in raw or cooked form to cure various types of skin disease like scabies, itches etc. *Mimosa pudica* roots are chewed for toothache. Rhizome paste of *Nymphaea nouchali* is administered to regulate menstruation. Tender twig of *Phyllanthus amarus* is used to cure dysentery. Leaf decoction of *Tephrosia purpurea* is prescribed to women against post natal complications. Decoction of *Tridax procumbens* leaf is applied topically on the boils, cuts, sores, wounds and eczema to promote healing. Crushed tuber powder of *Cyperus rotundus* is taken orally for jaundice. The present finding draws support from the studies of Panda *et al.* (2014) and Mishra (2017). A number of weeds such as *Alternanthera sessilis, Bacopa monneieri, Centella asiatica, Boerhavia diffusa, Commelina benghalensis, Eclipta prostrata, Enydra fluctuans,* and *Hygrophila auriculata* are reported to have both therapeutic and dietary functions and hence are used as medicinal food remedy. This overlap indicates the close relationship between health and food. Overlapping between food and medicines is quite well known in traditional societies (Mishra *et al.*, 2011).

Even though agricultural scientists and extension officers recommends eradicatation of the weeds, 89% of the most widespread and aggressive weeds in the world are edible (Rapoport *et al.*, 1995). Moreover, many of these species have a high nutritional value and medicinal properties (Duke, 1992). The consumption of weeds is a world-wide phenomenon that is noted as having an

important role for human nutrition (Duke, 1992; Turner *et al.*, 2011). In the study area, weeds like *Amaranthus spinosus, Glinus oppositifolius, Ipomoea aquatica, Monochoria hastata, Nymphaea pubescens, Oxalis corniculata, Portulaca oleracea* and *Portulaca quadrifida* are used for edible purposes by the local inhabitants. The weed species in the present study contained approximately 27.5% fodder plants which are supported by Marcelino *et al.* (2005). A good number of artifact items and household articles are prepared from *Aeschynomene aspera, Cyperus alopecuroides* and *Vetiveria zizanioides* by the artisans of the district. Similar observations have also been made in earlier studies (Tripathy *et al.*, 2014).

This paper provides a comprehensive documentation of the weed diversity of Bhadrak district along with their socio-economic values.Most plant species of the study area are of considerable ecological and economic importance, useful as bioresources to wild fauna and human beings. In contrast, some species recorded from this area are considered to be troublesome as they are invasive and weedy with rapid distribution; and the natural vegetation will be replaced by weeds in few years. Bhadrak district, like other areas of India, is developing rapidly, and this development has the potential to put the natural ecosystem under stress through increased human activities such as modern farming (application of fertilizers, irrigation and chemical spray), housing, road construction, and overgrazing; and this would lead to the loss of native species. For these reasons, additional research should be conducted to evaluate the intrinsic ecological values of the local flora and to incorporate characteristics of species composition with ecological functions will provide a baseline for planning and proper conservation measures to safeguard phytodiversity which is facing ever growing biotic stress.

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(Manuscript received on 19 August 2019; revised on 18 May 2020)