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Seasonal Exploration, Identification and Documentation of the Distribution and Abundance of Hydrophytic, marshy and amphibious flora found in Keonjhar district, Odisha, India

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ABSTRACT: Vegetation of an area plays an important role in controlling pollution level from the environment. Pollution due to mining is a major threat for open cast mining areas. Keonjhar district of Odisha is one of the polluted areas due to mining. Hence, the objective of this paper is to Seasonal Exploration, Identification and Documentation of the Distribution and Abundance of Hydrophytic, marshy and amphibious flora found in Keonjhar district, Odisha, India using appropriate standard techniques. Data obtained show that Out of which a total of 122 hydrophytic, marshy and amphibious plant species were identified which belong to 41 families. Amongst the genera, *Cyperus* is dominant having maximum number of species followed by *Polygonum*, *Brachiaria*, *Fimbristylis* and *Commelina*. So far as the hydrophytic types concerned 12 species are rooted floating, 7 free floating, 4 floating submerged, 2 rooted submerged and the rest 97 species are found to be amphibious. The results also revealed that *Eichhornia crassipes* (Mart.) Solms, *Salvinia cucullata* Roxb. ex Bory, *Salvinia molesta* D. Mitch., *Pistia stratiotes* L. and *Spirodella polyrhiza* (L.) Schleiden are the dominant floating species along with a wild grass namely *Typha angustata* Bory & Chaub. having a large population in the area under study.

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Mining is any activity that involves excavating the earth surface for the purpose of exploiting its mineral wealth. This could be for local economic and industrial development or for export purposes (David, 2002). The presence of mine has led to economic development and also has adverse environmental impacts on atmosphere, hydrosphere, lithosphere as well as biosphere. Mining plays a role like two sides of a coin, on one hand it improves socioeconomic conditions whereas on other hand it causes adverse environmental impacts (Arzoo et.al., 2016). As socioeconomic development of a country is possible due to mining, the way should be found to reduce the impact on the environment. Wetlands are potentially rich in aquatic resources, which play a significant role in maintaining biodiversity. They offer habitats suitable for supporting growth of a variety of aquatic vegetation called hydrophytes which are adapted to live in aquatic environments (Hazarika and Borthakur, 2012). Wetlands are also transitional lands between terrestrial and aquatic ecosystems where the water table is usually at or near the surface of the land

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and is covered by shallow water (Mitsch and Gosselink, 1986). In India it occupies 58.2 million hectares (Sukumaran and Jeeva, 2011). Aquatic plants play a vital role in the form of trapping solar energy and in determining the primary productivity of aquatic systems (Mohapatra et.al., 2007). Mining pollution can be controlled by proper management of natively found vegetation. In this study an exhaustive survey of vegetation cover specially diversity of hydrophytic, marshy and amphibious flora of mining area of Keonjhar district was undertaken. Keonjhar is part of the Singhbhum-Keonjhar-Banei iron belt. This belt stretches about 50 km and around 14.5 km lies within Kendujhar District. Daitari hills that border Kendujhar and Jajpur district are home to high grades of Iron ore. Odisha Mining Corporation along with TISCO and Bolani Mines Private Ltd run iron ore mines in Kendujhar. In addition there are many medium and small scale mining operations in the Barbil/Joda area. Keonjhar also has abundant manganese and Chromite deposits. Kendujhar supplies around 80% of Odisha's manganese production. The manganese mines are at Banspani, Barbil and Barjamda while the Chromite mines are at Baula, Nuasahi and Phulinjhorhuli (Das, 2017). Hence, the objective of this paper is to Seasonal Exploration, Identification and Documentation of the Distribution and Abundance of Hydrophytic, marshy and amphibious flora found in Keonjhar district, Odisha, India

MATERIALS AND METHODS

It was carried out at different seasons of the academic year 2021-2022 to explore, identify and document the distribution and abundance of diverse plant groups especially hydrophytic, marshy and amphibious forms. The study involved extensive field visit to the mining area at frequent intervals in different seasons. For the convenience of plant specimen collection, the study area was artificially divided into different geographical zone and each zone was visited several times in different seasons. Plant specimens were mostly collected while the representative mother plants were experiencing the state of flowering and fruiting as it became easy to ascertain the exact identification of the species bearing reproductive features. The specimens were collected in sets of 3 with a field number to choose the best specimen for making herbarium. Customary procedures were followed for the preparation of herbarium for long term preservation as well as for further study and reference. The specimen were identified following 'The Botany of Bihar and Orissa' and 'The Flora of Orissa' host of recent monographs and reviews (Haines, 1921).

RESULTS AND DISCUSSION

During the floristic exploration, a total of 122 hydrophytic, marshy and amphibious plant species were identified which belong to 41 families (Tables 1 to 4). Amongst the genera, *Cyperus* is dominant having maximum number of species followed by *Polygonum*, *Brachiaria*, *Fimbristylis* and *Commelina*. So far as the hydrophytic types concerned 12 species are rooted floating, 7 free floating, 4 floating submerged, 2 rooted submerged and rest 97 species are found to be of amphibious. The results also revealed that *Eichhornia crassipes* (Mart.) Solms, *Salvinia cucullata* Roxb. ex Bory, *Salvinia molesta* D. Mitch., *Pistia stratiotes* L. and *Spirodella polyrhiza* (L.) Schleiden are the dominant floating species along with a wild grass namely *Typha angustata* Bory & Chaub. having large population in the area under study. Similar type of vegetations were also found from a survey report of eastern region of Odisha which were carried out and reported a good number of aquatic and marshy plants (Chand *et al.,* 2009; Satpathy *et al.,* 2012; Satpathy, 2015; Nayak and Satpathy, 2015; Noor *et al.,* 2015).

Table 1: List of amphibious flora of the Study sites

Sl. No	Botanical name	Vernacular name(s)
Family: Acanthaceae		
1	*Hygrophila auriculata* (Schum.) Heine	Baripriya, Koilikhia (O); Bhankari(H); Marsh Barbel (E)
2	*Hygrophila heini* Sreemadh	AnupaBaripriya (O)
Family: Apiaceae		
3	*Centella asiatica* (L.) Urban	Thalkudi, Hatee kojia patra (O); Coinwort, Indian Pennywort, Spade leaf (E)
4	*Hydrocotyle sibthorpioides* Lam.	Hastee pada (O); Lawn marsh pennywort (E)
Family: Asteraceae		
5	*Eclipta prostrata* (L.) L.	Bhrungaraj, Kesharaj, Keshadura (O); False daisy (E)
6	*Enydra fluctuans* Lour.	Hidmichi, Madhurango (O); Water cress (E)
7	*Synedrella nodiflora* (L.) Gaertn.	Hemagrapuspi (O); Node weed (E)
Family: Balsaminaceae		
8	*Hydrocera trifolia* (L.)Wt & Arn.	Jalashrungi (O); Domuti (Beng); Marsh henna, Floating Balsam (E)
Family: Lythraceae		
9	*Ammania baccifera* L.	Mula Kurandica (O); Kurandica (San); Dadamari (H);

		Blistering ammannia (E)
10	*Ammania multiflora* Roxb.	Bahu Kurandica (O); Many Flowered Ammannia (E).
11	*Rotala indica* (Willd.) Koehne in Engl.	Deshee Chakrabala (O);Indian toothcup (E).
12	*Rotala rotundifolia* (Buch.-Ham. ex Roxb.) Koehne	Chakri Chakrabala (O); Roundleaf toothcup (E); Sim-sindur (S).
Family: Onagraceae		
13	*Ludwigia adscendens* (L.) Hara	Jala Bila Labanga(O); Water primrose (E)
14	*Ludwigia perennis* L.	Kshudra Bila Labanga (O); Perrenial water Primrose (E)
Family: Molluginaceae		
15	*Glinus oppositifolius* (L.) DC.	Sweta Pitagahama (O); Jima (Beng, H.); Lonely traveler (E)
16	*Mollugo pentaphylla* L.	Pita saga (O); Khet papara ,Jul papara (Beng); Five leaved carpetweed (E)
Family: Rubiaceae		
17	*Dentella repens* (L.) J.R. & G. Forst.	Shubhra taraka(O);Creeping Dentella (E)
18	*Mitracarpus villosus* (Sw.) DC.	Abrutaphala (O); Girdle pod (E)
Family: Oxalidaceae		
19	*Oxalis corniculata* L.	Ambiliti, Kumari (O); Changeri, Chukrika(San); Amrul sak, Chukutri pati (H); Creeping Wood Sorrel (E)
Family: Hydrophyllaceae		
20	*Hydrolea zeylanica* (L.) Vahl	Shyamataraka (O); Koliary (H); Ceylon Hydrolea (E)
Family: Scrophulariaceae		
21	*Limnophila heterophylla* (Roxb.) Benth.	Bisami Jalalovi (O)
22	*Limnophila indica* (L.) Druce	DesiJalalovi (O); Ambujah (San); Indian marshwood (E)
23	*Lindernia anagallis* (Burm.f.) Pennell.	Bhramapadee (O);Brittle false pimpernel (E)
24	*Lindernia crustacea* (L.) F.v. Muell.	Khetakurei (O); Malayasian false pimpernel (E)
25	*Mazus pumilus* (Burm. f.) steenis	Ankurika (O); Asian mazus (E)
26	*Mecardonia procumbens* (Mill.) Small.	Pinjala puspa (O);Baby jump up (E)
Family: Verbenaceae		
27	*Lippia javanica* (Burm.f.) Spreng.	Gandhapatali (O); Lemon Bush(E)
28	*Phyla nodiflora* (L.) Greene	Jalapippali (O); Bhuiokra (H);Frog Fruit (E)
Family: Amaranthaceae		
29	*Alternanthera philoxeroides* (C.Martius) Griseb.	Agra meenakshi,Bada madaranga (O); Alligator weed (E).
30	*Alternanthera sessilis* (L.) R.Br. ex DC.	Desi madaranga saga (O); Sessile Joyweed (E)
Family: Polygonaceae		
31	*Polygonum barbatum* L.	Romi bahukoni (O);Bekh-unjubaz (Beng.); Knotgrass (E)
32	*Polygonum lapathifolium* L.	Patri bahukoni (O);Curlytop knotweed (E)
33	*Polygonum minus* Huds.	krushi bahukoni (O);Pygmy Smartweed (E)
34	*Polygonum pulchrum* Bl.	Tari bahukoni (O)
Family: Euphorbiaceae		
35	*Phyllanthus fraternus* Webster	Badi aenla (O); Bhumyaamlaki (San); Gulf leaf flower (E)
Family: Commelinaceae		
36	*Commelina attenuta* Koenig ex Vahl	Sthuli kansiri(O).
37	*Commelina benghalensis* L.	Kanisiri (O); Kosapuspi (San); Bengal Day Flower (E)
38	*Commelina diffusa* Burm.f.	Nagna kanisiri (O); Spreading Day Flower (E).
39	*Commelina erecta* L.	Sidha Kansiri (O); White mouth day flower(E)
40	*Cyanotis cristata* (L.) D. Don	Chuli Neelima (O)
41	*Murdannia spirata* (L.) Brueck.	Kundali Shyamashova (O); Asiatic Dew Flower (E)
42	*Tonningia axillaris* (L.) Kuntze	Godhuli (O);Creeping Cradle Plant (E)
Family: Typhaceae		
43	*Typha angustata* Bory & Chaub.	Marjarapuchha (O); Lesser Indian Reed Mace (E)
Family: Araceae		
44	*Alocasia macrorrhizos* (L.) G. Don	Manasaru (O); Manna (H); Giant taro (E)
45	*Colocasia esculenta* L.	Saru (O), Green Taro, cocoyam, taro(E)
Family: Eriocaulaceae		
46	*Eriocaulon quinquangulare* L.	Sweta bitanica (O); Phurki (Beng).
Family: Cyperaceae		
47	*Cyperus alopecuroides* Rottb.	Berua (O); Foxtail flatsedge (E)
48	*Cyperus articulatus* L.	Sandhi mutha (O)
49	*Cyperus brevifolius* (Rottb.) Hassk.	Harit mutha (O)
50	*Cyperus cuspidatus* Kunth	Ankusha mutha (O)
51	*Cyperus diffusus* Vahl	Prasari mutha (O)
52	*Cyperus rotundus* L.	Mutha (O); coco grass, nutgrass, purple nutsedge (E)
53	*Eleocharis acutangula* (Roxb.) Schult. & Schult.f.	Randhri anupashova (O)
54	*Eleocharis dulcis* (Burm.f.) Hensch.	Harit Anupashova (O);Chinese Water Chestnut (E)
55	*Fimbristylis aestivalis* (Retz.) Vahl	Barsidantasalaka (O); Summer Fimbry (E)
56	*Fimbristylis argentea* (Rottb.) Vahl	Rajat dantashalaka (O)
57	*Fimbristylis dichotoma* (L.) Vahl,	Kani dantashalaka (O); Bara nirbishi (Beng) ; Summer Fimbry (E)
58	*Fimbristylis miliacea* (L.) Vahl	Shata dantashalaka (O), Bara javani (Beng.)

59	*Fuirena ciliaris* (L.) Roxb.	Pakshya Lomasira (O).
60	*Lipocarpha chinensis* (Osbeck) Kern	Prasari Snehaphala (O).
61	*Scirpus articulatus* L.	Gaichira (O), Pappati chikta (Beng).
62	*Alloteropsis cimicina* (L.) Stapf	KeepaBhinnapakshak (O)
63	*Alloteropsis semialata* (R.Br.) Hitchc.	Pakshya Bhinnapakhyak (O);Cockatoo grass (E).
64	*Bothriochloa pertusa* (L.) A.Camus	Basana (O); Kada chandi ghas (S); Sandhur (H).
65	*Brachiaria distachya* (L.) Stapf.	Pakshya Bahubalaya (O); Korama gaddi (Beng)
66	*Brachiaria miliformis* (J.S.Presl.) Chase	Bahu Bahubalaya (O)
67	*Brachiaria mutica* (Forssk.) Stapf	Abindu Bahubalaya (O)
68	*Brachiaria ramosa* (L.) Stapf	Sakha Bahubalaya (O)
69	*Cynodon dactylon* (L.) Pers.	Duba (O); Durva, Shambhabee (San);
70	*Dactyloctenium aegypticum* (L.) P. Beauv.	Krusamanjari (O); Makra, Makri (H)
71	*Desmostachya bipinnata* (L.) Stapf	Kusa (O); Darbha (San)
72	*Echinochloa colona* (L.) Link	Suanghasa (O); Shama (Beng)
73	*Echinochola stagnina* (Retz.)P.Beauv.	Bada Suan (O)
74	*Eleusine indica* (L.) Gaertn.	Ana mandia (O)
75	*Eragrostis ciliata* (Roxb.) Nees.	Pakhayabha Pritimanjari (O).
76	*Eragrostis unioloides* (Retz.) Nees. ex Steud.	Kambhu Preetimajari (O); Koni (Beng).
77	*Heteropogon contortus* (L.) P. Beauv ex Roem. & Schult.	Shankolika (O); Sauri (M); Saiya (Ho); Saurighas (H).
78	*Hygroryza aristata* (Retz.) Nees ex Wt & Arn.	Jalamuli (O).; Neevara (San)
79	*Oplismenus burmanii* (Retz.) P.Beauv.	Nali Kakapadi (O); Nini (H)
80	*Oryza rufipogon* Griff.	Balunga (O)
81	*Panicum brevifolium* L.	Harit Kurchika (O)
82	*Paspalidium flavidum* (Retz.) A. camus	Romi Bilailangi (O); Sanka (H)
83	*Paspalidium geminatum* (Forssk.) Stapf	Kuji Bilailangi (O)
84	*Paspalum distichum* L.	Dweebahu Kodua (O)
85	*Paspalum scrobiculatum*(L.)Mant.	Kodua Dhana (O); Kodaka (H)
86	*Pennisetum pedicellatum* Trin.	Bruti Pakshyasanku **(**O); Swati(Beng)
87	*Pennisetum purpureum* Schumach	Hastee Pakshyasanku (O);Elephant grass (E).
88	*Pseudoraphis brunoniana* Griff.	Kutasutrika (O); Pseudoraphis (E)
89	*Rottboellia cochinchinensis* (Lour.) Clayton	Agrabhangura (O);Bara swati (Beng.); Barsali (H)
90	*Saccharum spontaneum* L.	Kashatandi (O); Kans (H); Payal (Beng)
91	*Sacciolepsis indica* (L.) Chase	Desi Syutashalka (O);Nardula (Beng)
92	*Sacciolepsis interrupta* (Willd.) Stapf	BandhaSyutashalka(O);Nardula (Beng)
93	*Setaria pumila* (Poir.) Roem. & Schult.	Chhota Shankuja (O); Bandra (H); Pinginatchi (Beng)
94	*Setaria verticillata* (L.) P. Beauv.	Bada Shankuja (O); Silnaja (Beng)
95	*Vetiveria zizanioides* (L.) Nash	Bena (O); Khas-kas (H); Siron (Beng); Vetiver (E)
Family: Pteridaceae		
96	*Pteris vittata* L.	MrudheekaAngu (O); Feather fern(O)
Family: Dryopteridaceae		
97	*Dryopteris cochleata* (D. Don.) C. Chr.	Drumila pakshee (O), Common male fern, Wood fern (E)

Table-2: List of floating submersed and rooted submerged hydrophytic flora of the Study sites

Sl. No	Botanical name	Vernacular name(s)
Family: Haloragaceae		
1	*Myriophyllum tetrandrum* Roxb.	Shahashra Patri (O);Water-mifoils (E)
Family: Lentibulariaceae		
2	*Utricularia stellaris* Lour.	Syutika dala (O); Jhangi (Beng)
Family: Ceratophyllaceae		
3	*Ceratophyllum demersum* L.	Shrunjaparnee Dala (O); Coon's tail (E)
Family: Hydrocharitaceae		
4	*Hydrilla verticillata* (L.f.) Royle	Chingudia dala(O), Indian Stargrass (E)
5	*Ottelia alismoides* (L.) Pers.	Pani kundri (O); Duck lettuce (E)
Family: Najadaceae		
6	*Najas graminea* Del.	Shesanaga dala (O); Ricefield waternymph (E)

Table-3: List of rooted floating hydrophytic flora of the Study sites

Sl. No	Botanical name	Vernacular name(s)
Family: Ranunculaceae		
1	*Ranunculus scleratus*L	Pani Dhania (O); Celery Leafed Crow foot, Cursed Buttercup, Poisonous buttercup, Blister buttercup (E)
Family: Nymphaeaceae		
2	*Nelumbo nucifera* Gaertn.	Padma(O); Lotus, Sacred lotus, East Indian Lotus (E)
3	*Nymphaea pubescens* Willd.	Nalikain, Dhalakain (O); Indian waterlily (E)
Family: Mimosaceae		
4	*Neptunia oleracea* Lour.	Panilajakuli (O); Alambusa(San); Lajalu (H); Pani najak (Beng); Sensitive water plant (E)
Family: Trapaceae		
5	*Trapa natans* L.var *bispinosa* (Roxb.) Makino	Pani singada (O); Shringataka (San); Pani-phal (H); Water chest

		nut (E)
Family: Menyanthaceae		
6	*Nymphoides hydrophylla* (L.) Kuntze	Purna Chandramala (O); Tagarmul (H); Chandmalla (Beng); Crested floating heart (E)
7	*Nymphoides indica* (L.) Kuntze	Chira Chandramala (O); Kumudini (San); Barachuli (H); Panchuli (Beng); Water snowflake (E)
Family: Alismataceae		
8	*Sagittaria trifolia* L.	AnkuDhanushira (O); Muya muya, Chhoto-kut (Beng); Three leaf Arrow head (E)
Family: Potamogetonaceae		
9	*Potamogeton nodosus* Poir.	Ugragandha (O); Long-leaved Pond weed (E).
Family: Aponogetonaceae		
10	*Aponogeton natans* (L.) Engl. & Krause	Teebragandhi (O); Floating lace plant(E)
Family: Marsileaceae		
11	*Marsilea minuta* L.	Chhota sunsunia (O); Water-clover, pepperwort (E)
12	*Marsilea quadrifolia* L.	Sunsunia (O), Water-clover, pepperwort (E)

Table 4: List of free floating hydrophytic flora of the Study sites

Sl. No	Botanical name	Vernacular name(s)
Family: Pontederiaceae		
1	*Eichhornia crassipes* (Mart.) Solms in A.DC.	Bilatidala, (O); Jalakumbhi(San); Jal Kumbhi (H); Kachuripana (Beng); Common water hyacinth(E)
Family: Araceae		
2	*Pistia stratiotes* L.	Borajhanji (O); Water lettuce, Tropical duck-weed (E)
Family: Lemnaceae		
3	*Lemna perpusilla* Torrey	Bataka dala (O); Duck weeds (E).
4	*Spirodella polyrhiza* (L.) Schleiden	Kundalidala (O);Greater Duckweed (E)
Family: Azollaceae		
5	*Azolla pinnata* R.Br.	Chunidala (O), Azolla (E)
Family: Salviniaceae		
6	*Salvinia cucullata* Roxb. ex Bory	Khudra Indurakarnee (O); Indurkanni (Beng) Kariba weed Salvinia(E)
7	*Salvinia molesta* D. Mitch.	Bruhat Indurkarnee (O); Indurkanni (Beng); Kariba weed, Salvinia (E)

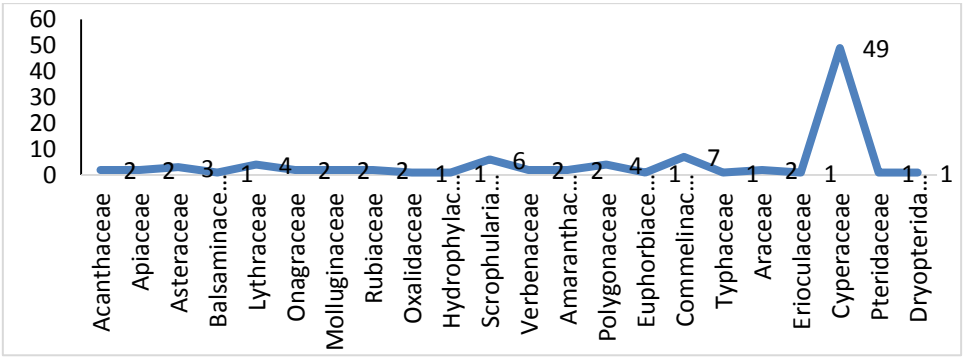

Fig-1: Amphibious floral diversity of study site

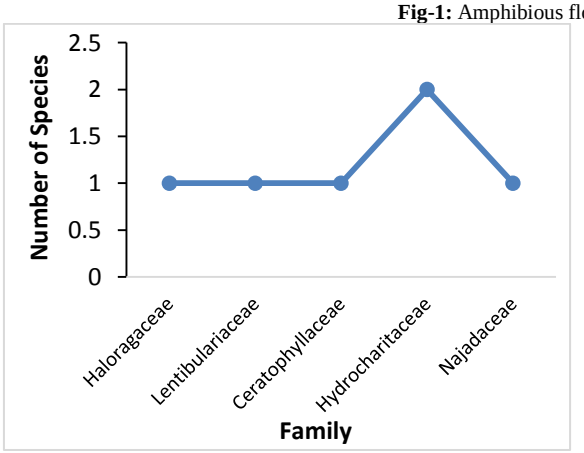

Fig-2: Submerged hydrophytic floral diversity

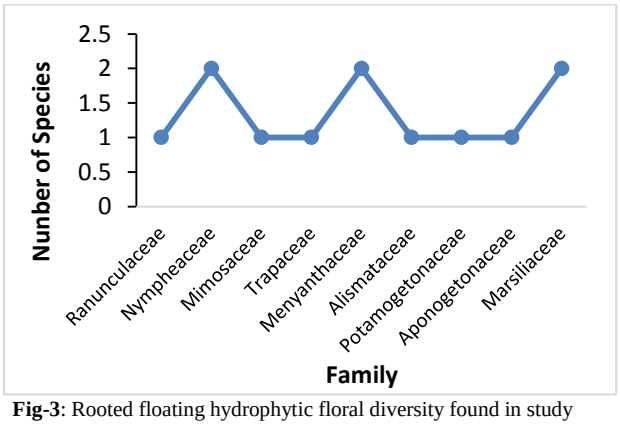

Fig-3: Rooted floating hydrophytic floral diversity found in study site

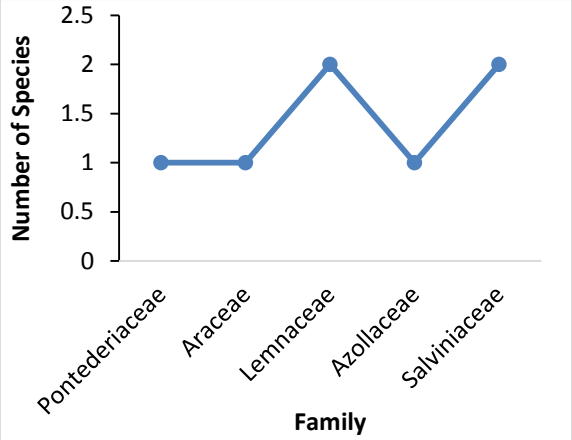

Fig-4: Free floating hydrophytic floral diversity

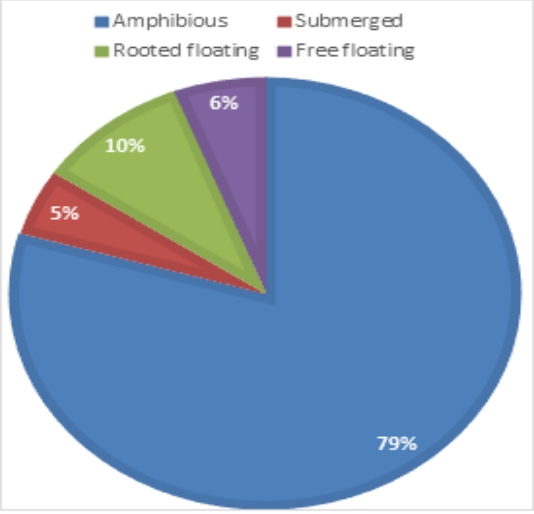

Fig 5: Percentage of Amphibious, submerged, rooted floating and free floating hydrophytes found in study site.

Conclusion: The current study revealed that wide ranges of hydrophytes which are economically important are found in polluted water bodies of Keonjhar mining area. This study also revealed that *Eichhornia crassipes* (Mart.) Solms ., *Salvinia cucullata* Roxb. ex Bory, *Salvinia molesta* D. Mitch., and *Spirodella polyrhiza* (L.) Schleiden are the dominant floating species along with a wild grass namely *Typha angustata* Bory & Chaub. having large population in the area under study. As these plants were accumulating toxic water from the polluted site and growing spontaneously. So these plants can be selected for phytoremediation of heavy metals.

Declaration of Conflict of Interest: The authors declare no conflict of interest.

Data Availability: Data are available upon request from the first author.

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