



Aquatic angiosperms of Bonai Forest Division, Sundargarh district, Odisha

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ABSTRACT

The Bonai Forest Division of Sundargarh district is situated between 21°39'-22°8' N and 84°30'-85°23' E towards the North-western boundary of the state of Odisha. The forest division spreads over an area of 2934.21 sq. km. The edaphic and climatic conditions of Bonai provide ideal habitats for a variety of aquatic life forms. During the floristic survey of Bonai forest division, a total of 125 aquatic, semi-aquatic and wetland species belonging to 77 genera under 33 families were recorded. Cyperaceae and Poaceae were the dominant families with 34 and 14 aquatic species respectively in the study area. Present investigation revealed that forests of Bonai in Sundargarh district harbour rich wetland plant diversity and documentation and conservation of these resources is the need of the hour.

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1. Introduction

Aquatic plants play vital role in the primary productivity of aquatic ecosystems. These plants have been used for various purposes mainly for food, fodder, fibre and medicine since historical times. The major habitats for the aquatic plants of Bonai forest division are ponds, pools, seasonal puddles, rivers and streams. Besides, several low-lying rice fields and ditches along roads are scattered throughout the forest division which form good habitats for aquatic plants. Currently, aquatic habitats face tremendous anthropogenic pressures such as large scale change in land use pattern and improper use of wetlands, which in turn greatly influence the aquatic biodiversity (Prasad *et al.*, 2002). Therefore, there is an urgent need to record and assess the diversity of aquatic plants and their habitats in Bonai forest division before they vanish for ever.

2. Study Area

The Bonai forest division is situated between 21°39'-22°8'N and 84°30'-85°23' E towards the North-western

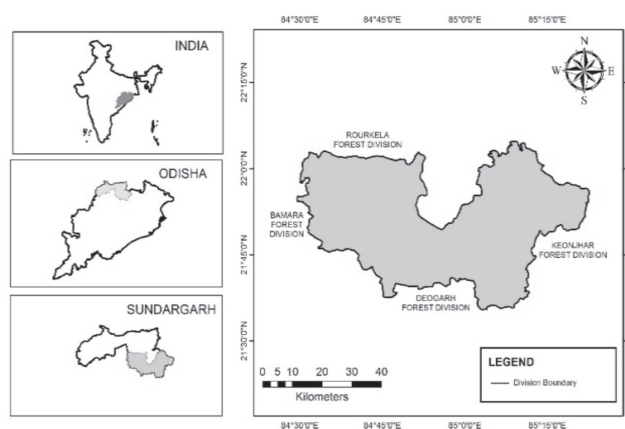


Fig. 1: Location map of Bonai Forest Division, Odisha

boundary of the state of Odisha. The forest division spreads over an area of 2934.21 sq. km of Sundargarh district. It is bounded on the North by Jharkhand State and Rourkela forest division. On the east, it is bounded by Keonjhar forest division and Deogarh forest division. On the west and south it is surrounded by Bamra forest division and Deogarh forest

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division. There are seven forest ranges in this division namely Bonai, Kuliposh, Tamra, Jarda, Sole, Barsuan and Koira. The forest division is part of the Chotanagpur plateau of Deccan Peninsular Biogeographic zone (Rodgers and Panwar, 1988).

3. Botanical Exploration: Past & Present

Haines (1921-25), the pioneer plant explorer of the state provided very scanty information about the flora of Sundargarh district as well as forests of Bonai. Later, Mooney (1950), Saxena & Brahmam (1994-96), Misra (2004) have contributed significantly to the flora of the region. Taxonomy and ecology of aquatic plants of India are well documented (Agarkar, 1923; Biswas & Calder, 1937; Subramanyam, 1974; Gupta, 1979; Lavania *et al.*, 1990), whereas studies on wetland plants of Odisha have been carried out by several workers (Choudhury & Patnaik, 1985; Choudhury & Choudhury, 1996; Pal & Nimse, 2006; Misra *et al.*, 2012; Subhadarsini *et al.*, 2016). However, some workers (Acharya *et al.*, 2010; Mallick *et al.*, 2015) have carried out floristic studies of Rourkela of Sundargarh district. Realizing the meagerness of the floristic work done for the district and considering the phyto-geographical and ethnobotanical importance of plant resources of this region, an inventory of flora of Sundargarh district has been undertaken since 2015 and the present work on aquatic angiosperms of Bonai Forest Division is a part of the study, which documents the rich aquatic plant biodiversity of a forest division of Sundargarh district.

4. Materials and methods

The present work was the outcome of the extensive survey of flora in and around rivers, rivulets, streams, waterfalls, ponds, pools, seasonal puddles, rice fields and other wetlands of Bonai forest division during the period December, 2015 to November, 2017. The entire forest division was covered in different months of the year to record the seasonal variation in plant diversity. All the species of aquatic plants were collected and detailed field notes were recorded in the field, which includes field number, date of collection, locality, habitat, phenology, local name, uses and the macroscopic characters which cannot be revealed from the dried specimens. Four samples of a species were carefully collected so as to include all possible types of variations. For the preservation of the specimens, standard guidelines were followed with little modification, wherever required. The specimens were identified with the help of relevant floras (Haines, 1921-25; Mooney, 1950; Saxena & Brahmam, 1994-96). Some doubtful specimens were taken to Central National Herbarium (CNH), Howrah and were matched with authentic materials available there. Up-to-date

nomenclature of plants was determined in consultation with different floras, monographs, revisions, The Plant List and IPNI databases. All the specimens were deposited in the Herbarium of the P.G. Department of Botany, North Orissa University, Baripada.

In the present study aquatic plants were classified depending upon their habitat, relation with water, soil, air and light.

Free floating: Commonly seen in stagnant water bodies, slow flowing water and are in contact with only water, air and light. Such species typically float on water surface with extensive root system. Very often these species occur in pure communities and completely cover up the water surface where favourable condition exists.

Submerged: Generally, in such species the foliage is entirely submerged, conduct with soil or rock but their reproductive parts are raised slightly above the water level.

Fixed floating: These types of plants are in contact with soil, water and air. Some of the plants occur on soft wet muddy substratum or root in water surface and are in contact with soil, water and air, even after the substratum is considerably dried up.

Amphibious: Commonly occur on exposed or submerged soils where the water table is beneath the soil surface. These plants are adopted to sustain in both aquatic and terrestrial modes of life. The aerial parts of these amphibious hydrophytes are with mesophytic characters and submerged part shows true hydrophytic characters. Many of these thrive well even after the substratum is considerably dried up.

Marshy: These are also known as border line plants and the soil is usually saturated with water at least in the early part of the plant life. They are frequently observed with in wet rice fields, bank of water bodies, wet areas near human habitation, along hill swamps and streams forests.

5. Results and discussion

As a result of intensive survey, we have collected 125 species of aquatic and semi-aquatic plants belonging to 77 genera under 33 families. Out of these monocots were represented by 68 species under 38 genera and 10 families, while 57 species under 39 genera and 23 families constituted the dicot flora. Besides, there were 78 species of marshy plants belonging to 41 genera and 16 families. Twenty six (26) species were amphibious in nature. Apart from these, fixed floating, submerged and free floating aquatics were represented by 8, 7 and 6 species respectively.

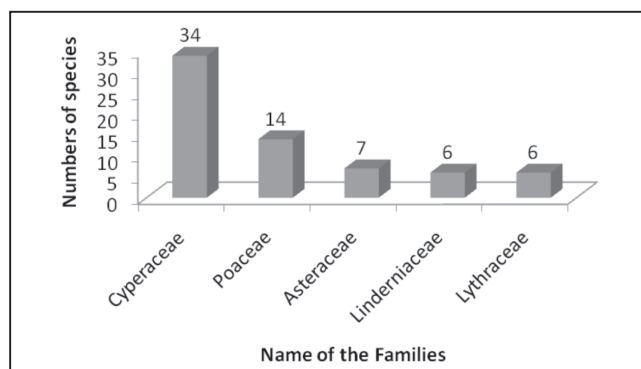


Fig. 2: Five dominant families of aquatic plants of Bonai Forest Division in terms of species content

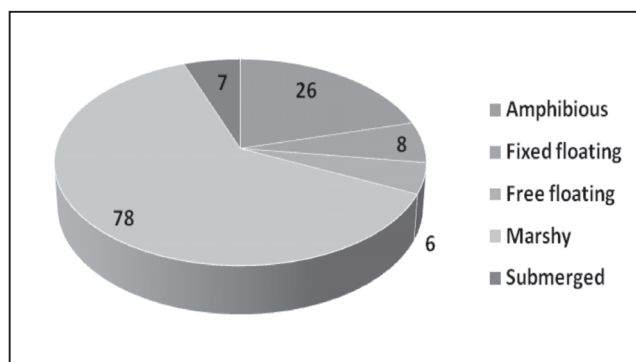


Fig. 3: Habitat wise distribution of aquatic plants in Bonai Forest Division

Cyperaceae with 34 species was the most speciose family followed by Poaceae with 14 species, Asteraceae with 7 species and Linderniaceae and Lythraceae with 6 species each. The five dominant families in terms of species content are shown in Fig.-2. The habitat -wise distribution

of species is represented in Fig.-3. The enumeration of aquatic plant species with up-to-date nomenclature, family name and habitat types are given in Table-1 and statistical analysis of flora of Bonai Forest Division is provided in Table-2.

Table 1

List of aquatic plants of Bonai Forest Division with family name and habitat

Sl.No	Botanical Name	Family	Habitat
1	<i>Acmella paniculata</i> (Wall. ex DC.) R.K.Jansen	Asteraceae	Marshy
2	<i>Actinoscirpus grossus</i> (L.f.) Goetgh. & D.A.Simpson	Cyperaceae	Amphibious
3	<i>Aeschynomene aspera</i> L.	Leguminosae	Amphibious
4	<i>Aeschynomene indica</i> L.	Leguminosae	Amphibious
5	<i>Alloteropsis cimicina</i> (L.) Stapf	Poaceae	Amphibious
6	<i>Alternanthera sessilis</i> (L.) R.Br. ex DC.	Amaranthaceae	Amphibious
7	<i>Ammannia baccifera</i> L.	Lythraceae	Marshy
8	<i>Ammannia multiflora</i> Roxb.	Lythraceae	Marshy
9	<i>Aponogeton natans</i> (L.) Engl. & K.Krause	Aponogetonaceae	Submerged
10	<i>Bacopa monnieri</i> (L.) Wettst.	Plantaginaceae	Marshy
11	<i>Blyxa echinosperma</i> (C.B.Clarke) Hook.f.	Hydrocharitaceae	Submerged
12	<i>Brachiaria distachya</i> (L.) Stapf	Poaceae	Marshy
13	<i>Centella asiatica</i> (L.) Urb.	Apiaceae	Marshy
14	<i>Centranthera indica</i> (L.) Gamble	Orobanchaceae	Marshy
15	<i>Ceratophyllum demersum</i> L.	Ceratophyllaceae	Submerged
16	<i>Chrysopogon zizanioides</i> (L.) Roberty	Poaceae	Marshy
17	<i>Colocasia esculenta</i> (L.) Schott	Araceae	Amphibious
18	<i>Commelina benghalensis</i> L.	Commelinaceae	Marshy
19	<i>Commelina erecta</i> L.	Commelinaceae	Marshy
20	<i>Commelina paludosa</i> Blume	Commelinaceae	Marshy
21	<i>Cyathocline purpurea</i> (Buch.-Ham. ex D. Don) Kuntze	Asteraceae	Amphibious
22	<i>Cyperus cephalotes</i> Vahl	Cyperaceae	Submerged

Sl.No	Botanical Name	Family	Habitat
23	<i>Cyperus compressus</i> L.	Cyperaceae	Marshy
24	<i>Cyperus difformis</i> L.	Cyperaceae	Marshy
25	<i>Cyperus diffusus</i> Vahl.	Cyperaceae	Marshy
26	<i>Cyperus distans</i> L.f.	Cyperaceae	Marshy
27	<i>Cyperus imbricatus</i> Retz.	Cyperaceae	Marshy
28	<i>Cyperus involucratus</i> Rottb.	Cyperaceae	Marshy
29	<i>Cyperus iria</i> L.	Cyperaceae	Marshy
30	<i>Cyperus nutans</i> Vahl	Cyperaceae	Marshy
31	<i>Cyperus paniceus</i> (Rottb.) Boeckeler	Cyperaceae	Marshy
32	<i>Cyperus pilosus</i> Vahl	Cyperaceae	Marshy
33	<i>Cyperus platystylis</i> R.Br.	Cyperaceae	Marshy
34	<i>Cyperus procerus</i> Rottb.	Cyperaceae	Marshy
35	<i>Cyperus rotundus</i> L.	Cyperaceae	Marshy
36	<i>Cyperus squarrosus</i> L.	Cyperaceae	Marshy
37	<i>Cyperus tenuispica</i> Steud.	Cyperaceae	Marshy
38	<i>Dentella repens</i> (L.) J.R.Forst. & G.Forst.	Rubiaceae	Marshy
39	<i>Dopatrium junceum</i> (Roxb.) Buch.-Ham. ex Benth.	Plantaginaceae	Marshy
40	<i>Echinochloa colona</i> (L.) Link	Poaceae	Marshy
41	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	Marshy
42	<i>Eichhornia crassipes</i> (Mart.) Solms	Pontederiaceae	Free floating
43	<i>Eleocharis congesta</i> D.Don	Cyperaceae	Marshy
44	<i>Eleocharis dulcis</i> (Burm.f.) Trin.ex Hensch.	Cyperaceae	Marshy
45	<i>Emilia sonchifolia</i> (L.) DC. ex DC.	Asteraceae	Marshy
46	<i>Enydra fluctuans</i> DC.	Asteraceae	Amphibious
47	<i>Eragrostis ciliaris</i> (L.) R.Br.	Poaceae	Marshy
48	<i>Eragrostis pilosa</i> (L.) P.Beauv.	Poaceae	Marshy
49	<i>Eragrostis unioides</i> (Retz.) Nees ex Steud.	Poaceae	Marshy
50	<i>Eriocaulon quinquangulare</i> L.	Eriocaulaceae	Amphibious
51	<i>Fimbristylis aestivalis</i> Vahl	Cyperaceae	Marshy
52	<i>Fimbristylis dichotoma</i> (L.) Vahl	Cyperaceae	Marshy
53	<i>Fimbristylis littoralis</i> Gaudich.	Cyperaceae	Marshy
54	<i>Fimbristylis quinquangularis</i> (Vahl) Kunth	Cyperaceae	Marshy
55	<i>Floscopa scandens</i> Lour.	Commelinaceae	Marshy
56	<i>Fuirena ciliaris</i> (L.) Roxb.	Cyperaceae	Marshy
57	<i>Glinus oppositifolius</i> (L.) Aug.DC.	Molluginaceae	Marshy
58	<i>Gnaphalium polycaulon</i> Pers.	Asteraceae	Marshy
59	<i>Homonoia riparia</i> Lour.	Euphorbiaceae	Amphibious
60	<i>Hydrilla verticillata</i> (L.f.) Royle	Hydrocharitaceae	Submerged
61	<i>Hydrocotyle sibthorpioides</i> Lam.	Araliaceae	Marshy
62	<i>Hydrolea zeylanica</i> (L.) Vahl	Hydroleaceae	Amphibious
63	<i>Hygrophila auriculata</i> (Schumach.) Heine	Acanthaceae	Amphibious

Sl.No	Botanical Name	Family	Habitat
64	<i>Ipomoea aquatica</i> Forssk.	Convolvulaceae	Fixed floating
65	<i>Ipomoea carnea</i> Jacq.	Convolvulaceae	Marshy
66	<i>Ipomoea pes-caprae</i> (L.) R. Br.	Convolvulaceae	Marshy
67	<i>Isachne globosa</i> (Thunb.) Kuntze	Poaceae	Marshy
68	<i>Kyllinga brevifolia</i> Rottb.	Cyperaceae	Marshy
69	<i>Lasia spinosa</i> (L.) Thwaites	Araceae	Marshy
70	<i>Leersia hexandra</i> Sw.	Poaceae	Marshy
71	<i>Limnophila aquatica</i> Alston	Plantaginaceae	Amphibious
72	<i>Limnophila indica</i> (L.) Druce	Plantaginaceae	Amphibious
73	<i>Lindernia anagallis</i> (Burm.f.) Pennell	Linderniaceae	Marshy
74	<i>Lindernia antipoda</i> (L.) Alston	Linderniaceae	Marshy
75	<i>Lindernia ciliata</i> (Colsm.) Pennell	Linderniaceae	Marshy
76	<i>Lindernia crustacea</i> (L.) F.Muell.	Linderniaceae	Marshy
77	<i>Lindernia procumbens</i> (Krock.) Philcox	Linderniaceae	Marshy
78	<i>Lindernia rotundifolia</i> (L.) Alston	Linderniaceae	Marshy
79	<i>Lipocarpha chinensis</i> (Osbeck) J.Kern	Cyperaceae	Marshy
80	<i>Lipocarpha gracilis</i> (Rich. ex Pers.) Nees	Cyperaceae	Marshy
81	<i>Lippia javanica</i> (Burm.f.) Spreng.	Verbenaceae	Marshy
82	<i>Ludwigia adscendens</i> (L.) H.Hara	Onagraceae	Fixed floating
83	<i>Ludwigia octovalvis</i> (Jacq.) P.H.Raven	Onagraceae	Fixed floating
84	<i>Monochoria hastata</i> (L.) Solms	Pontederiaceae	Amphibious
85	<i>Monochoria vaginalis</i> (Burm.f.) C.Presl	Pontederiaceae	Amphibious
86	<i>Nelumbo nucifera</i> Gaertn.	Nymphaeaceae	Fixed floating
87	<i>Nymphaea nouchali</i> Burm.f.	Nymphaeaceae	Fixed floating
88	<i>Nymphaea pubescens</i> Willd.	Nymphaeaceae	Fixed floating
89	<i>Nymphoides hydrophylla</i> (Lour.) Kuntze	Menyanthaceae	Fixed floating
90	<i>Nymphoides indica</i> (L.) Kuntze	Menyanthaceae	Fixed floating
91	<i>Oldenlandia corymbosa</i> L.	Rubiaceae	Marshy
92	<i>Oryza rufipogon</i> Griff.	Poaceae	Marshy
93	<i>Ottelia alismoides</i> (L.) Pers.	Hydrocharitaceae	Submerged
94	<i>Panicum repens</i> L.	Poaceae	Marshy
95	<i>Paspalidium flavidum</i> (Retz.) A.Camus	Poaceae	Marshy
96	<i>Persicaria barbata</i> (L.) H.Hara	Polygonaceae	Amphibious
97	<i>Persicaria glabra</i> (Willd.) M.Gómez	Polygonaceae	Amphibious
98	<i>Persicaria hydropiper</i> (L.) Delarbre	Polygonaceae	Amphibious
99	<i>Phyla nodiflora</i> (L.) Greene	Verbenaceae	Marshy
100	<i>Pistia stratiotes</i> L.	Araceae	Free floating
101	<i>Polygonum plebeium</i> R.Br.	Polygonaceae	Amphibious
102	<i>Pycnus flavidus</i> (Retz.) T.Koyama	Cyperaceae	Marshy
103	<i>Pycnus polystachyos</i> (Rottb.) P.Beauv.	Cyperaceae	Marshy
104	<i>Pycnus pumilus</i> (L.) Nees	Cyperaceae	Marshy

Sl.No	Botanical Name	Family	Habitat
105	<i>Pycnus puncticulatus</i> (Vahl) Nees	Cyperaceae	Marshy
106	<i>Pycnus sanguinolentus</i> (Vahl) Nees	Cyperaceae	Marshy
107	<i>Rotala indica</i> (Willd.) Koehne	Lythraceae	Marshy
108	<i>Rotala mexicana</i> Schltld. & Cham.	Lythraceae	Marshy
109	<i>Rotala rotundifolia</i> (Buch.-Ham. ex Roxb.) Koehne	Lythraceae	Marshy
110	<i>Rotula aquatica</i> Lour.	Boraginaceae	Marshy
111	<i>Sacciolepis indica</i> (L.) Chase	Poaceae	Marshy
112	<i>Sacciolepis interrupta</i> (Willd.) Stapf	Poaceae	Marshy
113	<i>Sagittaria guayanensis</i> Kunth	Alismataceae	Amphibious
114	<i>Schoenoplectiella articulata</i> (L.) Lye	Cyperaceae	Amphibious
115	<i>Scleria terrestris</i> (L.) Fasset	Cyperaceae	Marshy
116	<i>Sesbania bispinosa</i> (Jacq.) W.Wight	Leguminosae	Amphibious
117	<i>Smithia conferta</i> Sm.	Leguminosae	Amphibious
118	<i>Smithia sensitiva</i> Aiton	Leguminosae	Amphibious
119	<i>Spirodela polyrrhiza</i> (L.) Schleid.	Araceae	Free floating
120	<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	Marshy
121	<i>Trapa natans</i> L.	Lythraceae	Free floating
122	<i>Typha domingensis</i> Pers.	Typhaceae	Amphibious
123	<i>Utricularia aurea</i> Lour.	Lentibulariaceae	Free floating
124	<i>Vallisneria natans</i> (Lour.) H. Hara	Hydrocharitaceae	Submerged
125	<i>Wolffia arrhiza</i> (L.) Horkel ex Wimm.	Araceae	Free floating

Table 2

Statistical analysis of aquatic flora of Bonai Forest Division.

Groups	Dicots		Monocots		Total
	Number	Percent	Number	Percent	
Families	23	69.6%	10	30.3%	33
Genera	39	50.6%	38	49.3%	77
Species	57	45.6%	68	54.4%	125

The ecological classification of aquatic plants presented here is, to some extent, arbitrary and has been followed only for convenience and to depict the habit and habitat of the taxa. The hydrophytes sometimes show plasticity in their phenotypes and adaptability to a wide range of habitats. During rainy season, when water is plenty the species like *Ipomoea aquatica*, *Enydra fluctuans*, *Ipomoea aquatica* form floating mats but when the water bodies dry up, these species establish themselves in the wet soil and continue to grow as terrestrial plants. At times, some species such as *Eichhornia crassipes* and *Monochoria hastata* are found as emergent amphibious plants and *Hydrilla verticillata* as suspended

submerged hydrophytes. Thus, several species change their survival strategy to adapt to available ecological conditions.

However, majority of the species reported in this work fall under the category of marshy and amphibious types, indicating that the margin of the water bodies and river banks form ideal habitats for luxuriant growth of amphibious species. The true hydrophytes are considerably less in number.

6. Conclusion

The Bonai Forest Division was found to be a rich habitat for aquatic angiosperms and have a number of local use

values such as medicine, fodder and leafy vegetables. Further, they help in maintaining the ecosystem by providing habitats for a wide variety of water birds and wild animals. The present study provides first-hand field level information on aquatic angiosperms of Bonai, which will be helpful in compilation of biodiversity database of this forest division and identify species needing conservation action.

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