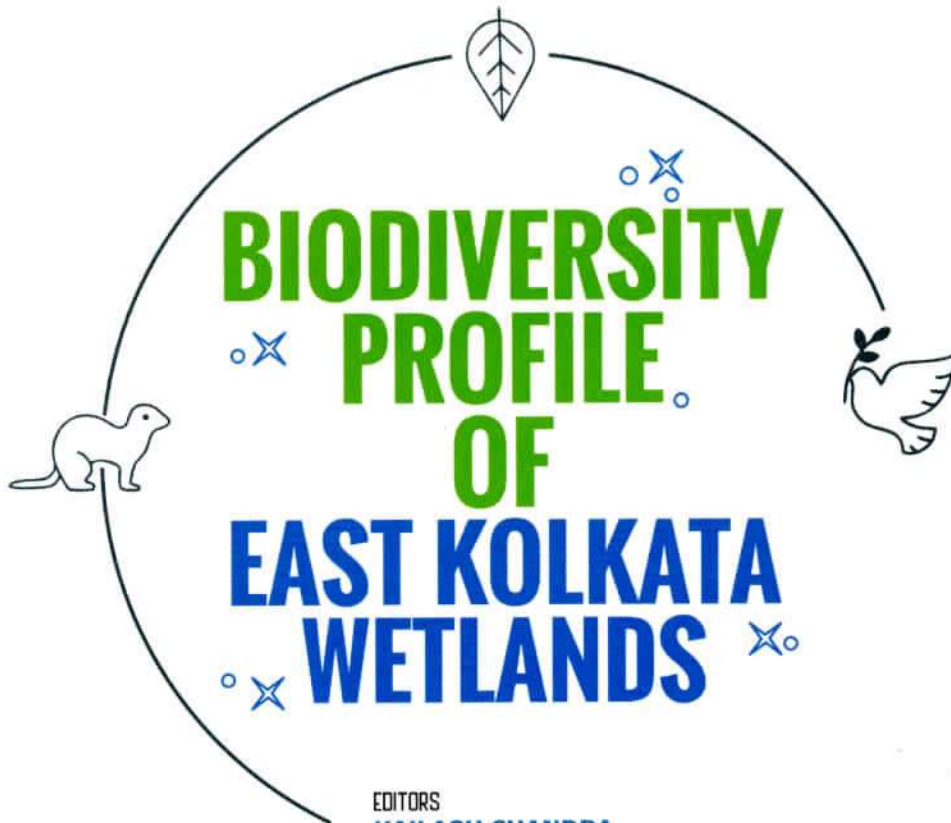




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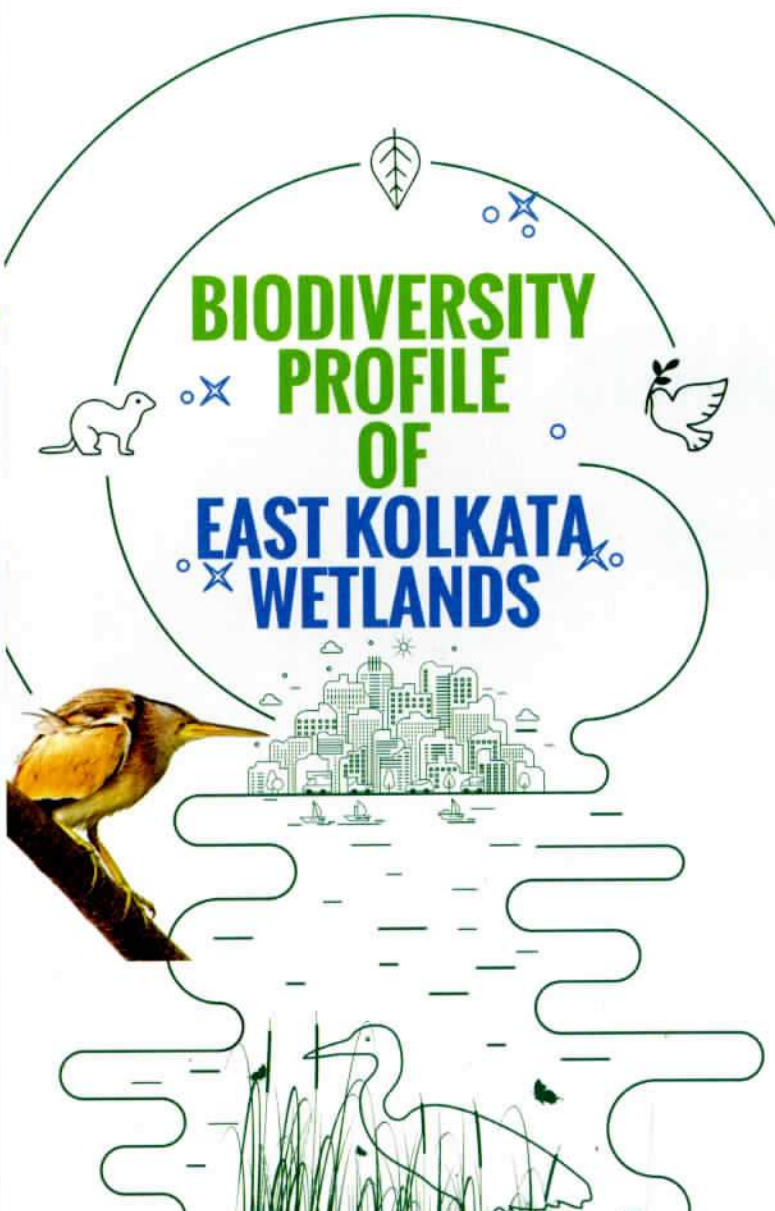


**BIODIVERSITY  
PROFILE  
OF  
EAST KOLKATA  
WETLANDS**

EDITORS  
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Forest and Climate Change  
Government of India  
&  
East Kolkata Wetlands  
Management Authority  
Department of Environment  
Government of West Bengal



# BIODIVERSITY PROFILE OF EAST KOLKATA WETLANDS

#### Citation

Chandra, K., Raghunathan, C. and Mao, A.A. 2020.  
*Biodiversity Profile of East Kolkata Wetlands*, 1- 326. Jointly published by the Director, Zool. Surv. India, Kolkata and East Kolkata Wetlands Management Authority, Department of Environment, Govt. of West Bengal

September 2020

ISBN: 978-81-8171-547-0

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# MACRO-FUNGI

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## ABSTRACT

Macro-fungi of Kolkata and suburbs are much less known, though highly diversified and form a very significant biological element of wet-land ecosystem in and around Kolkata. Organisms depend on wet land habitats are always having threat of losing their surroundings including macro-fungi due to developmental activities. As a result of survey undertaken in and around of East Kolkata Wetland, 50 species of macro-fungi belonging to 25 families and 40 genera were recorded. This preliminary information will be helpful for the rescue operation and management of wet land ecosystem in east Kolkata.

Keywords

Check list, Kolkata, Macro-fungi, Wetland.

Hembrom

MACRO-FUNGI



## INTRODUCTION

Fungi are beautiful creation of nature closely associated with social life of humans, animals and plants, involved either in their welfare or destructive activities. Recent phylogenetic knowledge of fungi indicates their close relationship with animals rather than plants. Among eight diverse phyla macro-fungi are those, in which, fruiting bodies can be observed by naked eyes. These fungi grow on soil, litters, trees and shrubs causing their decay either by saprophytic mode or by rotting for energy requirement and propagation. For layman morphologically they are known by 'mushrooms forms', 'bracketed polypore', 'jelly fungi', 'carbon & cushion fungi', 'stereoid fungi' and less explored crusty 'corticoid fungi'. Taxonomically, they are artificial group based on similar habit & habitat and do not fit under a particular rank. Good many of them cause serious damage to the trees on one hand and on the other hand are directly involved in recycling of minerals by decaying the organic substrate. During their life cycle some of them are associated with plants symbiotically while good many of them play role as natural recycler degrading organic matters into their natural components. Above all many are home to small animals while some are consumed by humans in the form of food or medicine.

East Kolkata Wetland is ecologically, economically and aesthetically integral part of this century old historic city and is under highly anthropogenic pressure. Thousands of acres of water bodies including human settlement areas, agriculture lands, manmade mini forests and natural vegetations though very rare creates suitable environments for growth of macro-fungi. These diversified, ecologically and economically important macro-fungal groups are almost neglected in terms of taxonomy from the East Kolkata Wet-land. Their taxonomic studies are of immense importance in terms of pathology, trees and timber industries, food & health products and basic life-science studies. This work is dealing with the exploration of diversity and taxonomic study of macrofungi. Macrofungi in and around of Kolkata were earlier studied by Some notable workers like Sulpiz Kurz and reported by Curry (1874), Banerjee 1917 & 1942-43, Roy (1948) and De 1996. However, only one macrofungi *Trogia benghalensis* was reported from this area by K. Acharya and A.K. Dutta (Dutta et al., 2017).

## MATERIAL AND METHODS

**Survey & Collection:** In 2019 (May to June), extensive and intensive macro-fungal survey has been undertaken repeatedly in the wetland and surrounding areas. Randomly macro-fungi were sampled from entire areas. During survey and collection, field photographs of fruiting bodies and its habitat were captured with the aid of Sony Cyber shot DSC-RX100. Each collection were given a field number and field information like name of locality along with GPS data, habitat, substratum/host and macromorphology of fruiting bodies were noted, then specimens were placed in brown paper bag labeled with field number.

**Macroscopic characterization:** Fresh specimens were characterized macroscopically on the same day just after return to the Central National Herbarium, Howrah. Then specimens were cut into manageable size and placed for drying, an important step towards preservation.

**Drying & preservation:** Fruiting bodies were dried after the collection either by spreading them in the sun during day time and under the fan during night or keeping them in field drier in which moderate hot air was produced by 200W electric bulb. Once the specimens are dried they were placed in moisture free airtight bags in duplicates.

**Microscopic characterization:** In the laboratory, macromorphological characters were again observed in the dry materials with the help of a stereo-zoom dissecting microscope Olympus SZ51. Micromorphological characters were recorded and microphotographs were taken with the help of a light microscope Olympus CX 41 from the free hand sections of the dry materials stained in a mixture of 5% KOH and phloxin and then mounted with 30% glycerol. Sections were also mounted in Cotton blue and Melzer's reagent separately. Microscopic structures like arrangement of hyphae, cystidia, setae, basidia, basidioles and other sterile structures were first observed under 40X objectives then to determine them finely observations were made under 100X objectives. Basidiospores were observed under 100X objectives and random measurements of 30 nos. of basidiospores were done in face and /or side views excluding the ornamentations (if observed).



**Identification:** Books (De, 1996; Pande, 2008; Sharma, 2012; Das et al., 2019) were consulted for identification.

**Preservation:** After the completion of collection trip the specimens were air dried again (50-55°C) at the institute properly and provided repeated exposure to -20°C for two days to kill most of the insects and pests and other larvae by wrapping them in a heavy duty plastic air tight bag in order to avoid the condensation of moisture on a specimens during the procedure. Once the specimens are freeze dried they were left as such in plastic bag until they attain the room temperature. Then, the specimens were placed in brown packets/ envelopes with standard size (15.0 × 9.3 cm), which are made by folding of 21.6 × 27.9 cm (8.5' × 11'). Finally, identified and duly labeled specimens were accessioned and placed in air tight plastic bag containing packets of silica gel and kept in the almirah of CAL herbarium.

## RESULTS

Macro-fungi specimens mostly belonging to two well known fungal phyla of 'Ascomycota' and 'Basidiomycota' were collected. Detail field observations followed by macro- and microscopic observations reveals 50 species belonging to 25 families and 40 genera (Table 1).

**Table 1:** Aquatic and Semi-Aquatic (Heteroptera) of East Kolkata Wetlands

	Family	Species
Bracket Macrofungi	Bondarzewiaceae	<i>Amylosporus campbellii</i> (Berk.) Ryvarden
	Ganodermataceae	<i>Ganoderma australe</i> (Fr.) Pat.
		<i>Ganoderma curtisii</i> (Berk.) Murrill
		<i>Ganoderma colossus</i> (Fr.) C.F. Baker
		<i>Ganoderma mediosinense</i> J.D. Zhao
	Hymenochaetaceae	<i>Fuscoporia senex</i> (Nees & Mont.) Ghob.-Nejh.
		<i>Inonotus pachyphloeus</i> (Pat.) T. Wagner & M. Fisch.
		<i>Phellinus allardii</i> (Bres.) S. Ahmad
		<i>Phellinus gilvus</i> (Schwein.) Pat.
	Meripilaceae	<i>Rigidoporus lineatus</i> (Pers.) Ryvarden
Polyporaceae	<i>Cellulariella acuta</i> (Berk.) Zmitr. & Malysheva	
	<i>Coriopsis occidentalis</i> (Klotzsch) Murrill	
	<i>Earliella scabrosa</i> (Pers.) Gilb. & Ryvarden	
	<i>Favolus grammocephalus</i> (Berk.) Imazeki	
	<i>Funalia caperata</i> (Berk.) Zmitr. & Malysheva	

	Family	Species
Pseudogilled Macrofungi		<i>Leiotrametes lactinea</i> (Berk.) Welti & Courtec.
		<i>Leiotrametes menziesii</i> (Berk.) Welti & Courtec.
		<i>Pycnoporus sanguineus</i> (L.) Murrill
		<i>Truncospora tephropora</i> (Mont.) Zmitr.
Gilled Macrofungi	Schizophyllaceae	<i>Schizophyllum commune</i> Fr.
	Serpulaceae	<i>Serpula similis</i> (Berk. & Broome) Ginns
Crust Macrofungi	Agaricaceae	<i>Agaricus</i> sp.
	Hymenogastraceae	<i>Gymnopilus purpureosquamulosus</i> Høil.
	Lyophyllaceae	<i>Termitomyces striatus</i> (Beeli) R. Heim
	Pluteaceae	<i>Pluteus chrysaegis</i> (Berk. & Broome) Petch
		<i>Volvariella volvacea</i> (Bull.) Singer
	Polyporaceae	<i>Lentinus polychrous</i> Lév.
		<i>Lentinus sajor-caju</i> (Fr.) Fr.
	Tricholomataceae	<i>Macrocybe gigantea</i> (Masse) Pegler & Lodge
	Psathyrellaceae	<i>Coprinopsis</i> sp. <i>Psathyrella</i> sp.
	Stereoid Macrofungi	Lachnocladiaceae
Meripilaceae		<i>Rigidoporus vinctus</i> (Pers.) Ryvarden
Peniophoraceae		<i>Duportella tristicula</i> (Berk. & Broome) Reinking
Phanerochaetaceae		<i>Porostereum spadiceum</i> (Pers.) Hjortstam & Ryvarden
Polyporaceae		<i>Grammothele fuligo</i> (Berk. & Broome) Ryvarden
Toothed Macrofungi	Meruliaceae	<i>Podoscypha petalodes</i> (Berk.) Boidin
	Stereopsidaceae	<i>Stereopsis dimiticum</i> (Rehill & B.K. Bakshi)
	Coniophoraceae	<i>Gyrodontium sacchari</i> (Spreng.) Hjortstam
	Meruliaceae	<i>Flavodon flavus</i> (Klotzsch) Ryvarden



	Family	Species
Jelly Macrofungi	Auriculariaceae	<i>Auricularia auricula-judae</i> (Bull.) Quél. <i>Auricularia nigricans</i> (Sw.) Birkebak, Looney & Sánchez-García
	Dacrymycetaceae	<i>Dacryopinax spathularia</i> (Schwein.) G.W. Martin
	Tremellaceae	<i>Tremella fuciformis</i> Berk.
Stink horn	Phallaceae	<i>Phallus atrovolvatus</i> Kreisel & Calonge
Carbon and Cushion Macrofungi	Hypoxylaceae	<i>Daldinia bambusicola</i> Y.M. Ju, J.D. Rogers & F. San Martin
		<i>Daldinia concentrica</i> (Bolton) Ces. & De Not.
		<i>Hypoxylon haematostroma</i> Mont.
	Xylariaceae	<i>Xylaria multiplex</i> (Kunze) Fr. <i>Xylaria polymorpha</i> (Pers.) Grev.

## DISCUSSION

Majority of the specimens i.e. 45 species were gathered from wood and are responsible for decaying of wood either by parasitic or saprophytic mode. Many of them appear throughout the year as their fruiting bodies remains intact even in drought period. Only 5 species *Agaricus* sp., *Coprinopsis* sp., *Psathyrella* sp., *Phallus atrovolvatus* and *Termitomyces striatus* were recorded growing on soil among leaf litters and grasses. These humicolous species appears after first shower of rain. *Ganoderma australe*, *Cellulariella acuta*, *Earliella scabrosa*, *Favolus grammocephalus*, *Truncospora tephropora*, *Schizophyllum commune*, *Scytinostroma duriusculum* and *Flavodon flavus* are found commonly throughout the wet-land on various living and dead trees. Jelly fungi like *Auricularia auricula-judae*, *A. nigricans*, *Dacryopinax spathularia* and *Tremella fuciformis* are totally dependent on moisture and are observed only after the rain. Good many wood-rotting macro-fungi doesn't have specific host choice while *Serpula similis* grows only on bamboos and *Grammothele fuligo* prefers monocot wood like bamboos and palms.

Due to limited time frame of the project the outcome in present work is only of preliminary nature and it doesn't give the full picture of macro-fungi of east Kolkata wet land. The list

may expand many folds if extensive and intensive survey will be undertaken in future. Thus, there is lot of scope to survey, collect and identify the macro-fungi from these beautiful and ecologically sensitive areas.



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## ABSTRACT

East Kolkata Wetlands (EKW), a Ramsar site, located in the eastern part of Kolkata city. It is also one of the largest natural waste-recycling regions of India. Altogether 130 freshwater algal taxa including 34 taxa of Cyanophyceae (21 genera, 11 families), 46 taxa of Chlorophyceae (25 genera, 13 families), 1 taxon of Xanthophyceae, 30 taxa of Euglenophyceae (10 genera, 3 families) and 19 taxa of Bacillariophyceae (11 genera, 10 families) are recorded during this present study. The ecological status of the water bodies is discussed here along with the analysis of the recorded taxa.



## INTRODUCTION

Algae are polyphyletic photosynthetic eukaryotes, which are microscopic as well as macroscopic thallophytes lacking any sterile covering of cells around reproductive organs and contain chlorophyll-a as primary photosynthetic pigment. They occur in wetlands as both phytoplankton and periphyton. Periphyton, the assemblages of algae attached to submerged surfaces, are integral part of the micro-biota in any wetlands. They are more ideal experimental tools to access any alterations in the wetland ecosystem infrastructure due to their high sensitivity towards any changes in water quality and nutrient availability. Thus, the study of algae in any wetland is essential for predicting and understanding the implications of environmental variation, anthropogenic effects, and changes in climate as well. Apart from being biological indicators, algae are also important in energy and nutrient cycling, stabilizing substrata and in water-column oxygen dynamics in a wetland through their photosynthesis and respiration processes.

The East Kolkata Wetlands (EKW), situated in the eastern part Kolkata city, is one of the largest natural waste-recycling regions of India. It was declared as a Ramsar site in 19<sup>th</sup> August 2002 and gained international importance due to its unique resource recovery systems, adopted by the locals through ages. It is a part of the lower deltaic plain of the Bhagirathi-Ganga river systems and is generally flat in nature. The area receives waste water of entire Kolkata city as a mixture of both domestic and industrial effluents, with high amount of heavy metals. About 45.93 % of the total area of EKW is man-made waters which include around 254 sewage fed pisciculture and agricultural lands, garbage farming fields and some built up area.

Preliminary documentation of algae from this wetland region was made in 2004 by Institute of Environmental Studies & Wetland Management (IESWM), reporting about 30 genera of phytoplankton, including 11 Myxophyceae, 12 Chlorophyceae and 7 Bacillariophyceae (Kundu *et al.*, 2008). Some further documentation were taxonomically limited and mentioned a few algal taxa only (Chakraborty *et al.*, 2006; Pradhan *et al.*, 2008; Ray Chaudhuri *et al.*, 2008a, 2008b). However, first detailed account on the algal diversity of EKW was made by Roy and Pal (2015a, 2015b, 2016), who collectively recorded 138 taxa of all major groups of algae.

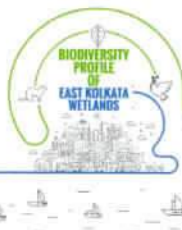
## MATERIAL AND METHODS

Algal samples were collected from different kinds of habitats like ponds, drains, canals, lakes, temporary pools, waterlogged fields and ditches for sampling of both planktonic and attached algal forms during April-June 2019. Plankton samples were collected using plankton nets of pore size 10 µm. The attached forms from rocks, stones, aquatic weeds and various other substrates were scrapped using tooth brush and scalpel. The algal specimens were collected in Tarson made specimen tubes and preserved with 4% formaldehyde solution, which were deposited in Central National Herbarium, Botanical Survey of India, Howrah (CAL). Light Microscopy for morphological observations was carried out with Nikon microscope Ni-11 fitted and Nikon Digital Camera DS-Ri1-U3 and operated by Nikon Imaging Software NIS-D+EDF. The algal taxa were identified with the help of standard literatures. The botanical names of the species were updated following AlgaeBase (Guiry and Guiry, 2019).

## RESULTS

A total of 130 algal taxa (Table 1, Figs. 1-8) were recorded from the freshwaters of East Kolkata Wetlands. These included 34 taxa of Cyanophyceae (21 genera, 11 families), 46 taxa of Chlorophyceae (25 genera, 13 families), 1 taxon of Xanthophyceae, 30 taxa of Euglenophyceae (10 genera, 3 families) and 19 taxa of Bacillariophyceae (11 genera, 10 families).

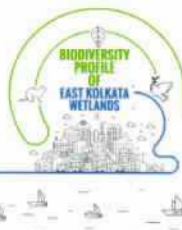


**Table 1:** List of algal taxa in different habitats of East Kolkata Wetlands

Sl. No.	Algal taxa	Family	Mode of occurrence
<b>Cyanophyceae</b>			
1	<i>Limnocoocus limneticus</i> (Lemmerm.) Komárk. & al.	Merismopediaceae	Planktonic
2	<i>Merismopedia minima</i> Beck	Merismopediaceae	Planktonic
3	<i>Merismopedia tenuissima</i> Lemmerm.	Merismopediaceae	Planktonic
4	<i>Merismopedia tranquilla</i> (Ehrenb.) Trevis.	Merismopediaceae	Planktonic
5	<i>Synechocystis aquatilis</i> Sauv.	Merismopediaceae	Planktonic
6	<i>Microcystis aeruginosa</i> (Kütz.) Kütz.	Microcystaceae	Planktonic
7	<i>Lemmermanniella pallida</i> (Lemmerm.) Geitler	Synechococcaceae	Planktonic
8	<i>Rhabdoderma irregulare</i> (Naumann) Geitler	Synechococcaceae	Planktonic
9	<i>Synechococcus elongatus</i> (Nägeli) Nägeli	Synechococcaceae	Planktonic
10	<i>Chroococcus dispersus</i> (Keisll.) Lemmerm.	Chroococcaceae	Planktonic; Attached
11	<i>Chroococcus turgidus</i> (Kütz.) Nägeli	Chroococcaceae	Planktonic
12	<i>Pseudanabaena catenata</i> Lauterb.	Pseudanabaenaceae	Planktonic
13	<i>Leptolyngbya subtilis</i> (West) Anagn.	Leptolyngbyaceae	Attached
14	<i>Planktolyngbya limnetica</i> (Lemmerm.) Komárk.-Legn. & Cornberg	Leptolyngbyaceae	Planktonic
15	<i>Spirulina major</i> Kütz. ex Gomont	Spirulinaceae	Planktonic
16	<i>Spirulina subsalsa</i> Oerst. ex Gomont	Spirulinaceae	Planktonic
17	<i>Spirulina gigantea</i> Schmidle	Spirulinaceae	Planktonic
18	<i>Microcoleus autumnalis</i> (Gomont) Strunecky & al.	Microcoleaceae	Attached
19	<i>Planktothrix isothrix</i> (Skuja) Komárek & Komárk.	Microcoleaceae	Planktonic
20	<i>Planktothrix rubescens</i> (DC. ex Gomont) Anagn. & Komárk	Microcoleaceae	Planktonic
21	<i>Kamptonema chlorinum</i> (Kütz. ex Gomont) Strunecky & al.	Oscillatoriaceae	Attached
22	<i>Kamptonema formosum</i> (Bory ex Gomont) Strunecky & al.	Oscillatoriaceae	Attached
23	<i>Lyngbya hieronymusii</i> Lemmerm.	Oscillatoriaceae	Attached
24	<i>Oscillatoria limosa</i> C.Agardh ex Gomont	Oscillatoriaceae	Planktonic; Attached

Sl. No.	Algal taxa	Family	Mode of occurrence
25	<i>Oscillatoria ornata</i> Kütz. ex Gomont	Oscillatoriaceae	Attached
26	<i>Oscillatoria crassa</i> (C.B.Rao) Anagn.	Oscillatoriaceae	Attached
27	<i>Oscillatoria subbrevis</i> Schmidle	Oscillatoriaceae	Planktonic; Attached
28	<i>Oscillatoria princeps</i> Vaucher ex Gomont	Oscillatoriaceae	Attached
29	<i>Phormidium tergestinum</i> (Rabenh. ex Gomont) Anagn. & Komárek	Oscillatoriaceae	Planktonic
30	<i>Phormidium chalybeum</i> (Martens ex Gomont) Anagn. & Komárek	Oscillatoriaceae	Planktonic
31	<i>Scytonema pseudohofmanni</i> Bharadwaja	Scytonemataceae	Attached
32	<i>Anabaena iyengarii</i> Bharadwaja	Nostocaceae	Planktonic
33	<i>Anabaena catenula</i> Kütz. ex Bornet & Flahault	Nostocaceae	Planktonic
34	<i>Cylindrospermum stagnale</i> Bornet & Flahault	Nostocaceae	Attached
<b>Chlorophyceae</b>			
1	<i>Chlamydomonas mucicola</i> Schmidle	Chlamydomonadaceae	Planktonic
2	<i>Edaphochlamys debaryana</i> (Gorozh.) Pröschold & Darienko	Chlamydomonadaceae	Planktonic
3	<i>Eudorina elegans</i> Ehrenb.	Volvocaceae	Planktonic
4	<i>Pandorina morum</i> (O.F.Müll.) Bory	Volvocaceae	Planktonic
5	<i>Oocystis borgei</i> J.Snow	Oocystaceae	Attached
6	<i>Chlorococcum infusionum</i> (Schrank) Menegh.	Chlorococcaceae	Attached
7	<i>Lacunastrum gracillimum</i> (West & G.S.West) McManus	Hydrodictyceae	Planktonic
8	<i>Goniochloris mutica</i> (A.Braun) Fott	Hydrodictyceae	Attached
9	<i>Pediastrum boryanum</i> var. <i>cornutum</i> (Racib.) Sulek	Hydrodictyceae	Planktonic; Attached
10	<i>Pediastrum duplex</i> Meyen	Hydrodictyceae	Planktonic
11	<i>Pediastrum sarmae</i> Keshri & Mullick	Hydrodictyceae	Planktonic
12	<i>Pediastrum subgranulatum</i> (Racib.) Komárek & Jánková	Hydrodictyceae	Attached
13	<i>Pseudopediastrum boryanum</i> (Turpin) E.Hegew.	Hydrodictyceae	Attached
14	<i>Stauridium privum</i> (Printz) E.Hegew.	Hydrodictyceae	Planktonic; Attached





Sl. No.	Algal taxa	Family	Mode of occurrence
15	<i>Stauridium tetras</i> (Ehrenb.) E.Hegew.	Hydrodictyaceae	Planktonic; Attached
16	<i>Tetraedron caudatum</i> (Corda) Hansg.	Hydrodictyaceae	Attached
17	<i>Tetraedron gracile</i> (Reinsch) Hansg.	Hydrodictyaceae	Planktonic
18	<i>Tetraedron minimum</i> (A.Braun) Hansg.	Hydrodictyaceae	Planktonic
19	<i>Tetraedron trigonum</i> (Nägeli) Hansg.	Hydrodictyaceae	Planktonic
20	<i>Coelastropsis costata</i> (Korshikov) Fott & Kalina	Scenedesmaceae	Attached
21	<i>Coelastrum microporum</i> Nägeli	Scenedesmaceae	Attached
22	<i>Desmodesmus brasiliensis</i> (Bohlin) E.Hegew.	Scenedesmaceae	Planktonic
23	<i>Desmodesmus pannonicus</i> (Hortob.) E.Hegew.	Scenedesmaceae	Planktonic
24	<i>Desmodesmus hystrix</i> (Lagerh.) E.Hegew.	Scenedesmaceae	Planktonic
25	<i>Scenedesmus armatus</i> (Chodat) Chodat	Scenedesmaceae	Planktonic
26	<i>Scenedesmus ecornis</i> (Ehrenb.) Chodat	Scenedesmaceae	Planktonic
27	<i>Scenedesmus lafevrii</i> var. <i>manguinii</i> M.Lafèvre & Bourr.	Scenedesmaceae	Planktonic
28	<i>Tetradesmus dimorphus</i> (Turpin) M.J.Wynne	Scenedesmaceae	Planktonic
29	<i>Tetradesmus incrassatulus</i> (Bohlin) M.J.Wynne	Scenedesmaceae	Planktonic
30	<i>Tetradesmus lagerheimii</i> M.J. Wynne & Guiry	Scenedesmaceae	Planktonic
31	<i>Tetradesmus obliquus</i> (Turpin) M.J.Wynne	Scenedesmaceae	Planktonic; Attached
32	<i>Kirchneriella lunaris</i> (Kirchn.) K.Möbius	Selenastraceae	Planktonic; Attached
33	<i>Kirchneriella obesa</i> (West) West & G.S.West	Selenastraceae	Planktonic; Attached
34	<i>Monoraphidium convolutum</i> (Corda) Komárk.-Legn.	Selenastraceae	Planktonic
35	<i>Monoraphidium contortum</i> (Thur.) Komárk.-Legn.	Selenastraceae	Planktonic
36	<i>Monoraphidium griffithii</i> (Berk.) Komárk.-Legn.	Selenastraceae	Planktonic
37	<i>Monoraphidium pseudobraunii</i> (J.H.Belcher & Swale) Heynig	Selenastraceae	Planktonic



Sl. No.	Algal taxa	Family	Mode of occurrence
38	<i>Monoraphidium pusillum</i> (Printz) Komárk.-Legn.	Selenastraceae	Planktonic
39	<i>Ulothrix</i> sp.	Ulotrichaceae	Attached
40	<i>Trentepohlia aurea</i> (L.) C.Mart.	Trentepohliaceae	Attached
41	<i>Trentepohlia willei</i> (Tiffany) Printz	Trentepohliaceae	Attached
42	<i>Cladophora glomerata</i> (L.) Kütz.	Cladophoraceae	Attached
43	<i>Oedogonium varians</i> Wittr. & P.Lundell ex Hirn	Oedogoniaceae	Attached
44	<i>Closterium costatum</i> Corda ex Ralfs	Closteriaceae	Planktonic
45	<i>Closterium littorale</i> F.Gay	Closteriaceae	Planktonic; Attached
46	<i>Spirogyra</i> sp.	Zygnemataceae	Attached
<b>Xanthophyceae</b>			
1	<i>Characium angustum</i> A.Braun	Characiaceae	Attached
<b>Euglenophyceae</b>			
1	<i>Cryptoglena skujae</i> Marin & Melkonian	Euglenaceae	Attached
2	<i>Euglena deses</i> Ehrenb.	Euglenaceae	Planktonic
3	<i>Euglena gracilis</i> G.A.Klebs	Euglenaceae	Planktonic
4	<i>Euglena granulata</i> (G.A.Klebs) F.Schmitz	Euglenaceae	Planktonic
5	<i>Euglena sanguinea</i> Ehrenb.	Euglenaceae	Planktonic
6	<i>Euglena tuberculata</i> Swirenko	Euglenaceae	Planktonic
7	<i>Euglena viridis</i> (O.F.Müll.) Ehrenb.	Euglenaceae	Planktonic
8	<i>Euglenaria anabaena</i> (Mainx) Karnkowska & E.W.Linton	Euglenaceae	Planktonic
9	<i>Euglenaria clavata</i> (Skuja) Karnkowska & E.W.Linton	Euglenaceae	Planktonic
10	<i>Eugleniformis proxima</i> (P.A.Dang.) M.S.Benn. & Triemer	Euglenaceae	Planktonic
11	<i>Monomorpha pyrum</i> (Ehrenb.) Mereschk.	Euglenaceae	Attached
12	<i>Strombomonas triquetra</i> (Playfair) Deflandre	Euglenaceae	Planktonic; Attached
13	<i>Trachelomonas abrupta</i> var. <i>minor</i> Deflandre	Euglenaceae	Planktonic
14	<i>Trachelomonas intermedia</i> P.A.Dang.	Euglenaceae	Planktonic
15	<i>Trachelomonas volzii</i> var. <i>intermedia</i> Playfair	Euglenaceae	Planktonic
16	<i>Peranemopsis trichophora</i> (Ehrenb.) L.S.Péterfi	Peranemidae	Planktonic



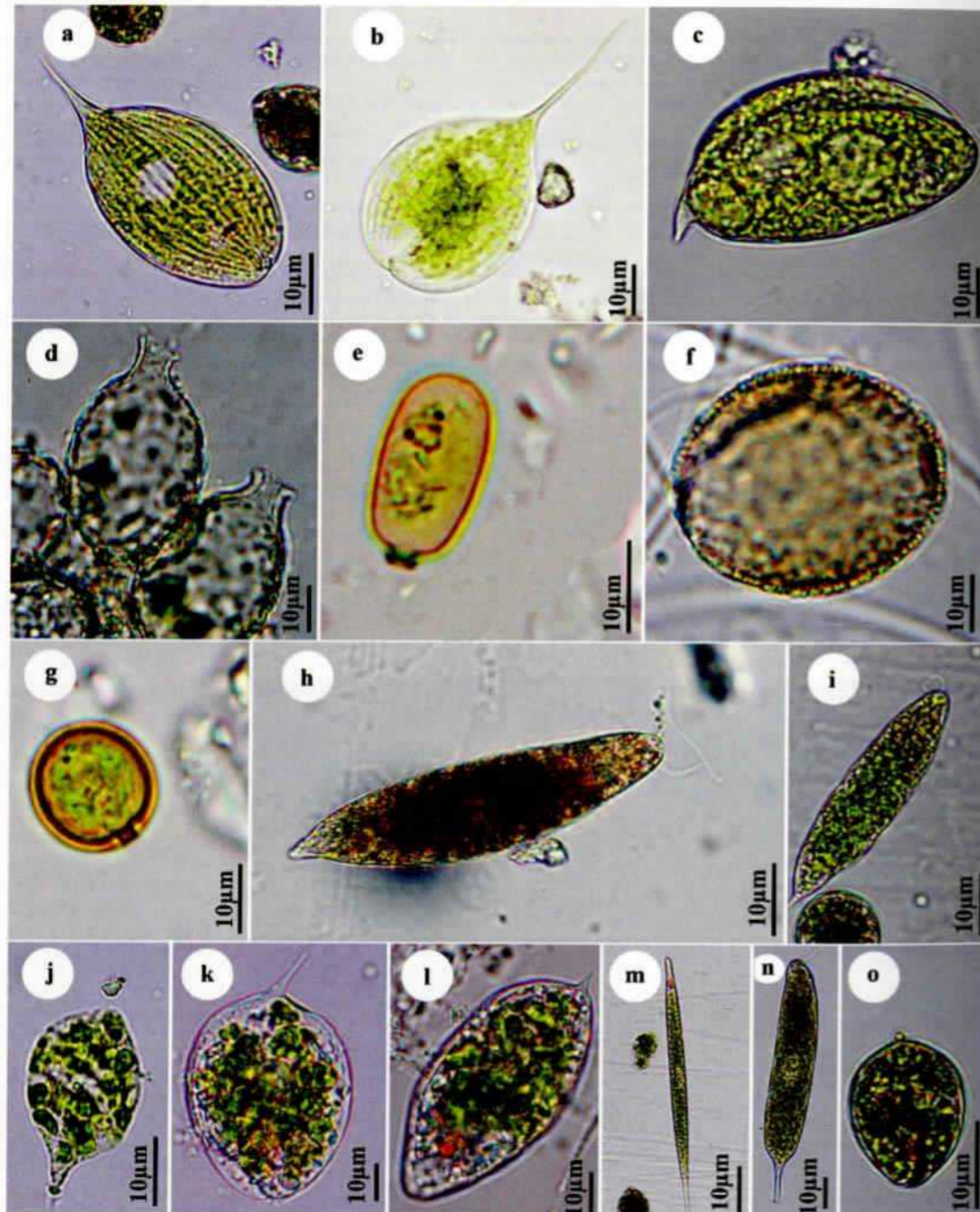
Sl. No.	Algal taxa	Family	Mode of occurrence
17	<i>Lepocinclis acus</i> (O.F.Müll.) Marin & Melkonian	Phacaceae	Planktonic
18	<i>Lepocinclis fusca</i> (Klebs) Kosmala & Zakry?	Phacaceae	Planktonic
19	<i>Lepocinclis fusiformis</i> (H.J.Carter) Lemmerm.	Phacaceae	Planktonic
20	<i>Lepocinclis ovum</i> (Ehrenb.) Lemmerm.	Phacaceae	Planktonic
21	<i>Lepocinclis salina</i> F.E.Fritsch	Phacaceae	Planktonic
22	<i>Phacus acuminatus</i> A.Stokes	Phacaceae	Planktonic
23	<i>Phacus caudatus</i> K.Hübner	Phacaceae	Planktonic
24	<i>Phacus curvicauda</i> Svirenko	Phacaceae	Planktonic
25	<i>Phacus glaber</i> Pochm.	Phacaceae	Planktonic
26	<i>Phacus hamatus</i> Pochm.	Phacaceae	Planktonic
27	<i>Phacus helikoides</i> Pochm.	Phacaceae	Planktonic
28	<i>Phacus longicauda</i> (Ehrenb.) Dujard.	Phacaceae	Planktonic
29	<i>Phacus tortus</i> (Lemmerm.) Skvortzov	Phacaceae	Planktonic
30	<i>Phacus triqueter</i> (Ehrenb.) Perty	Phacaceae	Planktonic
<b>Bacillariophyceae</b>			
1	<i>Aulacoseira</i> sp.	Aulacosieraceae	Planktonic
2	<i>Cyclotella meneghiniana</i> Kütz.	Stephanodiscaceae	Planktonic
3	<i>Diademesmia confervacea</i> Kütz.	Diademesmiaceae	Planktonic; Attached
4	<i>Achnantheidium minutissimum</i> (Kütz.) Czarnecki	Achnantheidiaceae	Attached
5	<i>Anomoeoneis sphaerophora</i> Pfitzer	Anomoeoneidaceae	Attached
6	<i>Cymbella lanceolata</i> (C.Agardh) C.Agardh	Cymbellaceae	Planktonic
7	<i>Cymbella tumida</i> (Bréb.) Van Heurck	Cymbellaceae	Planktonic; Attached
8	<i>Gyrosigma acuminatum</i> (Kütz.) Rabenh.	Naviculaceae	Attached
9	<i>Navicula cryptocephala</i> Kütz.	Naviculaceae	Attached
10	<i>Navicula peregrina</i> (Ehrenb.) Kütz.	Naviculaceae	Attached

Sl. No.	Algal taxa	Family	Mode of occurrence
11	<i>Navicula phyllepta</i> Kütz.	Naviculaceae	Attached
12	<i>Navicula tripunctata</i> (O.F.Müll.) Bory	Naviculaceae	Planktonic; Attached
13	<i>Craticula cuspidata</i> (Kütz.) D.G.Mann	Stauroneidaceae	Attached
14	<i>Craticula halophila</i> (Grunow) D.G.Mann	Stauroneidaceae	Attached
15	<i>Halamphora coffaeiformis</i> (C.Agardh) Mereschk.	Amphipleuraceae	Planktonic
16	<i>Nitzschia acicularis</i> (Kütz.) W.Sm.	Bacillariaceae	Planktonic
17	<i>Nitzschia frustulum</i> (Kütz.) Grunow	Bacillariaceae	Attached
18	<i>Nitzschia fruticosa</i> Hust.	Bacillariaceae	Attached
19	<i>Nitzschia palea</i> (Kütz.) W.Sm.	Bacillariaceae	Attached

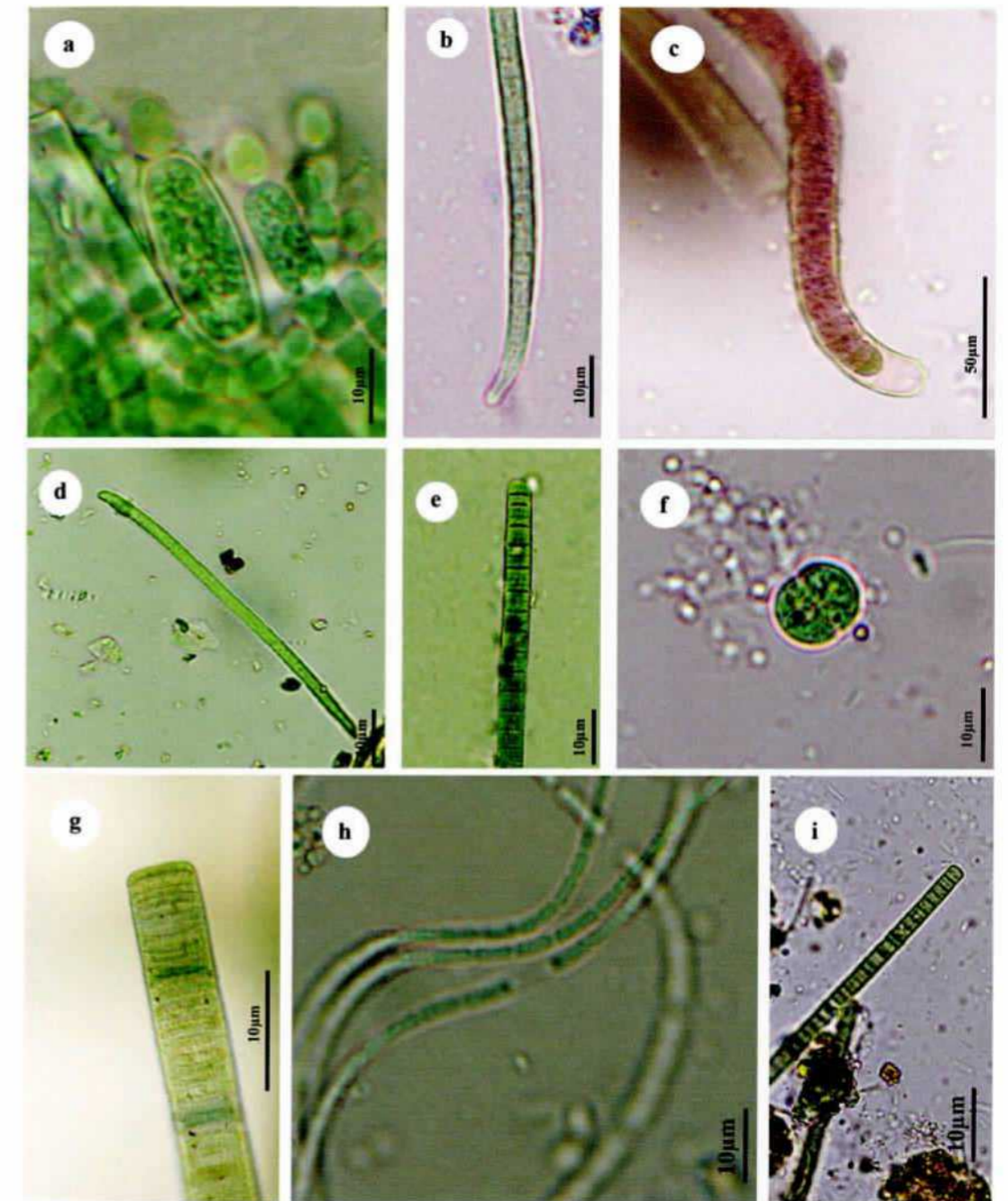


**Fig. 1:** Freshwater algal diversity in East Kolkata Wetlands. a. Floating mass of *Oedogonium*, b. Epiphytic algal biofilms on submerged plants, c. Floating green algae (*Spirogyra*), d. Brown coloured diatom scum, e. Collection of attached (epiphytic) algae, f. Green coloured bloom of euglenoids



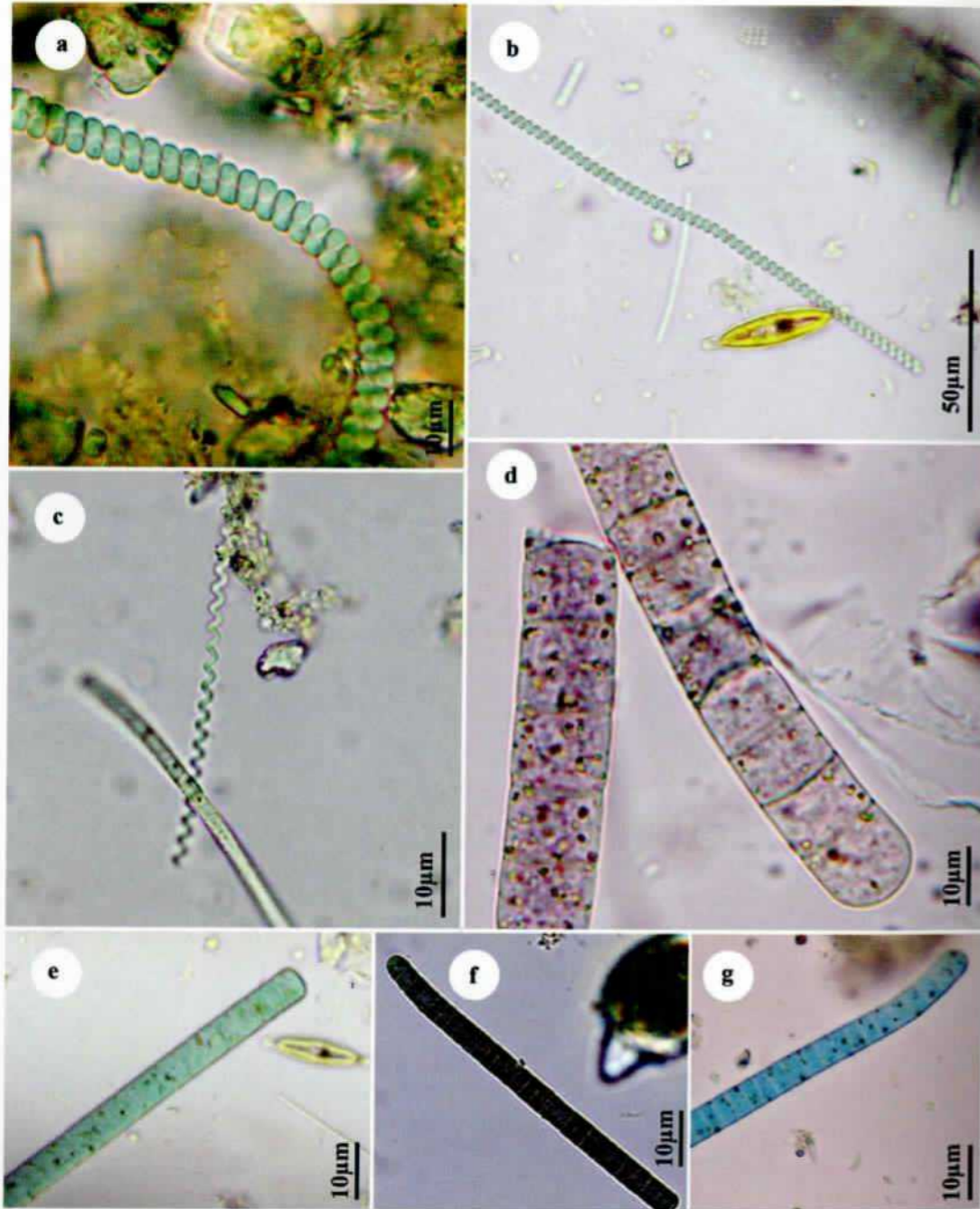


**Fig. 2:** Freshwater algal diversity in East Kolkata Wetlands. a. *Phacus helicoides* Pochm., b. *Phacus longicauda* (Ehrenb.) Dujard., c. *Phacus triqueter* (Ehrenb.) Perty, d. *Strombomonas triquetra* (Playfair) Deflandre, e. *Trachelomonas abrupta* var. minor Deflandre, f. *Trachelomonas intermedia* P.A.Dang., g. *Trachelomonas volzii* var. *intermedia* Playfair, h. *Euglena sanguinea* Ehrenb., i. *Euglena viridis* (O.F.Müll.) Ehrenb., j. *Euglenaria anabaena* (Mainx) Karnkowska & E.W.Linton, k. *Phacus hamatus* Pochm., l. *Euglenaria clavata* (Skuja) Karnkowska & E.W.Linton, m. *Lepocinclis acus* (O.F.Müll.) Marin & Melkonian, n. *Lepocinclis fusca* (Klebs) Kosmala & Zakryš, o. *Lepocinclis ovum* (Ehrenb.) Lemmerm.

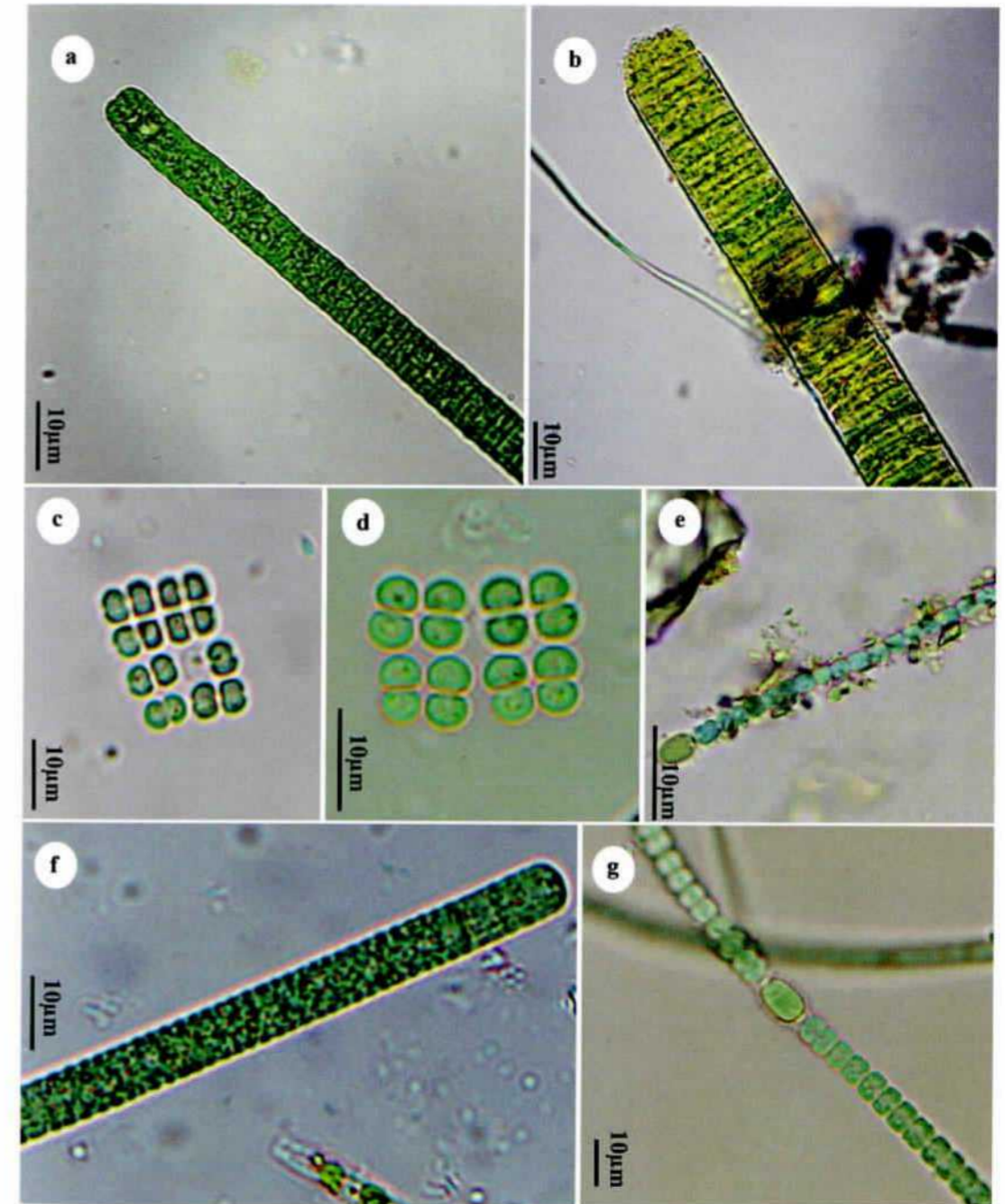


**Fig. 3:** Freshwater algal diversity in East Kolkata Wetlands. a. *Cylindrospermum stagnale* Bornet & Flahault, b. *Microcoleus autumnalis* (Gomont) Strunecky & al., c. *Scytonema pseudohofmanni* Bharadwaja, d. *Kamptonema formosum* (Bory ex Gomont) Strunecky & al., e. *Kamptonema chlorinum* (Kütz. ex Gomont) Strunecky & al., f. *Limnococcus limneticus* (Lemmerm.) Komárk. & al., g. *Oscillatoria princeps* Vaucher ex Gomont, h. *Leptolyngbya subtilis* (West) Anagn., i. *Phormidium tergestinum* (Rabenh. ex Gomont) Anagn. & Komárek



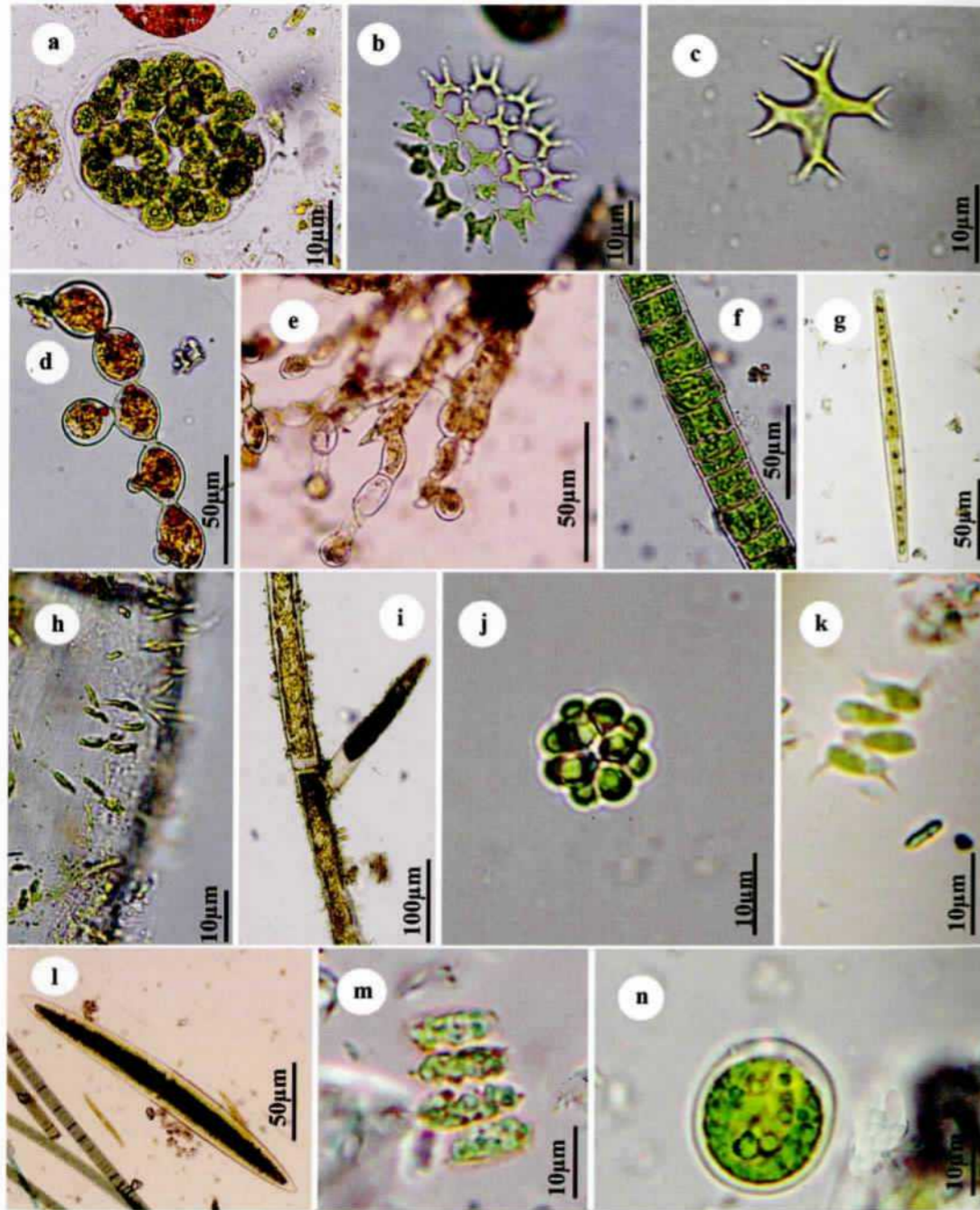


**Fig. 4:** Freshwater algal diversity in East Kolkata Wetlands. **a.** *Spirulina subsalsa* Oerst. ex Gomont, **b.** *Spirulina gigantea* Schmidle, **c.** *Spirulina major* Kütz. ex Gomont, **d.** *Planktothrix rubescens* (DC. ex Gomont) Anagn. & Komärk, **e.** *Oscillatoria subbrevis* Schmidle., **f.** *Oscillatoria crassa* (C.B.Rao) Anagn., **g.** *Phormidium chalybeum* (Martens ex Gomont) Anagn. & Komárek & Darienko

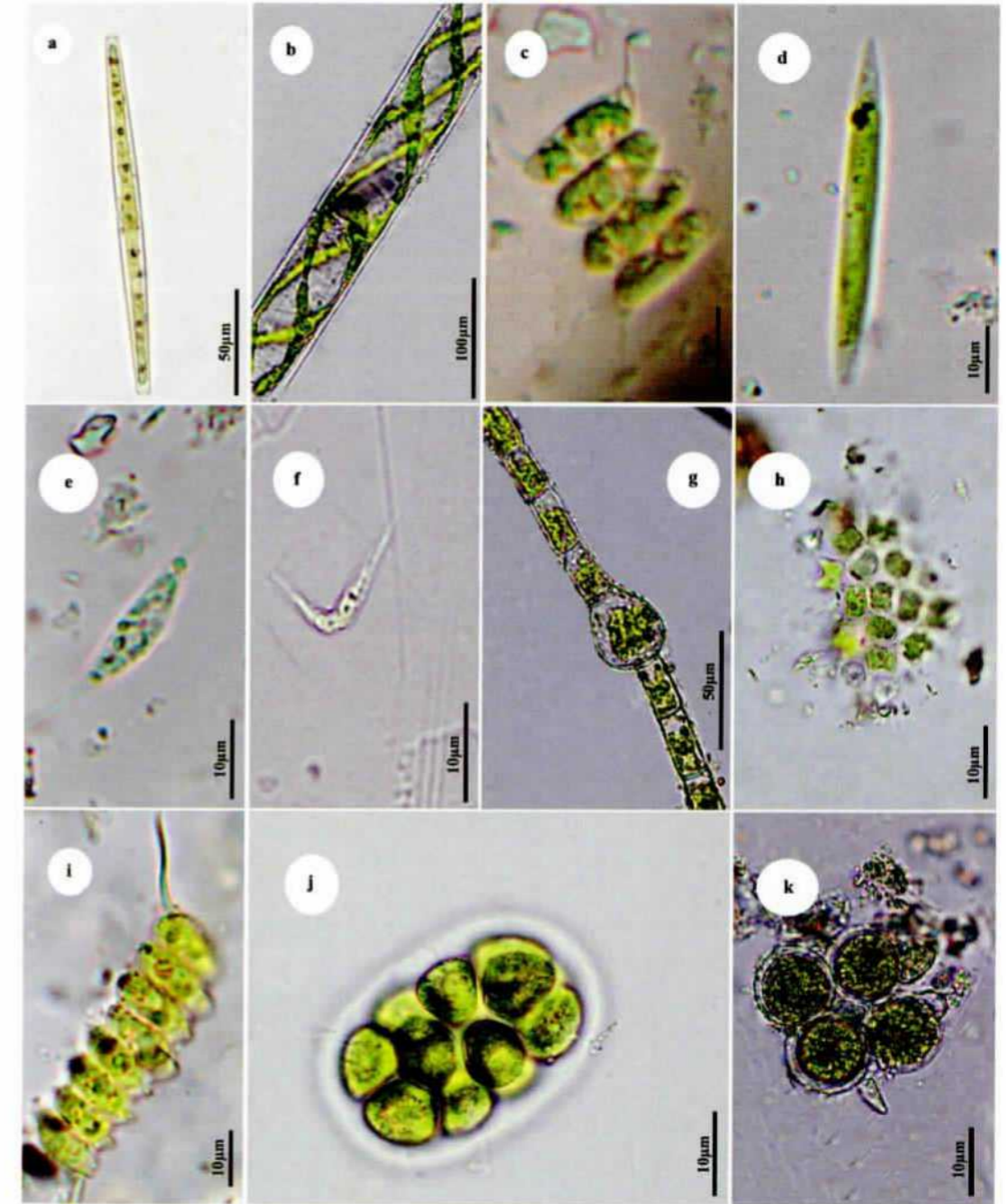


**Fig. 5:** Freshwater algal diversity in East Kolkata Wetlands. **a.** *Oscillatoria ornata* Kütz. ex Gomont, **b.** *Oscillatoria limosa* C. Agardh ex Gomont, **c.** *Merismopedia tenuissima* Lemmer., **d.** *Merismopedia tenuissima* Lemmer., **e.** *Anabaena iyengarii* Bharadwaja, **f.** *Planktothrix isothrix* (Skuja) Komárek & Komärk., **g.** *Anabaena catenula* Kütz. ex Bornet & Flahault



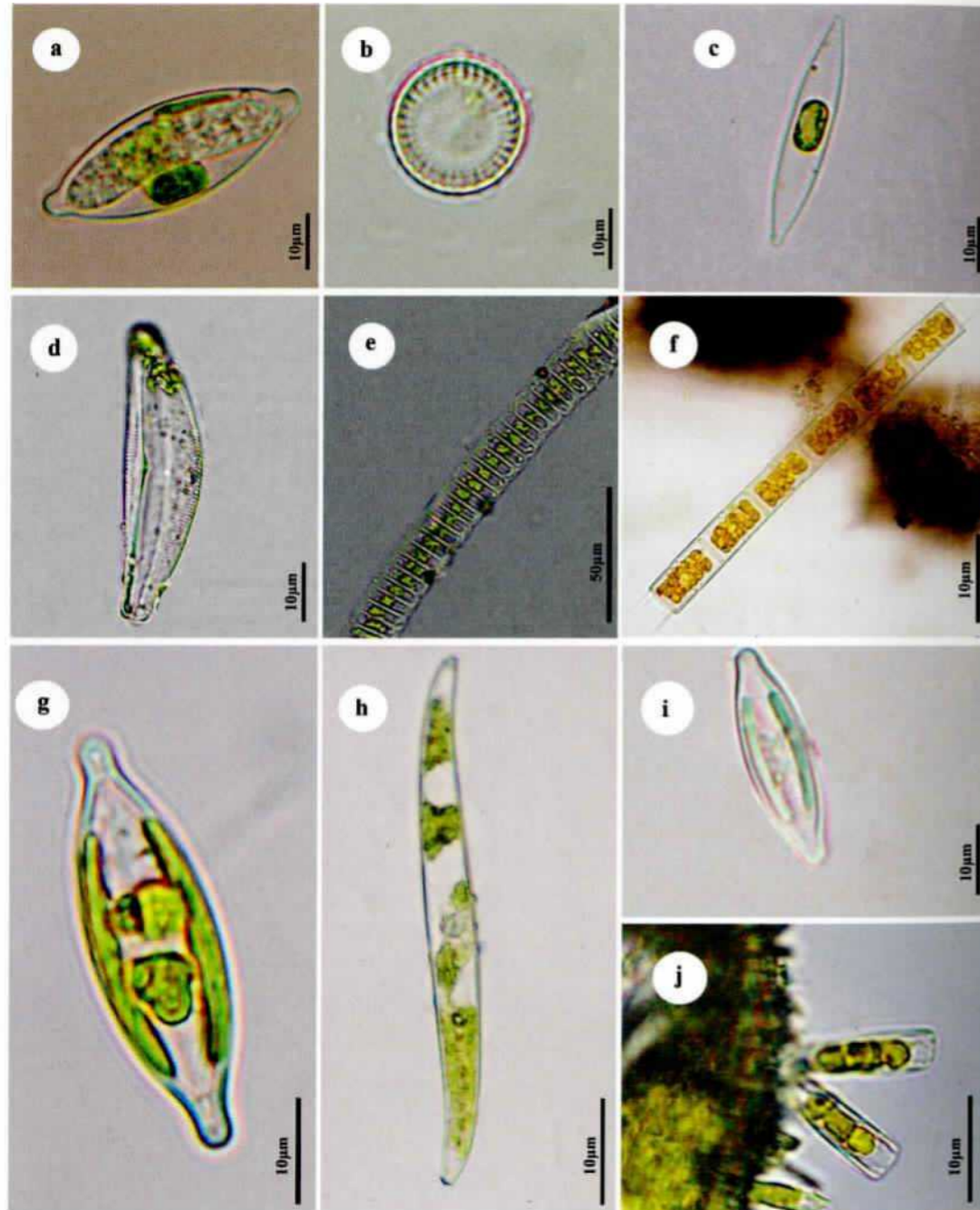


**Fig. 6:** Freshwater algal diversity in East Kolkata Wetlands. a. *Eudorina elegans* Ehrenb., b. *Lacunastrum gracillimum* (West & G.S.West) McManus, c. *Tetraedron gracile* (Reinsch) Hansg., d. *Trentepohlia aurea* (L.) C.Mart., e. *Trentepohlia willei* (Tiffany) Printz, f. *Ulothrix* sp., g. *Closterium littorale* F.Gay, h. *Characium angustum* A.Braun, i. *Cladophora glomerata* (L.) Kütz., j. *Coelastrum microporum* Nägeli, k. *Desmodesmus pannonicus* (Hortob.) E.Hegew., l. *Closterium costatum* Corda ex Ralfs, m. *Desmodesmus hystrix* (Lagerh.) E.Hegew., n. *Edaphochlamys debaryana* (Gorozh.) Pröschold & Darienko



**Fig. 7:** Freshwater algal diversity in East Kolkata Wetlands. a. *Closterium littorale* F. Gay, b. *Spirogyra* sp., c. *Scenedesmus armatus* (Chodat) Chodat, d. *Monoraphidium pseudobraunii* (J.H.Belcher & Swale) Heynig, e. *Monoraphidium griffithii* (Berk.) Komárk-Legn., f. *Monoraphidium contortum* (Thur.) Komárk-Legn., g. *Oedogonium varians* Wittr. & P.Lundell ex Hirn, h. *Pediastrum boryanum* var. *cornutum* (Racib.) Sulek, i. *Scenedesmus lafevrii* var. *manguinii* M.Lafèvre & Bourr., j. *Pandorina morum* (O.F.Müll.) Bory, k. *Coelastropsis costata* (Korshikov) Fott & Kalina





**Fig. 8:** Freshwater algal diversity in East Kolkata Wetlands. a. *Navicula cryptocephala* Kütz., b. *Cyclotella meneghiniana* Kütz., c. *Nitzschia palea* (Kütz.) W.Sm., d. *Cymbella tumida* (Bréb.) Van Heurck, e. *Diadesmis confervaceae* Kütz., f. *Aulacoseira* sp., g. *Anomooneis spaerophora* Pfitzer, h. *Gyrosigma acuminatum* (Kütz.) Rabenh., i. *Navicula cryptocephala* Kütz., j. *Achnanthydium minutissimum* (Kütz.) Czarnecki

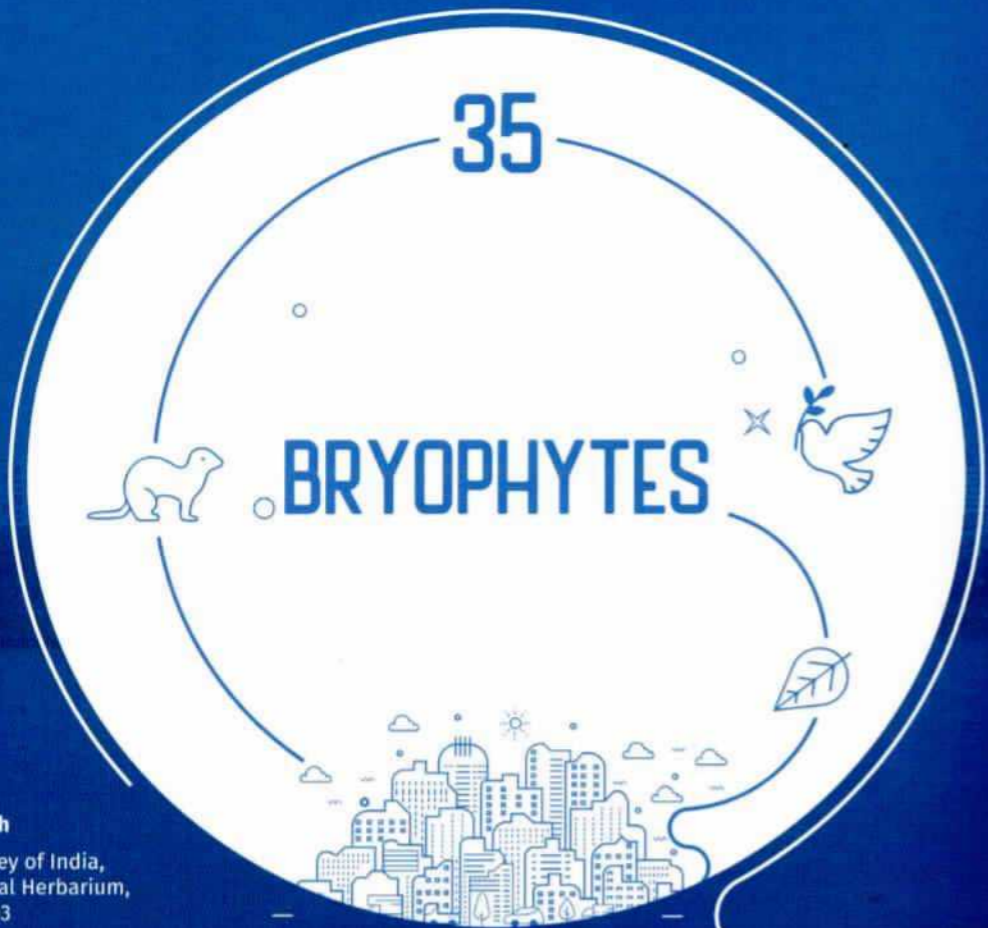
## DISCUSSION

Most of the algae (78 taxa) belonging to Chlorophyceae and Bacillariophyceae were found growing as phytoplankton in different pisciculture and community ponds. The euglenoids found forming blooms in the ponds, showing their nutrient-enriched conditions. These blooms also cause a poor periphyton composition in the ponds by obstructing sun light. The benthos in these water bodies were mostly colonized by diatoms (Bacillariophyceae) and few members of Cyanophyceae. The overall diversity of algae in East Kolkata Wetlands showed the water health as eutrophic, which can be understood inferring the periphyton assemblages, which were dominated by members of *Oscillatoria*, *Planktothrix* and *Nitzschia*. Desmids (members of Chlorophyceae) are potential bio-indicators, which prefer slightly alkaline and oligotrophic waters. Their absence in the freshwaters of EKW may be due to the increased acidity following high nutrient availability. Coccal Cyanophyceae and Chlorophyceae were mostly recorded from the fish-ponds as phytoplankton.

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## ABSTRACT

The present study documents the 16 species of bryophytes for the first time from East Calcutta Wetlands. Of, these seven species belonging to three families and four genera to Marchantiophyta (liverworts) and nine species belonging to five families and six genera to Bryophyta (mosses).

Singh

BRYOPHYTES



## INTRODUCTION

The East Calcutta Wetlands (22° 27' N 88° 27' E) is a complex of natural and man-made ponds including marshes, salt meadows, as well as sewage farms located in east side of Kolkata, West Bengal bordered by new township at Rajarhat on one hand and Salt Lake Township on the other. The hot and humid climate of this Wetlands almost throughout the year with 1600 mm average rainfall resembles tropical region with sufficient sunlight and vast water regime. East Calcutta Wetlands is not so much suitable for the growth of bryophytes, but the various ponds, localized dampness area and trees of this region favours the growth of bryophytes.

Bryophytes, the Amphibians of the Plant Kingdom, and the second largest group of green plants comprising 2780 taxa (Mao & Dash, 2018) in India next only to angiosperms, constitute a fascinating component of biodiversity. They usually inhabit damp and shady conditions due to lack of true vascular system and absorb water and nutrients through their general surface of plant body. They are distributed globally in almost every available and conceivable habitat, except in marine environment. Bryophytes collectively represent three different groups (phyla), viz. Bryophyta (mosses), Marchantiophyta (liverworts) and the Anthocerotophyta (hornworts) and play an important role mainly to maintain the ecosystem.

A total of 363 taxa of liverworts and hornworts are known from West Bengal including bryologically rich Darjeeling district. Of, these only five species of liverworts (Singh *et al.*, 2016) and 24 species of mosses are known from Kolkata (Gangulee, 1969 - 1978; Chopra, 1975; Lal, 2007; Aziz & Vohra, 2008; Singh, 2013) without their minor locations, but none of the species were recorded from East Calcutta, Wetlands in particular. The present study revealed the occurrence of 16 species of bryophytes in East Calcutta Wetlands.

## METHODOLOGY

Various types of habitat and ecological niche have been surveyed during the month of April - June 2019. The collected specimens were preserved in the form of Herbarium packets as well as in pickled conditions (70% alcohol), especially in case of thallose forms, for anatomical studies. Field notes of collected specimens like colour of the plants, habit, habitat and associated species were noted and all the properly annotated specimens have been deposited in the Cryptogamic section of the Central National Herbarium, Botanical Survey of India, Howrah (CAL). The external morphology were studied under Stereo-zoom Dissection Microscope model Leica S8APO, anatomical details and microstructures were studied with the help of Biological Research Microscope model Nikon Eclipse Ni-I.





Fig. 1. Habitat A. A general view near to Dhapa; B. A view of wetlands near to Captain Bery; C-E. Terricolous (bryophytes growing on thick soil); F, G. Saxicolous (plants growing on rock or on brick wall surfaces); H-J. Corticolous (plants growing on bark of trees).

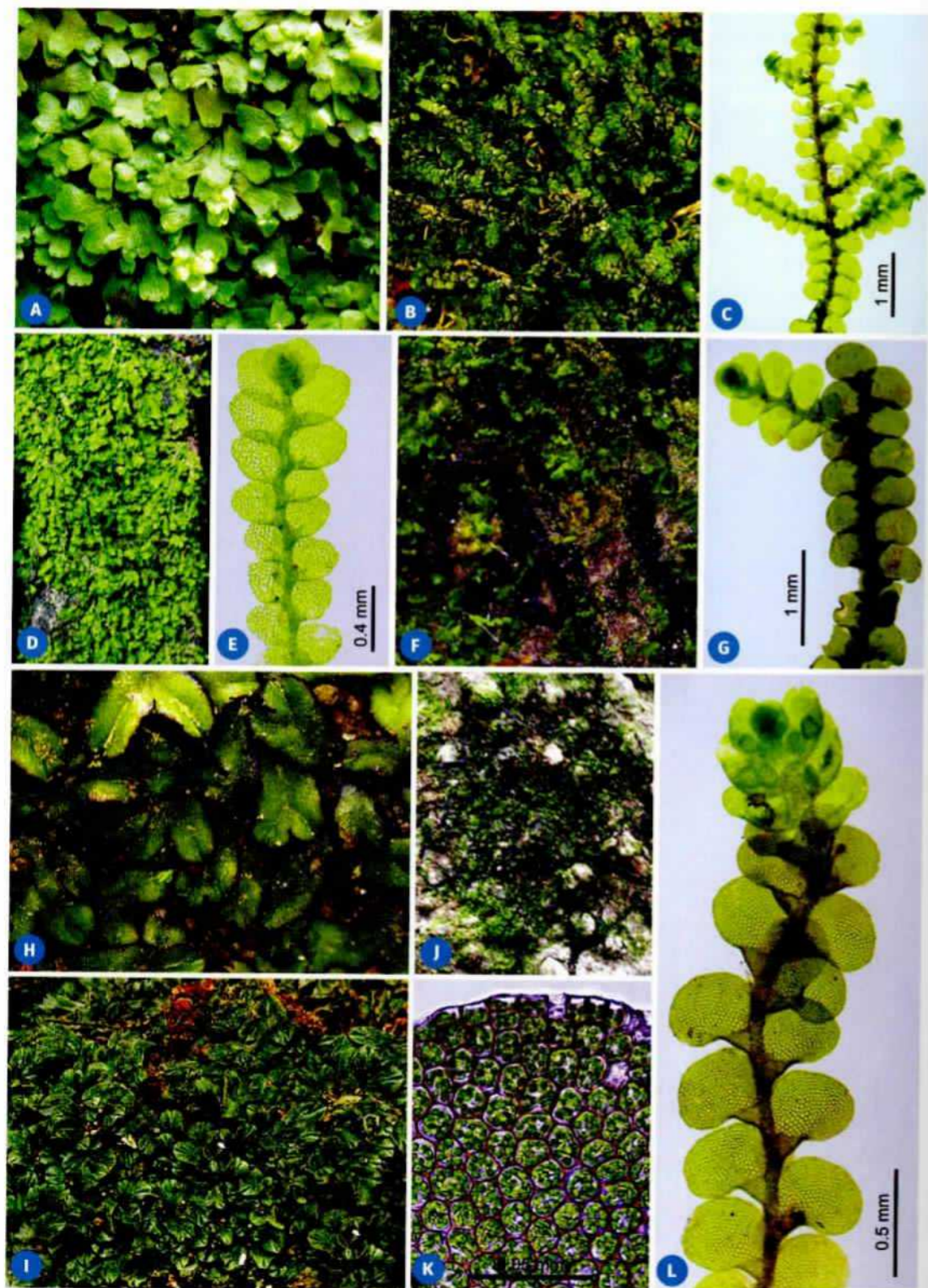
## RESULTS AND DISCUSSION

A total of sixteen species (seven liverworts and nine mosses) belonging to eight families and 10 genera were recorded from different localities of East Kolkata Wetlands in the month of April to June 2019, though the growth of bryophytes in this period is not suitable. However, edges of several water bodies and trees in the Wetlands supports the growth of bryophytes. During the study bryophytes growth was mostly observed as growing on thick soil in shady condition, on the bark of trees just opposite side of the sunlight or on rock and brick wall surfaces. The members of the lejeuneoid population of liverworts and family Pottiaceae of mosses are dominantly growing in the Wetland. The present findings provides the base line information of bryophytes East Kolkata Wetlands and it will help in future for other biological studies including plant-microbe and vertebral interaction. They play important role not only to maintain the ecosystem like soil conservation, habitat modification, nutrient cycling and pollution detection and monitoring, but also help and provide the shelter and security to various microorganism like cyanobacteria, diatoms and invertebrates. The majority of the bryophytes having flavonoids and terpenoids show many biological activities with chemical and pharmaceutical significance.

### Key to the families, genera and species of East Kolkata Wetlands

- 1a. Plants thalloid, arranged nonspirally in 2-3 rows, rhizoids unicellular, aseptate.....2 Liverworts
- 1b. Plants always leafy usually with distinct midrib, leaves arranged spirally in 3 rows, rhizoids, septate absence oil-bodies.....8. Mosses
- 2a. Plants leafy with leaves and stem.....3
- 2b. Plants thalloid.....6
- 3a. Underleaves bilobed.....4. *Lejeunea*
- 3b. Underleaves entire, not bilobed.....5
- 4a. First tooth of leaf lobule 2-4-celled.....*L. devendrae*
- 4b. First tooth of leaf lobule unicellular.....*L. alata*
- 5a. Plants blackish brown .....*Lopholejeunea sikkimensis*
- 5b. Plants yellowish green .....*Spruceanthus minutilobulus*
- 6a. Thallus thin, translucent.....*Cyathodium cavernarum*
- 6b. Thallus thick, opaque.....7. *Riccia*
- 7a. Plants monoicous .....*R. billardieri*
- 7b. Plants dioicous.....*R. discolor*
- 8a. Leaf midrib reduced or absent.....9
- 8b. Leaf with distinct midrib.....10
- 9a. Leaf midrib always absent .....*Erpodium mangiferae*
- 9b. Leaf midrib reduced at basal portion only.....*Entodontopsis tavoyensis*
- 10a. Leaves ditichous (arranged alternately in two opposite vertical row).....11. *Fissidens*
- 10b. Leaves simple, not ditichous.....12
- 11a. Apical portion of leaf margin margin crenulate.....*F. crenulatus*
- 11b. Apical portion of leaf margin margin entire.....*F. sylvaticus*
- 12a. Leaf cells smooth, usually rhomboidal.....*Bryum plumosum*
- 12b. Leaf cells papillose, usually rounded-quadrate.....13. *Pottiaceae*
- 13a. Leaves ligulate to lanceolate.....14. *Hyogonium*
- 13b. Leaves spatulate.....15. *Hyophila*
- 14a. Leaves with acute apices.....*H. arcuatum*
- 14b. Leaves with obtuse apices.....*H. consanguineum*
- 15a. Leaf margin distinctly serrulate in upper 1/3 portion .....*H. involuta*
- 15b. Leaf margin smooth throughout.....*H. nymaniana*





**Fig. 2 Liverworts** A. *Cyathodium cavernarum* Kunze ex Lehm.; B, C. *Lejeunea alata* Gottsche; D, E. *Lejeunea devendrae* (Sushil K. Singh) P.K. Verma & K.K. Rawat; F, G. *Lopholejeunea sikhimensis* Steph.; H. *Riccia billardierei* Mont. & Nees; I. *Riccia discolor* Lehm. & Lindenb.; J-K. *Spruceanthus minutilobulus* (Udar & U.S. Awasthi) Sushil K. Singh



**Fig. 3. Mosses** A, B. *Bryum plumosum* Dozy & Molke; C, D. *Entodontopsis tavoyensis* (Hook.) W.R. Buck & Ireland; E. *Erpodium mangiferae* Müll. Hal.; F-H. *Fissidens crenulatus* Mitt.; I-K. *Fissidens sylvaticus* Griff.; L, M. *Hydrogonium arcuatum* (Griff.) Wijk & Margad.; N, O. *Hydrogonium consanguineum* (Thwaites & Mitt.) Hilp.; P, Q. *Hyophila involuta* (Hook.) A. Jaeger; R, S. *Hyophila nymaniana* (M. Fleisch.) M. Menzel.

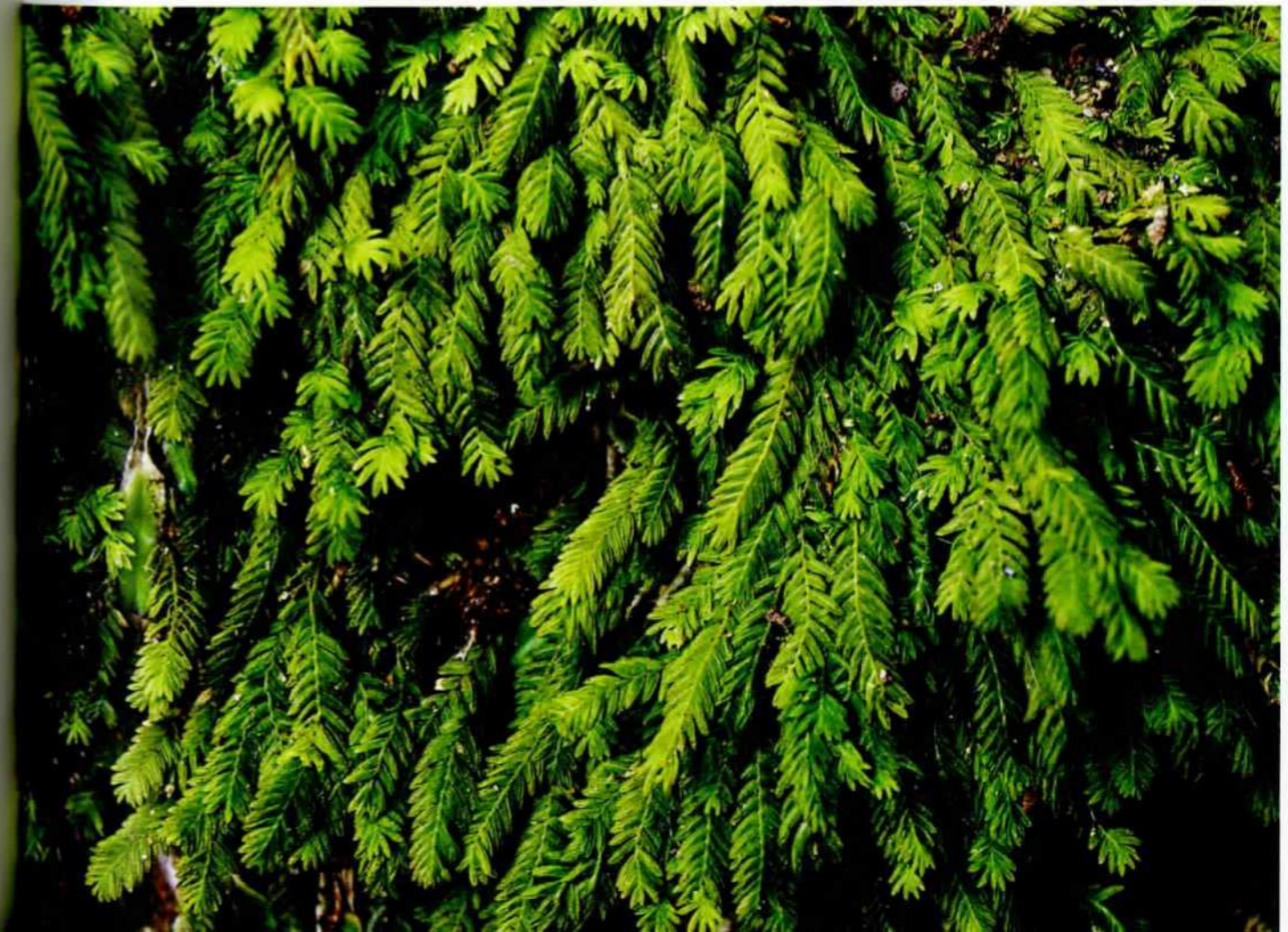


**Table 1:** List of the species of Bryophytes and their collection sites in East Kolkata Wetlands

S. No.	Name of the species	Family	Habitat	Locations
<b>Marchantiophyta (Liverworts)</b>				
1.	<i>Cyathodium cavernarum</i> Kunze ex Lehm.	Cyathodiaceae	Saxicolous	Nalban, N 22°56'09.24'' 088°42'89.22''E, 12 m
2.	<i>Lejeunea alata</i> Gottsche	Lejeuneaceae	Corticolous	Borali Village, N 22°50'00.09'' 088°58'97.91''E, 25 m
3.	<i>Lejeunea devendrae</i> (Sushil K. Singh) P.K.Verma & K.K.Rawat	Lejeuneaceae	Corticolous	Borali Village, N 22°50'00.09'' 088°58'97.91''E, 25 m
4.	<i>Lopholejeunea sikkimensis</i> Steph.	Lejeuneaceae	Corticolous	Borali Village, N 22°30'19.90'' 088°35'47.10''E, 30 m
5.	<i>Riccia billardierei</i> Mont. & Nees	Ricciaceae	Terricolous	Near Nalban, N 22°57'42.91'' 088°45'13.38''E, 11 m
6.	<i>Riccia discolor</i> Lehm. & Lindenb.	Ricciaceae	Terricolous	Near Nalban, N 22°57'42.91'' 088°45'13.38''E, 11 m
7.	<i>Spruceanthus minutilobulus</i> (Udar & U.S.Awasthi) Sushil K. Singh	Lejeuneaceae	Corticolous	Borali Village, N 22°30'19.90'' 088°35'47.10''E, 30 m
<b>Bryophyta (Mosses)</b>				
8.	<i>Bryum plumosum</i> Dozy & Molk.	Bryaceae	Saxicolous	Hatgacha N 22°54'99.99'' 088°46'75.44''E, 5 m
9.	<i>Entodontopsis tavoyensis</i> (Hook.) W.R. Buck & Ireland	Stereophyllaceae	Corticolous	Borali Village, N 22°30'19.90'' 088°35'47.10''E, 30 m
10.	<i>Erpodium mangiferae</i> Müll. Hal.	Erpodiaceae	Corticolous	Borali Village, N 22°30'19.90'' 088°35'47.10''E, 30 m
11.	<i>Fissidens crenulatus</i> Mitt.	Fissidentaceae	Terricolous	Borali Village, N 22°30'19.90'' 088°35'47.10''E, 30 m
12.	<i>Fissidens sylvaticus</i> Griff.	Fissidentaceae	Terricolous	Hatgacha N 22°54'99.99'' 088°46'75.44''E, 5 m
13.	<i>Hydrogonium arcuatum</i> (Griff.) Wijk & Margad.	Pottiaceae	Terricolous	Hatgacha N 22°54'99.99'' 088°46'75.44''E, 5 m
14.	<i>Hydrogonium consanguineum</i> (Thwaites & Mitt.) Hilp.	Pottiaceae	Terricolous	Hatgacha N 22°54'99.99'' 088°46'75.44''E, 5 m
15.	<i>Hyophila involuta</i> (Hook.) A. Jaeger	Pottiaceae	Terricolous	Hatgacha N 22°54'99.99'' 088°46'75.44''E, 5 m
16.	<i>Hyophila nymaniana</i> (M. Fleisch.) M. Menzel	Pottiaceae	Terricolous	Kouragawa, N 22°29'59.99'' 088°38'10.05''E, 14 m

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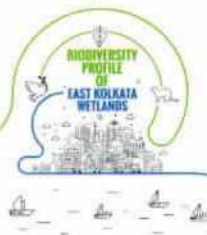
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## ABSTRACT

The East Kolkata Wetlands (EKW) supports local community who depend on fish farming and agriculture for their livelihood. About 4,718.56 ha of land are used by the people for cultivation. The present study resulted in the documentation of a total of 60 plants cultivated using traditional methods supporting the livelihood of the local people.

### Keywords

Local community, Agriculture, East Kolkata Wetlands



## INTRODUCTION

The wetland system represents the largest and possibly one of the oldest dual resource recovery practice on the globe which uses both agriculture and aquaculture practices. Food security, employment and income generation are some of the important and actual benefits of urban aquaculture, especially for the local communities from lower socio-economic strata. However, greater benefits offered to the society like managed waste reuse helping to improve public and environmental health protection, monetary benefits such as increased tax revenue and subsidised management of waste, non-renewable recovery of resource and other functional and non-functional benefits may also be ascribed to urban aquaculture. EKW is also not an exception. Livelihoods of the East Kolkata Wetlands communities are clearly linked to the resources available in the wetlands. Approximately, 74% of the local working community depends on agriculture, fish farming, and horticulture in these areas (Ghosh, 2005; Kundu *et al.*, 2005). There are four major types of land use patterns prevalently seen in these manmade wetlands covering 37 mouzas (Bhattacharyya *et al.*, 2008). They are:

1. Substantially waterbody-oriented area (primarily sewage fed fisheries): 5852.14 ha,
2. Agricultural Area: 4718.56 ha.
3. Productive Farming Area (garbage dumping, Dhapa): 602.78 and
4. Urban and Rural settlement: 1326.52 ha.

## PRODUCTION

Around 29.9 tonnes of fish and 150 tonnes of vegetables are produced almost every day from EKW area. Most of the vegetables produced here are harvested from small-scale horticultural plots irrigated with wastewater. Vegetable production here is a household activity with many people cultivating in small plots for their own household sustenance and income. The paddy fields produce around 16,000 tonnes of winter paddy varieties grown during post monsoon period (Bhattacharya *et al.*, 2012). Individually, the average annual yield of the boro paddy variety is highest (5 tonnes ha<sup>-1</sup>), followed by aman (3 tonnes ha<sup>-1</sup>). Waste recycling in the EKW involves three major resource recovery practices, namely sewage fed fisheries, paddy-cultivation by utilizing fish pond effluents and cultivation of vegetables using organic waste as fertilizer (Banerjee & Dey, 2017). Pal (2016) recorded a total of 24 crops and vegetables which are commonly cultivated in the EKW during the post-monsoon season.

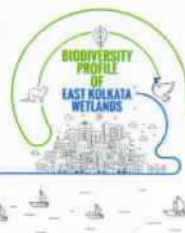
## RESULTS

The present study on the diversity of the agriculture crops cultivated in EKW has resulted in the documentation of 60 plants cultivated (Table 1, Plates 1&2) using traditional methods or harvested from the natural regeneration and become the part of livelihood for the local people.

**Table 1:** Cultivation crop plans of East Kolkata Wetlands

Sl. No.	Local Name	Scientific Name	Family
1.	Bhindi	<i>Abelmoschus esculentus</i> (L.) Moench	Malvaceae
2.	Bel	<i>Aegle marmelos</i> (L.) Corrêa	Rutaceae
3.	Lalsag	<i>Amaranthus cruentus</i> L.	Amaranthaceae
4.	Kanta Note	<i>Amaranthus spinosus</i> L.	Amaranthaceae
5.	Dengua	<i>Amaranthus tricolor</i> L.	Amaranthaceae
6.	Note	<i>Amaranthus viridis</i> L.	Amaranthaceae
7.	Ol	<i>Amorophallus paeoniifolius</i> (Dennst.) Nicolson	Araceae
8.	Supari	<i>Areca catechu</i> L.	Areaceae





Sl. No.	Local Name	Scientific Name	Family
9.	Kathal	<i>Artocarpus heterophyllus</i> Lam.	Moraceae
10.	Bramhi	<i>Bacopa monnieri</i> (L.) Wettst.	Scrophulariaceae
11.	Pui	<i>Basella alba</i> L.	Basellaceae
12.	Taal	<i>Borassus flabellifer</i> L.	Arecaceae
13.	Phul Kophi	<i>Brassica oleracea</i> var. <i>botrytis</i> L.	Brassicaceae
14.	Lanka	<i>Capsicum annuum</i> L.	Solanaceae
15.	Pepe	<i>Carica papaya</i> L.	Caricaceae
16.	Karamcha	<i>Carissa carandas</i> L.	Apocynaceae
17.	Bethu	<i>Chenopodium album</i> L.	Chenopodiaceae
18.	Lebu	<i>Citrus aurantiifolia</i> (Christm.) Swingle	Rutaceae
19.	Pati Lebu	<i>Citrus limon</i> (L.) Osbeck	Rutaceae
20.	Batabi Lebu	<i>Citrus maxima</i> (Burm.) Merr.	Rutaceae
21.	Kundri	<i>Coccinia grandis</i> (L.) Voigt	Cucurbitaceae
22.	Narkel	<i>Cocos nucifera</i> L.	Arecaceae
23.	Kochu	<i>Colocasia esculenta</i> (L.) Schott	Araceae
24.	Pat	<i>Corchorus olitorius</i> L.	Tiliaceae
25.	Kumro	<i>Cucurbita maxima</i> Duchesne	Cucurbitaceae
26.	Holud	<i>Curcuma longa</i> L.	Zingiberaceae
27.	Aans	<i>Dimocarpus longan</i> Lour.	Sapindaceae
28.	Lombu	<i>Dysoxylum alliaceum</i> (Blume) Blume	Meliaceae
29.	Surjamukhi	<i>Helianthus annuus</i> L.	Asteraceae
30.	Kulekhara	<i>Hygrophila schullii</i> M.R. Almeida & S.M. Almeida	Acanthaceae
31.	Kalmi	<i>Ipomoea aquatica</i> Forssk.	Convolvulaceae
32.	Sim	<i>Labiab purpureus</i> (L.) Sweet	Fabaceae
33.	Lau	<i>Lagenaria siceraria</i> (Molina) Standl.	Cucurbitaceae
34.	Katbel	<i>Limonia accidissima</i> L.	Rutaceae
35.	Tometo	<i>Lycopersicon esculentum</i> Mill.	Solanaceae
36.	Aam	<i>Mangifera indica</i> L.	Anacardiaceae
37.	Safeda	<i>Manilkara zapota</i> (L.) P. Royen	Sapotaceae
38.	Susni	<i>Marsilea minuta</i> L.	Marsileaceae
39.	Uchhe	<i>Momordica charantia</i> L.	Cucurbitaceae
40.	Sojne	<i>Moringa oleifera</i> Lam.	Moringaceae
41.	Kari Pata	<i>Murraya koenigii</i> (L.) Spreng.	Rutaceae
42.	Kola	<i>Musa paradisiaca</i> L.	Musaceae
43.	Shaluk	<i>Nymphaea pubescens</i> Willd.	Nymphaeaceae
44.	Tulsi	<i>Ocimum tenuiflorum</i> L.	Lamiaceae
45.	Dhan	<i>Oryza sativa</i> L.	Poaceae
46.	Khejur	<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae
47.	Hari fal	<i>Phyllanthus acidus</i> (L.) Skeels	Euphorbiaceae
48.	Pyara	<i>Psidium guajava</i> L.	Myrtaceae



Sl. No.	Local Name	Scientific Name	Family
49.	Bedana	<i>Punica granatum</i> L.	Punicaceae
50.	Mulo	<i>Raphanus sativus</i> L.	Brassicaceae
51.	Til	<i>Sesamum indicum</i> L.	Pedaliaceae
52.	Begun	<i>Solanum melongena</i> L.	Solanaceae
53.	Palak	<i>Spinacia oleracea</i> L.	Amaranthaceae
54.	Aamra	<i>Spondias pinnata</i> (L. f.) Kurz	Anacardiaceae
55.	Jam	<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae
56.	Golap jam	<i>Syzygium samarangense</i> (Blume) Merr. & L.M. Perry	Myrtaceae
57.	Tetul	<i>Tamarindus indica</i> L.	Caesalpiniaceae
58.	Pani fal	<i>Trapa natans</i> L.	Trapaceae
59.	Ghatkanchu	<i>Typhonium flagelliforme</i> (Lodd.) Blume	Araceae
60.	Bhutta	<i>Zea mays</i> L.	Poaceae

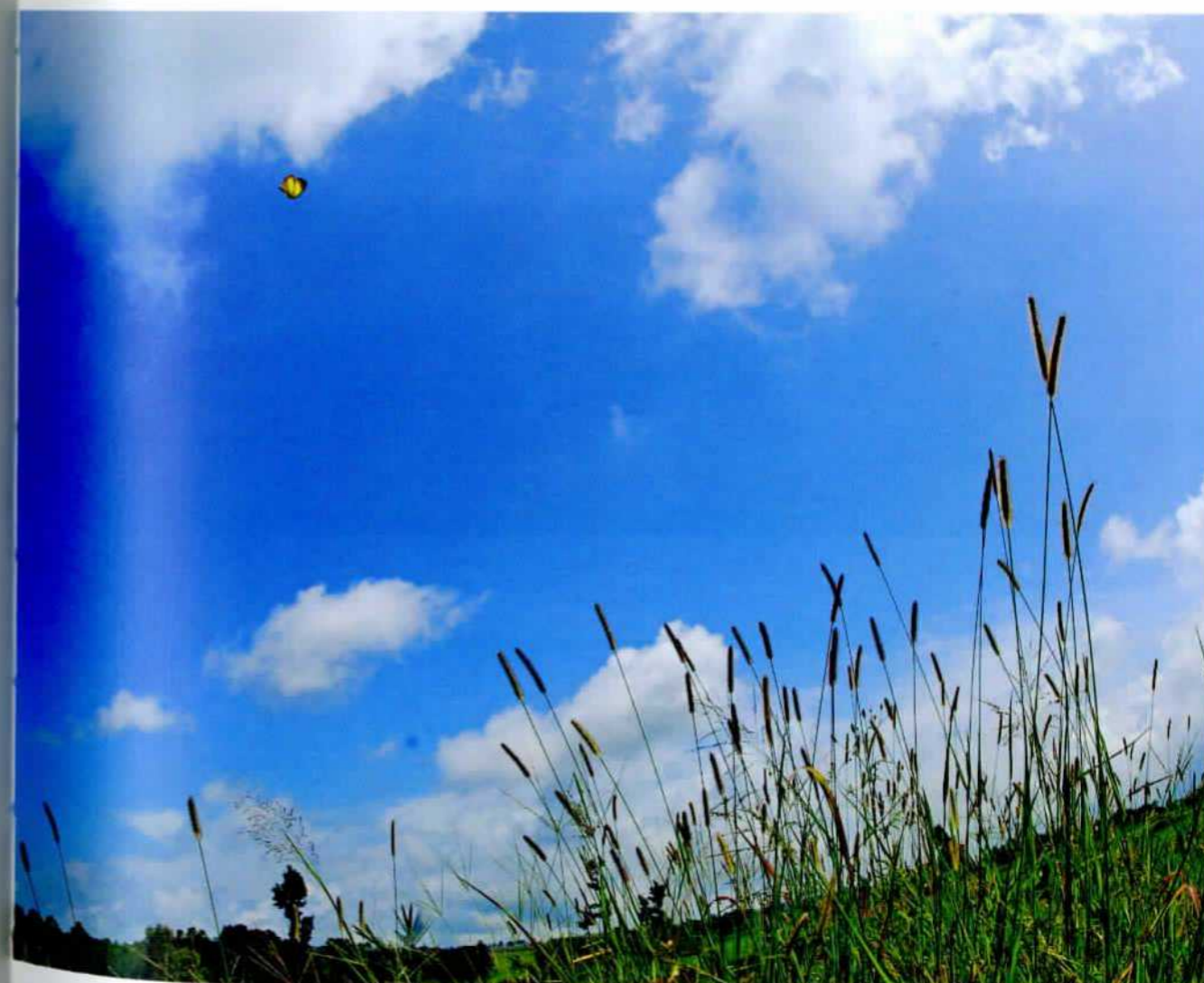




Plate 1: (Agriculture)



Plate 1:

- A. Locals engaged in sowing vegetable crops;
- B. Paddy cultivation in EKW;
- C. Cultivation of *Ocimum tenuiflorum* L. (Tulsi) - a medicinally important plant;
- D. Cultivation of *Solanum melongena* L. (Begun);
- E. Cultivation of *Curcuma longa* L. (Halud);
- F. Cultivation of *Helianthus annuus* L.

Plate 2: (Agriculture)



Plate 2:

- A. Cultivation of *Brassica oleracea* var. *botrytis* L. (Kophi);
- B. Cultivation of *Basella alba* L. (Pui);
- C. Cultivation of *Musa paradisiaca* L. (Kola);
- D. Cultivation of *Dysoxylum alliaceum* (Blume) Blume (Lambu);
- E. Paddy harvesting in EKW;
- F. Locals carrying vegetables to the local market.



## DISCUSSION

A closer look on the demand and production scenario underlines a success story of agricultural practices in EKW for generations. Assured bulk demand of aqua-products in urban markets in the vicinity of EKW is the important factor responsible for the development of many aquaculture activities in the area. Farmers practicing urban aquaculture get more advantage in comparison with their rural counterparts in terms of easy transportation which enable them to deliver fresh products in a short time, thus potentially securing more demand in the urban markets.

The wise use of waste water and by-products from food processing and agriculture in EKW, is the best solution to address the scarcity of the supply of nutrients and water resources faced by the farmers in conventional agricultural practices in developing countries. The optimum utilization of waste water and mineral available in solid and liquid waste will ensure the reduced pressure on renewable freshwater resources and non-renewable nutrient resources. Furthermore, it provides added benefit of environmental protection in terms of productive reuse of sewage in urban aquaculture compared to conventional practices on the disposal of wastewater and solid organic waste in many developing countries.

## RECOMMENDATIONS

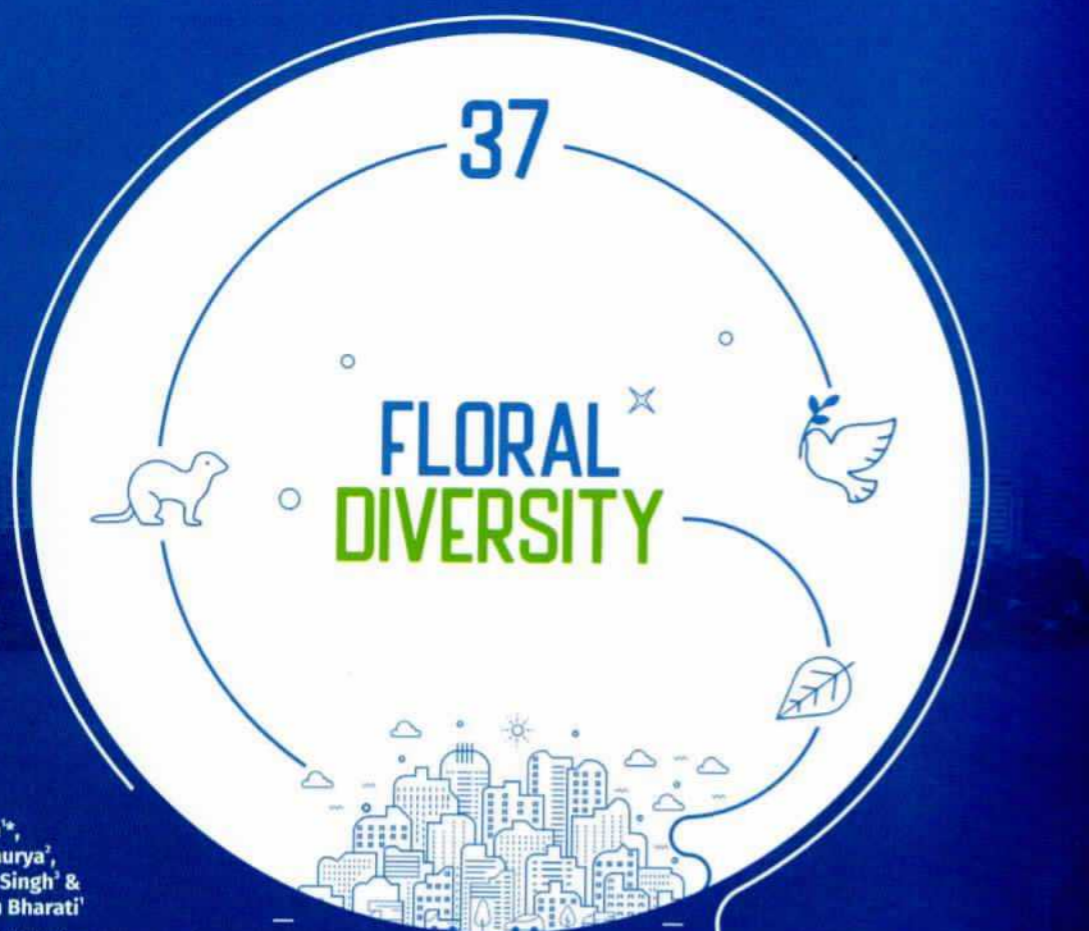
1. The effluents from industries, exclusively from the leather industries can severely affect the crop and vegetables cultivation in the wetlands. Efforts should be made to check the effluent inflow to avoid contamination of water with toxic chemicals and heavy metals.
2. The wetland ecosystem should be protected through proper management plans focussing on the conservation of ecosystem providing alternative support for the livelihood improvement and creating awareness among the local public in maintaining the ecosystem through sustainable utilization of the resources.
3. The EKW purifies the waste water drained from the city, supports the production of huge edible resources which is in turn supplied to the city, provides employment to the local community and also shelters rich and diverse flora. These wetlands are of extreme importance for maintaining the ecological balance. Steps should be taken to preserve this area from urban encroachment to ensure proper functioning of this unique wetland ecosystem.

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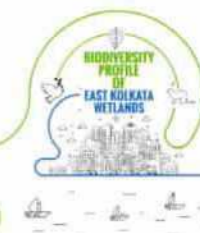
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## ABSTRACT

The East Kolkata Wetlands (EKW) is a mixture of man-made and natural wetlands and the largest waste water wetland among the 37 RAMSAR sites in India. The present study on the flora of EKW has resulted in the documentation of 381 taxa belonging to 371 taxa of angiosperms, 1 gymnosperm and 9 taxa of pteridophytes from 282 genera and 92 families. Among the angiosperms, 77% of the taxa were dicots and 23% taxa were monocots. The rich floristic diversity amidst a rapidly expanding city should be protected to preserve this wetland ecosystem.



## INTRODUCTION

The East Kolkata Wetlands (EKW), a manmade wetland located on the eastern peripheries of Kolkata, West Bengal, form a part of the huge inter-distributary water networks of the Gangetic Delta (Fig. 1). Extending over two districts namely the North and South 24 Parganas, between 22°25'to 22°40'North latitudes and 88°20'to 88°35'East longitudes, EKW with an area of 12,500 hectare (125 sq. km. approx.) wide wetlands unfurling over 37 mouzas with a total of 11,085 water-bodies is helping as a natural sewage treatment plant in Kolkata for more than a century (Bhattacharyya et al., 2008). It experiences hot and humid climate throughout the year with an average rainfall of 1600 mm (mainly concentrated in the rainy season from mid-June to October) which makes the area rich in bio-diversity. It mainly consists of intertidal marshes, salt meadows with substantial waste water treatment areas like settling ponds (locally known as Bheries and Jheels), farms and Sewage Canals, oxidation basins, dumping ground, green zone and cultivable lands (Chaudhuri et al., 2012). Initially, these were salt water lakes ranging between the Bidyadhari river on the east and river Hooghly on the west primarily serving as Flood control plain, Waste recycling region and as high productive area. This wetland has been described as "one of the rare examples of environmental protection and development management where a complex ecological process has been adopted by the local farmers for mastering the resource recovery activities" by Ramsar Convention on Wetlands. In 19<sup>th</sup> August 2002, the East Kolkata Wetlands area has been designated as "wetland of international importance" under the article 8 by the Ramsar Convention on Wetlands on the basis of wise use to produce a range of goods and services, sustainable and eco-friendly system of waste water treatment and a habitat for variety of flora and fauna (Kundu et al., 2008). The wetlands system represents the largest and possibly one of the oldest dual resource recovery practice on the globe which uses a blending of agriculture and aquaculture practices which has made Kolkata into an ecologically subsidized city. East Kolkata Wetland is the only Ramsar site (Site No. 1208) in the state of West Bengal that falls under Freshwater category. It is also the largest wetland area (12,500 ha) in the world having both freshwater and sewage-fed aquaculture ecosystems.

Before the establishment of Kolkata, the lake formed here was a backwater swamp and spill area of the Bidyadhari and Hooghly rivers. The Bidyadhari river no longer exists since beginning of the twentieth century. There have been significant changes in the pattern of land use since the eighteenth century especially because of river siltation, reclamation and diversion of sewage water (including domestic and industrial) leading to the stagnation of the marshes that lost its connection with the Bay of Bengal.

In the past it was a rich abode of wilderness and was well-known for its rich floral & faunal diversity. At present, these wetlands are haven for many biological resources that help to maintain the ecological balance of this system. Productivity and food chain, bio-geochemical cycling, water purification, maintaining O<sup>2</sup> - CO<sup>2</sup> budget are the major environmental role of biodiversity inhabiting in the wetland system. Apart from the environmental implication, wetland biodiversity is responsible for socio-economic uplifting. A good number of biological resources of this EKW are used as food, fodder, fuel, vegetables, pulses, oils, paper-pulp, thatching material, medicine and other wetland based cottage industries. Today, the wetland also provides broader ecosystem services of carbon sequestration and recreation. Fascinating as the wetland system is, even more fascinating is the way the flow of traditional knowledge takes place from one generation to another that resulted in evolving of the outstanding practices that are still preserved today.

To assess the present status of the floristic diversity of this wetland complex, the Botanical Survey of India with its experts on various plant groups conducted field surveys to make an assessment of the floristic diversity which could help in designing methods for conservation and sustainable utilization of the plant resources of East Kolkata Wetlands.



Fig. 1: Map of East Kolkata Wetlands



## LITERATURE REVIEW

The studies on the Flora of the East Kolkata Wetlands was first carried out by Biswas (1927), who recorded 70 species from various zones distributed within embankments of east Calcutta. Majumder (1965), while studying the aquatic plants from Kolkata and adjacent localities, recorded 38 species of dicots from 19 families, 62 species of monocots from 12 families and 3 species of ferns from 3 families. Dasgupta (1973) recorded 97 species among which, 34 species were restricted to saline water habitat. He also made remarks on the existence of mangrove plants in these regions. This study clearly indicated the presence of saline condition in the wetlands which has changed over time. Recently, Chaudhuri *et al.* (2012) mentioned the existence of about 104 plant species from the EKW. However, a comprehensive study was lacking to document the floristic diversity of the East Kolkata Wetland.

## MATERIAL AND METHODS

The present study has been carried out with an objective to provide a comprehensive account of the flora of East Kolkata Wetlands (EKW). Prior to field studies, specimens deposited in CAL were studied and literatures pertaining to the flora of the study area were surveyed. The area was explored periodically from April-December, 2019 covering different parts of the study area and voucher specimens were collected following conventional herbarium methodology (Jain and Rao, 1977). Data on habit, habitat, locality, elevation, associated plants, distribution pattern, abundance, phenology and local uses were recorded in the field notebook. Digital photographs were taken to record the flora, vegetation and different microhabitats along with GPS location for all the plants collected. The specimens were carefully studied for morphological characters for their accurate identification. Identification and nomenclature of the plants were determined based on recent monographs, revisionary studies and relevant floras. The specimens were also compared with authenticated specimens deposited in CAL. The present study covers the aquatic, semiaquatic, marshy angiosperms as well as plants occurring in drier boundaries along the wetlands.

## RESULTS

Most of the wetlands of East Kolkata are segmented to several plots called bheries to facilitate fish culture. These bheries are generally less in hydrophyte diversity with few patches of *Eichhornia crassipes*, *Pistia stratiotes*, *Lemna perpusilla* etc. Natural wetlands and those which are without fish culture are comparatively rich in aquatic vegetation. The major aquatic herbs occurring in these wetlands are submerged aquatic herbs like *Ceratophyllum demersum*, *Hydrilla verticillata*, *Najas graminea*, *Nechamandra alternifolia*, *Ottelia alismoides*, *Potamogeton crispus*, *Vallisneria spiralis*, etc. The common free floating hydrophytes are *Azolla pinnata*, *Eichhornia crassipes*, *Lemna perpusilla*, *Lemna minor*, *Pistia stratiotes*, *Wolffia globosa* etc. Hydrophytes that are rooted at the bottom and with floating leaves include *Aponogeton natans*, *Nelumbo nucifera*, *Nymphaea nouchali*, *Nymphaea pubescens*, *Nymphoides cristata*, *Nymphoides indica* etc.

Along the edges of the waterbodies, where the habitat is marshy, many varieties of flora are encountered which adapts to both aquatic and moist/wet substratum. Large, dense patches of *Aeschynomene aspera*, *Alternanthera philoxeroides*, *Bacopa monnieri*, *Colocasia esculenta*, *Commelina benghalensis*, *Dentella repens*, *Eclipta prostrata*, *Enydra fluctuans*, *Glinus oppositifolius*, *Grangea maderaspatana*, *Hygrophila schulli*, *Ipomoea aquatica*, *Limnophila heterophylla*, *Ludwigia adscendens*, *Sagittaria montevidensis*, *Schoenoplectiella articulata*, *Monochoria vaginalis*, *Oxalis corniculata*, *Persicaria barbata*, *Persicaria hydropiper*, *Phyla nodiflora*, *Polygonum plebeium* are commonly found. Dense patches of *Typha domingensis* and *Cyperus* spp. are also found frequently.

The edges of the water bodies, on the elevated places which remain drier during most of the year also possess rich and diverse flora. Several herbs, shrubs and trees preferring moist habitat are seen here. Herbs like *Cleome gynandra*, *Cleome rutidosperma*, *Datura metel*, *Nicotiana plumbaginifolia*, *Physalis minima*, *Portulaca oleracea*, *Rorippa indica*, *Scoparia dulcis*, *Solanum sisymbriifolium*, *Synedrella nodiflora* etc., undershrubs like *Abutilon indicum*, *Glycosmis pentaphylla*, *Sida acuta*, *Senna occidentalis* etc., shrubs like *Cestrum diurnum*, *Jatropha curcas*, *Jatropha gossypifolia*, *Ricinus communis*, *Senna alata* and climbers like *Cardiospermum halicacabum*, *Cayratia trifolia*, *Coccinia grandis*, *Cuscuta campestris* and *Passiflora foetida* are very commonly found here. Trees like *Acacia nilotica* ssp. *indica*, *Borassus flabellifer*, *Ficus hispida*, *Phoenix sylvestris*, *Streblus asper* are also common. Several weeds of agricultural fields, invasive species, garden escapes are also noticed here.

The roads and pathways inside the wetland areas are also rich in floral diversity. Several invasive species are frequently encountered along these roads. Several planted trees and garden escapes are also noticed. Shrubs like *Calotropis gigantea*, *Lantana camara* and climbers like *Ipomoea marginata*, *Mikania scandens* and *Tinospora cordifolia* are common. Trees like *Albizia saman*, *Areca catechu*, *Ficus benghalensis*, *Ficus racemosa*, *Putranjiva roxburghii*, *Trewia nudiflora*, *Trema orientalis* are frequently found here.

The present study on the Floristic diversity of East Kolkata Wetlands, West Bengal has resulted in the collection of 381 taxa of plants belonging to 371 taxa of angiosperms 1 gymnosperm and 9 taxa of



pteridophytes from 282 genera and 92 families. Among the angiosperms, dicots dominate the flora with 284 taxa (77%) belonging to 220 genera under 69 families and monocots are represented by 87 taxa (23%) belonging to 62 genera under 18 families (Tables 1 & 2, Plates 1-4).

**Table 1:** Floristic diversity of East Kolkata Wetlands

Sl. No.	Name	Family	Habit
1	<i>Ranunculus sceleratus</i> L.	Ranunculaceae	Herb
2	<i>Magnolia champaca</i> (L.) Baill. ex Pierre	Magnoliaceae	Tree
3	<i>Annona reticulata</i> L.	Annonaceae	Tree
4	<i>Polyalthia longifolia</i> (Sonn.) Thwaites	Annonaceae	Tree
5	<i>Cissampelos pareira</i> L.	Menispermaceae	Climber
6	<i>Tinospora cordifolia</i> (Willd.) Miers	Menispermaceae	Climber
7	<i>Stephania japonica</i> (Thunb.) Miers var. <i>discolor</i> (Blume) Forman	Menispermaceae	Climber
8	<i>Nymphaea nouchali</i> Burm.f.	Nymphaeaceae	Herb
9	<i>Nymphaea pubescens</i> Willd.	Nymphaeaceae	Herb
10	<i>Nelumbo nucifera</i> Gaertn.	Nelumbonaceae	Herb
11	<i>Argemone mexicana</i> L.	Papaveraceae	Herb
12	<i>Brassica juncea</i> (L.) Czern.	Brassicaceae	Herb
13	<i>Rorippa indica</i> (L.) Hiern	Brassicaceae	Herb
14	<i>Capparis zeylanica</i> L.	Capparaceae	Scandent shrub
15	<i>Cleome gynandra</i> L.	Capparaceae	Herb
16	<i>Cleome rutidosperma</i> DC.	Capparaceae	Herb
17	<i>Cleome viscosa</i> L.	Capparaceae	Herb
18	<i>Portulaca oleracea</i> L.	Portulacaceae	Herb
19	<i>Abelmoschus esculentus</i> (L.) Moench	Malvaceae	Undershrub
20	<i>Abutilon indicum</i> (L.) Sweet	Malvaceae	Undershrub
21	<i>Hibiscus mutabilis</i> L.	Malvaceae	Shrub
22	<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Shrub
23	<i>Hibiscus vitifolius</i> L.	Malvaceae	Undershrub
24	<i>Malachra capitata</i> (L.) L.	Malvaceae	Undershrub
25	<i>Malvastrum coromandelianum</i> (L.) Garcke	Malvaceae	Undershrub
26	<i>Sida acuta</i> Burm.f.	Malvaceae	Undershrub
27	<i>Sida cordata</i> (Burm.f.) Borss. Waalk.	Malvaceae	Undershrub
28	<i>Sida rhombifolia</i> L.	Malvaceae	Undershrub
29	<i>Urena lobata</i> L.	Malvaceae	Herb
30	<i>Urena sinuata</i> L.	Malvaceae	Herb
31	<i>Ceiba pentandra</i> (L.) Gaertn.	Bombacaceae	Tree
32	<i>Abroma augusta</i> (L.) L.f.	Sterculiaceae	Shrub
33	<i>Melochia corchorifolia</i> L.	Sterculiaceae	Undershrub

Sl. No.	Name	Family	Habit
34	<i>Corchorus aestuans</i> L.	Tiliaceae	Undershrub
35	<i>Oxalis corniculata</i> L.	Oxalidaceae	Herb
36	<i>Averrhoa bilimbi</i> L.	Averrhoaceae	Tree
37	<i>Aegle marmelos</i> (L.) Corrêa	Rutaceae	Tree
38	<i>Citrus aurantiifolia</i> (Christm.) Swingle	Rutaceae	Tree
39	<i>Citrus limon</i> (L.) Osbeck	Rutaceae	Tree
40	<i>Citrus maxima</i> (Burm.) Merr.	Rutaceae	Tree
41	<i>Glycosmis pentaphylla</i> (Retz.) DC.	Rutaceae	Undershrub
42	<i>Limonia accidissima</i> L.	Rutaceae	Tree
43	<i>Murraya koenigii</i> (L.) Spreng.	Rutaceae	Shrub
44	<i>Murraya paniculata</i> (L.) Jack	Rutaceae	Tree
45	<i>Azadirachta indica</i> A. Juss.	Meliaceae	Tree
46	<i>Melia azedarach</i> L.	Meliaceae	Tree
47	<i>Swietenia mahogani</i> L.	Meliaceae	Tree
48	<i>Ziziphus oenopolia</i> (L.) Mill.	Rhamnaceae	Shrub
49	<i>Cayratia trifolia</i> (L.) Domin	Vitaceae	Climber
50	<i>Cardiospermum halicacabum</i> L.	Sapindaceae	Climber
51	<i>Dimocarpus longan</i> Lour.	Sapindaceae	Tree
52	<i>Anacardium occidentale</i> L.	Anacardiaceae	Tree
53	<i>Mangifera indica</i> L.	Anacardiaceae	Tree
54	<i>Spondias pinnata</i> (L. f.) Kurz	Anacardiaceae	Tree
55	<i>Moringa oleifera</i> Lam.	Moringaceae	Tree
56	<i>Bauhinia acuminata</i> L.	Caesalpiniaceae	Tree
57	<i>Caesalpinia bonduc</i> (L.) Roxb.	Caesalpiniaceae	Shrub
58	<i>Cassia fistula</i> L.	Caesalpiniaceae	Tree
59	<i>Cassia javanica</i> subsp. <i>nodosa</i> (Roxb.) K. Larsen & S.S. Larsen	Caesalpiniaceae	Tree
60	<i>Delonix regia</i> (Bojer ex Hook.) Raf.	Caesalpiniaceae	Tree
61	<i>Peltophorum pterocarpum</i> (DC.) Baker ex K. Heyne	Caesalpiniaceae	Tree
62	<i>Senna alata</i> (L.) Roxb.	Caesalpiniaceae	Shrub
63	<i>Senna obtusifolia</i> (L.) Irwin & Barneby	Caesalpiniaceae	Undershrub
64	<i>Senna occidentalis</i> (L.) Link	Caesalpiniaceae	Undershrub
65	<i>Senna siamea</i> (Lam.) H.S. Irwin & Barneby	Caesalpiniaceae	Tree
66	<i>Senna tora</i> (L.) Roxb.	Caesalpiniaceae	Undershrub
67	<i>Tamarindus indica</i> L.	Caesalpiniaceae	Tree
68	<i>Acacia auriculiformis</i> A.Cunn. ex Benth.	Mimosaceae	Tree
69	<i>Acacia nilotica</i> (L.) Willd. ex Delile ssp. <i>indica</i> (Benth.) Brenan	Mimosaceae	Tree
70	<i>Albizia lebbek</i> (L.) Benth.	Mimosaceae	Tree



Sl. No.	Name	Family	Habit
71	<i>Albizia saman</i> (Jacq.) Merr.	Mimosaceae	Tree
72	<i>Lysiloma latisiliquum</i> (L.) Benth.	Mimosaceae	Tree
73	<i>Neptunia oleracea</i> Lour.	Mimosaceae	Herb
74	<i>Pithecellobium dulce</i> (Roxb.) Benth.	Mimosaceae	Tree
75	<i>Aeschynomene aspera</i> L.	Fabaceae	Herb
76	<i>Aeschynomene indica</i> L.	Fabaceae	Herb
77	<i>Alysicarpus vaginalis</i> (L.) DC.	Fabaceae	Herb
78	<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	Tree
79	<i>Dalbergia latifolia</i> Roxb.	Fabaceae	Tree
80	<i>Desmodium gangeticum</i> (L.) DC.	Fabaceae	Herb
81	<i>Desmodium triflorum</i> (L.) DC.	Fabaceae	Herb
82	<i>Erythrina variegata</i> L.	Fabaceae	Tree
83	<i>Sesbania sesban</i> (L.) Merr.	Fabaceae	Shrub
84	<i>Smithia sensitiva</i> Aiton	Fabaceae	Herb
85	<i>Teramnus labialis</i> (L.f.) Spreng.	Fabaceae	Climber
86	<i>Myriophyllum tetrandrum</i> Roxb.	Haloragaceae	Herb
87	<i>Combretum indicum</i> (L.) DeFilipps	Combretaceae	Climber
88	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.	Combretaceae	Tree
89	<i>Terminalia catappa</i> L.	Combretaceae	Tree
90	<i>Corymbia citriodora</i> (Hook.) K.D. Hill & L.A.S. Johnson	Myrtaceae	Tree
91	<i>Callistemon lanceolatus</i> (Sm.) Sweet	Myrtaceae	Tree
92	<i>Psidium guajava</i> L.	Myrtaceae	Tree
93	<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	Tree
94	<i>Syzygium samarangense</i> (Blume) Merr. & L.M. Perry	Myrtaceae	Tree
95	<i>Ammannia baccifera</i> L.	Lythraceae	Herb
96	<i>Lagerstroemia speciosa</i> (L.) Pers.	Lythraceae	Tree
97	<i>Lawsonia inermis</i> L.	Lythraceae	Shrub
98	<i>Punica granatum</i> L.	Punicaceae	Shrub
99	<i>Ludwigia adscendens</i> (L.) H. Hara	Onagraceae	Herb
100	<i>Ludwigia hyssopifolia</i> (G. Don) Exell	Onagraceae	Herb
101	<i>Ludwigia perennis</i> L.	Onagraceae	Herb
102	<i>Trapa natans</i> L.	Trapaceae	Herb
103	<i>Passiflora foetida</i> L.	Passifloraceae	Climber
104	<i>Passiflora suberosa</i> L.	Passifloraceae	Climber
105	<i>Carica papaya</i> L.	Caricaceae	Tree
106	<i>Coccinia grandis</i> (L.) Voigt	Cucurbitaceae	Climber
107	<i>Cucurbita coccinea</i> G. Don	Cucurbitaceae	Climber
108	<i>Momordica charantia</i> L.	Cucurbitaceae	Climber
109	<i>Glinus lotoides</i> L.	Aizoaceae	Herb

Sl. No.	Name	Family	Habit
110	<i>Glinus oppositifolius</i> (L.) Aug. DC.	Aizoaceae	Herb
111	<i>Trianthema portulacastrum</i> L.	Aizoaceae	Herb
112	<i>Centella asiatica</i> (L.) Urb.	Apiaceae	Herb
113	<i>Foeniculum vulgare</i> Mill.	Apiaceae	Herb
114	<i>Oenanthe javanica</i> (Blume) DC.	Apiaceae	Herb
115	<i>Alangium salvifolium</i> (L.f.) Wangerin	Alangiaceae	Tree
116	<i>Dentella repens</i> (L.) J.R. Forst. & G. Forst.	Rubiaceae	Herb
117	<i>Ixora chinensis</i> Lam.	Rubiaceae	Shrub
118	<i>Morinda angustifolia</i> Roxb.	Rubiaceae	Shrub
119	<i>Mussaenda philippica</i> A. Rich.	Rubiaceae	Shrub
120	<i>Neolamarckia cadamba</i> (Roxb.) Bosser	Rubiaceae	Tree
121	<i>Oldenlandia biflora</i> L.	Rubiaceae	Herb
122	<i>Oldenlandia corymbosa</i> L.	Rubiaceae	Herb
123	<i>Paederia foetida</i> L.	Rubiaceae	Climber
124	<i>Ageratum conyzoides</i> (L.) L.	Asteraceae	Herb
125	<i>Blumea lacera</i> (Burm.f.) DC.	Asteraceae	Herb
126	<i>Caesulia axillaris</i> Roxb.	Asteraceae	Herb
127	<i>Cyanthillium cinereum</i> (L.) H. Rob.	Asteraceae	Herb
128	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	Herb
129	<i>Eleutheranthera ruderalis</i> (Sw.) Sch. Bip.	Asteraceae	Herb
130	<i>Enydra fluctuans</i> DC.	Asteraceae	Herb
131	<i>Grangea maderaspatana</i> (L.) Poir.	Asteraceae	Herb
132	<i>Helianthus annuus</i> L.	Asteraceae	Undershrub
133	<i>Laphangium luteoalbum</i> (L.) Tzvelev	Asteraceae	Herb
134	<i>Mikania micrantha</i> Kunth	Asteraceae	Climber
135	<i>Parthenium hysterophorus</i> L.	Asteraceae	Herb
136	<i>Pluchea indica</i> (L.) Less.	Asteraceae	Herb
137	<i>Pseudelephantopus spicatus</i> (B. Juss. ex Aubl.) Rohr ex C.F. Baker	Asteraceae	Herb
138	<i>Sonchus arvensis</i> L.	Asteraceae	Herb
139	<i>Tridax procumbens</i> (L.) L.	Asteraceae	Herb
140	<i>Xanthium strumarium</i> L.	Asteraceae	Undershrub
141	<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	Herb
142	<i>Sphagneticola calendulacea</i> (L.) Pruski	Asteraceae	Herb
143	<i>Sphenoclea zeylanica</i> Gaertn.	Sphenocleaceae	Herb
144	<i>Manilkara zapota</i> (L.) P. Royen	Sapotaceae	Tree
145	<i>Nyctanthes arbor-tristis</i> L.	Oleaceae	Tree
146	<i>Allamanda cathartica</i> L.	Apocynaceae	Climber
147	<i>Alstonia scholaris</i> (L.) R. Br.	Apocynaceae	Tree
148	<i>Cascabela thevetia</i> (L.) Lippold	Apocynaceae	Tree
149	<i>Carissa carandas</i> L.	Apocynaceae	Tree



Sl. No.	Name	Family	Habit
150	<i>Catharanthus roseus</i> (L.) G. Don	Apocynaceae	Herb
151	<i>Kopsia fruticosa</i> (Roxb.) A. DC.	Apocynaceae	Tree
152	<i>Nerium oleander</i> L.	Apocynaceae	Shrub
153	<i>Rauvolfia tetraphylla</i> L.	Apocynaceae	Undershrub
154	<i>Tabernaemontana divaricata</i> (L.) R. Br. ex Roem. & Schult.	Apocynaceae	Shrub
155	<i>Calotropis gigantea</i> (L.) R. Br.	Asclepiadaceae	Shrub
156	<i>Pergularia daemia</i> (Forssk.) Chiov.	Asclepiadaceae	Climber
157	<i>Dregea volubilis</i> (L.f.) Benth. ex Hook.f.	Asclepiadaceae	Climber
158	<i>Nymphoides cristata</i> (Roxb.) Kuntze	Menyanthaceae	Herb
159	<i>Nymphoides indica</i> (L.) Kuntze	Menyanthaceae	Herb
160	<i>Heliotropium curassavicum</i> L.	Boraginaceae	Herb
161	<i>Heliotropium indicum</i> L.	Boraginaceae	Herb
162	<i>Heliotropium ovalifolium</i> Forssk.	Boraginaceae	Herb
163	<i>Cuscuta campestris</i> Yunck.	Convolvulaceae	Climber
164	<i>Evolvulus alsinoides</i> (L.) L.	Convolvulaceae	Herb
165	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	Herb
166	<i>Hewittia malabarica</i> (L.) Suresh	Convolvulaceae	Climber
167	<i>Ipomoea aquatica</i> Forssk.	Convolvulaceae	Herb
168	<i>Ipomoea carnea</i> Jacq. subsp. <i>fistulosa</i> (Mart. ex Choisy) D.F. Austin	Convolvulaceae	Undershrub
169	<i>Ipomoea obscura</i> (L.) Ker Gawl.	Convolvulaceae	Climber
170	<i>Ipomoea marginata</i> (Desr.) Verdc.	Convolvulaceae	Climber
171	<i>Ipomoea triloba</i> L.	Convolvulaceae	Climber
172	<i>Operculina turpethum</i> (L.) Silva Manso	Convolvulaceae	Climber
173	<i>Capsicum annuum</i> L.	Solanaceae	Herb
174	<i>Cestrum diurnum</i> L.	Solanaceae	Shrub
175	<i>Datura metel</i> L.	Solanaceae	Herb
176	<i>Lycopersicon esculentum</i> Mill.	Solanaceae	Herb
177	<i>Nicotiana plumbaginifolia</i> Viv.	Solanaceae	Herb
178	<i>Physalis minima</i> L.	Solanaceae	Herb
179	<i>Solanum americanum</i> Mill.	Solanaceae	Herb
180	<i>Solanum indicum</i> L.	Solanaceae	Herb
181	<i>Solanum melongena</i> L.	Solanaceae	Herb
182	<i>Solanum sisymbriifolium</i> Lam.	Solanaceae	Herb
183	<i>Solanum torvum</i> Sw.	Solanaceae	Herb
184	<i>Bacopa monnieri</i> (L.) Wettst.	Scrophulariaceae	Herb
185	<i>Limnophila heterophylla</i> (Roxb.) Benth.	Scrophulariaceae	Herb
186	<i>Lindernia oppositifolia</i> (Retz.) Mukherjee	Scrophulariaceae	Herb
187	<i>Mazus pumilus</i> (Burm.f.) Steenis	Scrophulariaceae	Herb
188	<i>Mecardonia procumbens</i> (Mill.) Small	Scrophulariaceae	Herb

Sl. No.	Name	Family	Habit
189	<i>Scoparia dulcis</i> L.	Scrophulariaceae	Herb
190	<i>Utricularia aurea</i> Lour.	Lentibulariaceae	Herb
191	<i>Utricularia stellaris</i> L.f.	Lentibulariaceae	Herb
192	<i>Tabebuia aurea</i> (Silva Manso) Benth. & Hook.f. ex S. Moore	Bignoniaceae	Tree
193	<i>Spathodea campanulata</i> P. Beauv.	Bignoniaceae	Tree
194	<i>Sesamum indicum</i> L.	Pedaliaceae	Herb
195	<i>Acanthus ilicifolius</i> L.	Acanthaceae	Undershrub
196	<i>Andrographis paniculata</i> (Burm. f.) Wall. ex Nees	Acanthaceae	Herb
197	<i>Asystasia gangetica</i> (L.) T. Anderson	Acanthaceae	Herb
198	<i>Barleria prionitis</i> L.	Acanthaceae	Undershrub
199	<i>Hemigraphis hirta</i> (Vahl) T. Anderson	Acanthaceae	Herb
200	<i>Hygrophila schullii</i> M.R. Almeida & S.M. Almeida	Acanthaceae	Herb
201	<i>Hygrophila triflora</i> (Roxb. ex Nees) Fosberg & Sacht	Acanthaceae	Herb
202	<i>Justicia adhatoda</i> L.	Acanthaceae	Undershrub
203	<i>Justicia gendarussa</i> Burm.f.	Acanthaceae	Undershrub
204	<i>Justicia simplex</i> D. Don	Acanthaceae	Herb
205	<i>Ruellia prostrata</i> Poir.	Acanthaceae	Herb
206	<i>Ruellia tuberosa</i> L.	Acanthaceae	Herb
207	<i>Clerodendrum indicum</i> (L.) Kuntze	Verbenaceae	Undershrub
208	<i>Clerodendrum infortunatum</i> L.	Verbenaceae	Undershrub
209	<i>Duranta erecta</i> L.	Verbenaceae	Shrub
210	<i>Gmelina arborea</i> Roxb.	Verbenaceae	Tree
211	<i>Lantana camara</i> L.	Verbenaceae	Shrub
212	<i>Lippia alba</i> (Mill.) N.E. Br. ex Britton & P. Wilson	Verbenaceae	Undershrub
213	<i>Phyla nodiflora</i> (L.) Greene	Verbenaceae	Herb
214	<i>Tectona grandis</i> L.f.	Verbenaceae	Tree
215	<i>Vitex negundo</i> L.	Verbenaceae	Shrub
216	<i>Volkameria inermis</i> L.	Verbenaceae	Shrub
217	<i>Anisomeles indica</i> (L.) Kuntze	Lamiaceae	Undershrub
218	<i>Leonurus sibiricus</i> L.	Lamiaceae	Undershrub
219	<i>Leucas aspera</i> (Willd.) Link	Lamiaceae	Herb
220	<i>Hyptis suaveolens</i> (L.) Poit	Lamiaceae	Herb
221	<i>Ocimum tenuiflorum</i> L.	Lamiaceae	Herb
222	<i>Boerhavia diffusa</i> L.	Lamiaceae	Herb
223	<i>Boerhavia repens</i> L.	Lamiaceae	Herb
224	<i>Mirabilis jalapa</i> L.	Lamiaceae	Herb
225	<i>Achyranthes aspera</i> L.	Amaranthaceae	Herb





Sl. No.	Name	Family	Habit
226	<i>Aerva lanata</i> (L.) Juss.	Amaranthaceae	Herb
227	<i>Alternanthera ficoidea</i> (L.) Sm.	Amaranthaceae	Herb
228	<i>Alternanthera paronychioides</i> A.St.-Hil.	Amaranthaceae	Herb
229	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Amaranthaceae	Herb
230	<i>Alternanthera sessilis</i> (L.) R.Br. ex DC.	Amaranthaceae	Herb
231	<i>Amaranthus cruentus</i> L.	Amaranthaceae	Herb
232	<i>Amaranthus hybridus</i> L.	Amaranthaceae	Herb
233	<i>Amaranthus spinosus</i> L.	Amaranthaceae	Herb
234	<i>Amaranthus tricolor</i> L.	Amaranthaceae	Herb
235	<i>Amaranthus viridis</i> L.	Amaranthaceae	Herb
236	<i>Celosia argentea</i> L.	Amaranthaceae	Herb
237	<i>Gomphrena globosa</i> L.	Amaranthaceae	Herb
238	<i>Chenopodium album</i> L.	Chenopodiaceae	Herb
239	<i>Suaeda maritima</i> (L.) Dumort.	Chenopodiaceae	Herb
240	<i>Basella alba</i> L.	Basellaceae	Climber
241	<i>Persicaria barbata</i> (L.) H. Hara	Polygonaceae	Herb
242	<i>Persicaria glabra</i> (Willd.) M. Gómez	Polygonaceae	Herb
243	<i>Persicaria hydropiper</i> (L.) Delarbre	Polygonaceae	Herb
244	<i>Persicaria orientalis</i> (L.) Spach	Polygonaceae	Herb
245	<i>Polygonum plebeium</i> R. Br.	Polygonaceae	Herb
246	<i>Rumex dentatus</i> L.	Polygonaceae	Herb
247	<i>Peperomia pellucida</i> (L.) Kunth	Piperaceae	Herb
248	<i>Litsea glutinosa</i> (Lour.) C.B. Rob.	Lauraceae	Tree
249	<i>Acalypha indica</i> L.	Euphorbiaceae	Herb
250	<i>Chrozophora rottleri</i> (Geiseler) A. Juss. ex Spreng.	Euphorbiaceae	Undershrub
251	<i>Codiaeum variegatum</i> (L.) Rumph. ex A. Juss.	Euphorbiaceae	Shrub
252	<i>Croton bonplandianus</i> Baill.	Euphorbiaceae	Undershrub
253	<i>Euphorbia antiquorum</i> L.	Euphorbiaceae	Shrub
254	<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	Undershrub
255	<i>Euphorbia hirta</i> L.	Euphorbiaceae	Herb
256	<i>Euphorbia indica</i> Lam.	Euphorbiaceae	Herb
257	<i>Euphorbia nivulia</i> Buch.-Ham.	Euphorbiaceae	Shrub
258	<i>Euphorbia prostrata</i> Aiton	Euphorbiaceae	Herb
259	<i>Euphorbia thymifolia</i> L.	Euphorbiaceae	Herb
260	<i>Euphorbia tithymaloides</i> L.	Euphorbiaceae	Undershrub
261	<i>Excoecaria agallocha</i> L.	Euphorbiaceae	Tree
262	<i>Flueggea virosa</i> (Roxb. ex Willd.) Voigt	Euphorbiaceae	Shrub
263	<i>Jatropha curcas</i> L.	Euphorbiaceae	Shrub



Sl. No.	Name	Family	Habit
264	<i>Jatropha gossypifolia</i> L.	Euphorbiaceae	Shrub
265	<i>Trewia nudiflora</i> L.	Euphorbiaceae	Tree
266	<i>Putranjiva roxburghii</i> Wall.	Euphorbiaceae	Tree
267	<i>Phyllanthus acidus</i> (L.) Skeels	Euphorbiaceae	Tree
268	<i>Phyllanthus amarus</i> Schumach. & Thonn.	Euphorbiaceae	Herb
269	<i>Phyllanthus emblica</i> L.	Euphorbiaceae	Tree
270	<i>Phyllanthus reticulatus</i> Poir.	Euphorbiaceae	Shrub
271	<i>Phyllanthus urinaria</i> L.	Euphorbiaceae	Herb
272	<i>Ricinus communis</i> L.	Euphorbiaceae	Shrub
273	<i>Pilea microphylla</i> (L.) Liebm.	Urticaceae	Herb
274	<i>Pouzolzia zeylanica</i> (L.) Benn.	Urticaceae	Herb
275	<i>Cannabis sativa</i> L.	Cannabaceae	Shrub
276	<i>Trema orientalis</i> (L.) Blume	Cannabaceae	Tree
277	<i>Artocarpus heterophyllus</i> Lam.	Moraceae	Tree
278	<i>Ficus benghalensis</i> L.	Moraceae	Tree
279	<i>Ficus hispida</i> L.f.	Moraceae	Tree
280	<i>Ficus racemosa</i> L.	Moraceae	Tree
281	<i>Ficus religiosa</i> L.	Moraceae	Tree
282	<i>Streblus asper</i> Lour.	Moraceae	Shrub
283	<i>Casuarina equisetifolia</i> L.	Casuarinaceae	Tree
284	<i>Ceratophyllum demersum</i> L.	Ceratophyllaceae	Herb
285	<i>Hydrilla verticillata</i> (L.f.) Royle	Hydrocharitaceae	Herb
286	<i>Nechamandra alternifolia</i> (Roxb. ex Wight) Thwaites	Hydrocharitaceae	Herb
287	<i>Ottelia alismoides</i> (L.) Pers.	Hydrocharitaceae	Herb
288	<i>Vallisneria spiralis</i> L.	Hydrocharitaceae	Herb
289	<i>Vanda tessellata</i> (Roxb.) Hook. ex G. Don	Orchidaceae	Herb
290	<i>Curcuma longa</i> L.	Zingiberaceae	Herb
291	<i>Musa paradisiaca</i> L.	Musaceae	Herb
292	<i>Canna indica</i> L.	Cannaceae	Herb
293	<i>Dioscorea bulbifera</i> L.	Dioscoreaceae	Climber
294	<i>Eichhornia crassipes</i> (Mart.) Solms	Pontederiaceae	Herb
295	<i>Monochoria hastata</i> (L.) Solms	Pontederiaceae	Herb
296	<i>Monochoria vaginalis</i> (Burm.f.) C. Presl	Pontederiaceae	Herb
297	<i>Commelina benghalensis</i> L.	Commelinaceae	Herb
298	<i>Commelina diffusa</i> Burm.f.	Commelinaceae	Herb
299	<i>Commelina longifolia</i> Lam.	Commelinaceae	Herb
300	<i>Commelina paludosa</i> Blume	Commelinaceae	Herb
301	<i>Murdannia vaginata</i> (L.) G.Brückn.	Commelinaceae	Herb





Sl. No.	Name	Family	Habit
302	<i>Cyanotis axillaris</i> (L.) D. Don ex Sweet	Commelinaceae	Herb
303	<i>Areca catechu</i> L.	Arecaceae	Tree
304	<i>Borassus flabellifer</i> L.	Arecaceae	Tree
305	<i>Cocos nucifera</i> L.	Arecaceae	Tree
306	<i>Dypsis lutescens</i> (H. Wendl.) Beentje & J. Dransf.	Arecaceae	Shrub
307	<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	Tree
308	<i>Typha angustifolia</i> L.	Typhaceae	Herb
309	<i>Typha domingensis</i> Pers.	Typhaceae	Herb
310	<i>Alocasia macrorrhizos</i> (L.) G. Don	Araceae	Herb
311	<i>Colocasia esculenta</i> (L.) Schott	Araceae	Herb
312	<i>Cryptocoryne spiralis</i> (Retz.) Fisch. ex Wydler	Araceae	Herb
313	<i>Pistia stratiotes</i> L.	Araceae	Herb
314	<i>Typhonium flagelliforme</i> (Lodd.) Blume	Araceae	Herb
315	<i>Lemna minor</i> L.	Lemnaceae	Herb
316	<i>Lemna perpusilla</i> Torrey	Lemnaceae	Herb
317	<i>Spirodela polyrrhiza</i> (L.) Schleid.	Lemnaceae	Herb
318	<i>Wolffia globosa</i> (Roxb.) Hartog & Plas	Lemnaceae	Herb
319	<i>Sagittaria guayanensis</i> Kunth	Alismataceae	Herb
320	<i>Sagittaria montevidensis</i> Cham. & Schlttdl.	Alismataceae	Herb
321	<i>Sagittaria sagittifolia</i> L.	Alismataceae	Herb
322	<i>Najas graminea</i> Delile	Najadaceae	Herb
323	<i>Aponogeton natans</i> (L.) Engl. & K. Krause	Aponogetonaceae	Herb
324	<i>Potamogeton crispus</i> L.	Potamogetonaceae	Herb
325	<i>Bolboschoenus maritimus</i> subsp. <i>affinis</i> (Roth.) T. Koyama	Cyperaceae	Herb
326	<i>Bulbostylis densa</i> (Wall.) Hand.-Mazz.	Cyperaceae	Herb
327	<i>Cyperus alopecuroides</i> Rottb.	Cyperaceae	Herb
328	<i>Cyperus articulatus</i> L.	Cyperaceae	Herb
329	<i>Cyperus compressus</i> L.	Cyperaceae	Herb
330	<i>Cyperus corymbosus</i> Rottb.	Cyperaceae	Herb
331	<i>Cyperus difformis</i> L.	Cyperaceae	Herb
332	<i>Cyperus distans</i> L.f.	Cyperaceae	Herb
333	<i>Cyperus kyllingia</i> Endl.	Cyperaceae	Herb
334	<i>Cyperus nutans</i> Vahl	Cyperaceae	Herb
335	<i>Cyperus pangorei</i> Rottb.	Cyperaceae	Herb
336	<i>Cyperus pilosus</i> Vahl	Cyperaceae	Herb
337	<i>Cyperus polystachyos</i> Rottb.	Cyperaceae	Herb
338	<i>Cyperus pumilus</i> L.	Cyperaceae	Herb



Sl. No.	Name	Family	Habit
339	<i>Cyperus rotundus</i> L.	Cyperaceae	Herb
340	<i>Eleocharis spiralis</i> (Rottb.) Roem. & Schult.	Cyperaceae	Herb
341	<i>Fimbristylis eragrostis</i> (Nees) Hance	Cyperaceae	Herb
342	<i>Fimbristylis polytrichoides</i> (Retz.) Vahl	Cyperaceae	Herb
343	<i>Fimbristylis schoenoides</i> (Retz.) Vahl	Cyperaceae	Herb
344	<i>Kyllinga brevifolia</i> Rottb.	Cyperaceae	Herb
345	<i>Mariscus aristatus</i> (Rottb.) T. Tang & F.T. Wang	Cyperaceae	Herb
346	<i>Pycreus polystachyos</i> (Rottb.) P. Beauv.	Cyperaceae	Herb
347	<i>Schoenoplectiella articulata</i> (L.) Lye	Cyperaceae	Herb
348	<i>Brachiaria reptans</i> (L.) C.A. Gardner & C.E. Hubb.	Poaceae	Herb
349	<i>Chloris barbata</i> Sw.	Poaceae	Herb
350	<i>Chrysopogon aciculatus</i> (Retz.) Trin.	Poaceae	Herb
351	<i>Coix aquatica</i> Roxb.	Poaceae	Herb
352	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Herb
353	<i>Dactyloctenium aegyptium</i> (L.) Willd.	Poaceae	Herb
354	<i>Echinochloa colona</i> (L.) Link	Poaceae	Herb
355	<i>Echinochloa crus-galli</i> (L.) P.Beauv.	Poaceae	Herb
356	<i>Eleusine indica</i> (L.) Gaertn.	Poaceae	Herb
357	<i>Eragrostis amabilis</i> (L.) Wight & Arn.	Poaceae	Herb
358	<i>Hygroryza aristata</i> (Retz.) Nees ex Wight & Arn.	Poaceae	Herb
359	<i>Imperata cylindrica</i> (L.) Raeusch.	Poaceae	Herb
360	<i>Isachne globosa</i> (Thunb.) Kuntze	Poaceae	Herb
361	<i>Leersia hexandra</i> Sw.	Poaceae	Herb
362	<i>Leptochloa chinensis</i> (L.) Nees	Poaceae	Herb
363	<i>Panicum paludosum</i> Roxb.	Poaceae	Herb
364	<i>Paspalidium flavidum</i> (Retz.) A. Camus	Poaceae	Herb
365	<i>Paspalidium punctatum</i> (Burm.) A. Camus	Poaceae	Herb
366	<i>Paspalum conjugatum</i> P.J. Bergius	Poaceae	Herb
367	<i>Paspalum scrobiculatum</i> L.	Poaceae	Herb
368	<i>Phragmites karka</i> (Retz.) Trin. ex Steud.	Poaceae	Herb
369	<i>Phyllostachys aurea</i> Rivière & C. Rivière	Poaceae	Herb
370	<i>Vetiveria zizanioides</i> (L.) Nash	Poaceae	Herb
371	<i>Zoysia matrella</i> (L.) Merr.	Poaceae	Herb
372	<i>Azolla imbricata</i> (Roxb. ex Griff.) Nakai	Salviniaceae	Herb
373	<i>Salvinia molesta</i> D.S. Mitch.	Salviniaceae	Herb



Sl. No.	Name	Family	Habit
374	<i>Salvinia natans</i> (L.) All.	Salviniaceae	Herb
375	<i>Marsilea minuta</i> L.	Marsileaceae	Herb
376	<i>Ceratopteris thalictroides</i> (L.) Brongn.	Pteridaceae	Herb
377	<i>Adiantum</i> sp.	Pteridaceae	Herb
378	<i>Pteris vittata</i> L.	Pteridaceae	Herb
379	<i>Asplenium nidus</i> L.	Aspleniaceae	Herb
380	<i>Drynaria quercifolia</i> (L.) J. Sm.	Polypodiaceae	Herb
381	<i>Platyclusus orientalis</i> (L.) Franco	Cupressaceae	Shrub

**Table 2:** Floristic analysis of East Kolkata Wetlands

Plant Groups	Plant Groups	No. of Families	No. of Genera	No. of Taxa
Angiosperms	Dicots	69	220	284
Monocots	18	62	87	
Gymnosperms	1	1	1	
Pteridophytes	5	8	9	
<b>Total</b>	<b>93</b>	<b>291</b>	<b>381</b>	

The flora of East Kolkata Wetlands is dominated by the families Poaceae and Euphorbiaceae with 24 taxa each. Cyperaceae ranks next with 23 taxa followed by Asteraceae (19) and Amaranthaceae (13). The families Acanthaceae, Caesalpinaceae and Malvaceae are represented by 12 taxa each. The families Fabaceae (11 taxa), Solanaceae (11 taxa), Convolvulaceae (10 taxa) and Verbenaceae (10 taxa) are also well represented in the EKW.

An analysis of the flora based on their life-forms categories such as herbs, shrubs, undershrub, trees and climbers reveals that the EKW is dominated by herbaceous flora (55%). A total of 209 herbaceous taxa were recorded from the study area. Trees form 19% of the total taxa recorded from the study area (73 taxa). Shrubs and under shrubs together constitute 17% (64 taxa). A total of 25 climbers (7%) including lianas were also recorded from the East Kolkata Wetland.

**Plate 1:** (Vegetation)



**Plate 1:**

- A. Sewage entrance point of the Wetland;
- B. Sewage water channels supporting lush vegetation;
- C. A man made pond supporting a variety of hydrophytic flora;
- D. Dense population of *Sagittaria montevidensis*;
- E. Patches of *Typha* spp.;
- F. A natural pond in the study area.



Plate 2: (Aquatic vegetation)

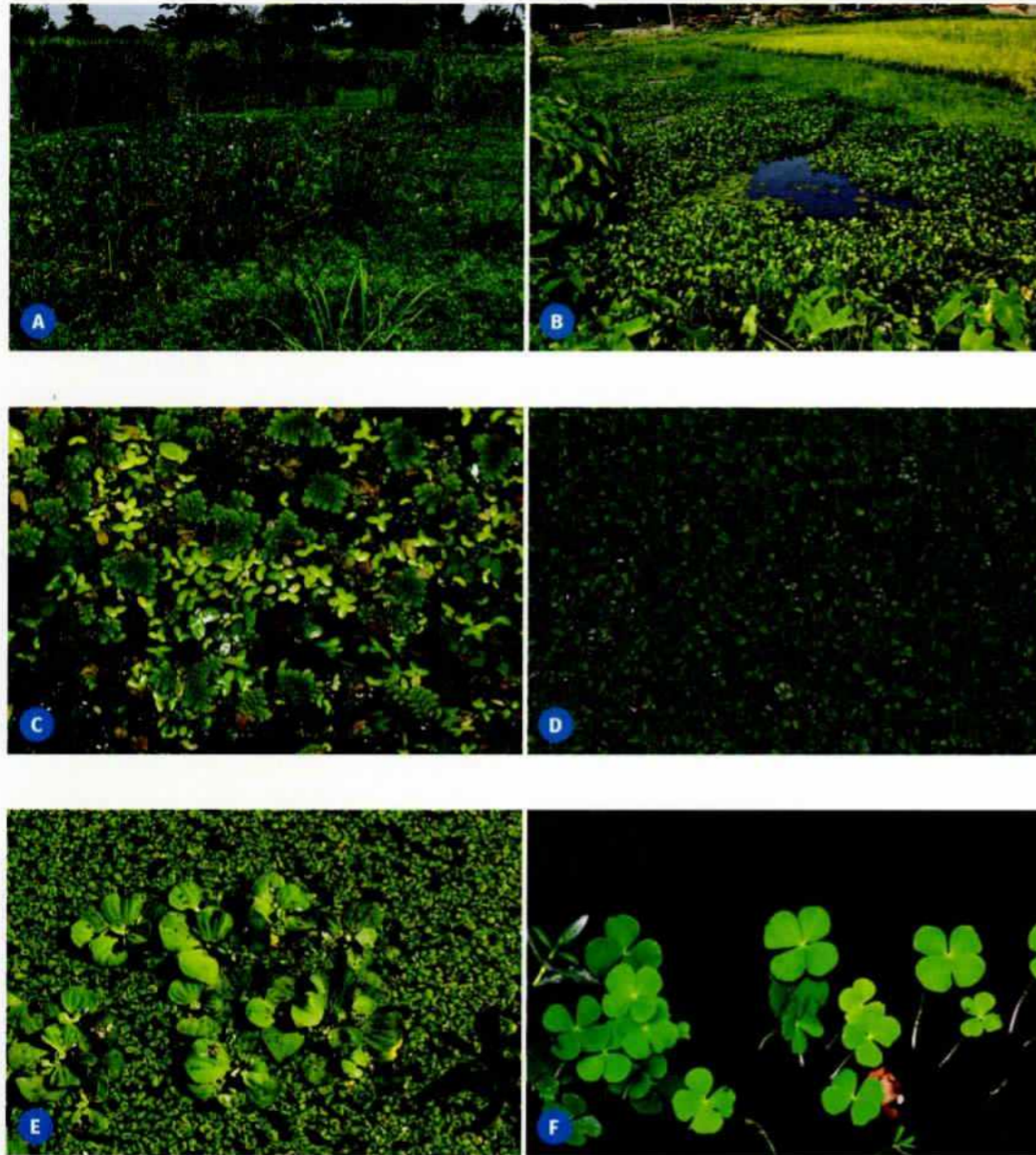


Plate 2:

- A. Dense patches of *Cyperus* spp.;
- B. *Eichhornia crassipes* - a dominant species of the wetland;
- C. Dense colony of floating and submerged hydrophytic flora;
- D. Dense growth of *Lemna perpusilla*;
- E. *Pistia stratiotes* - a common hydrophyte;
- F. *Marsilea minuta* - common aquatic fern

Plate 3: (Aquatic herbs)

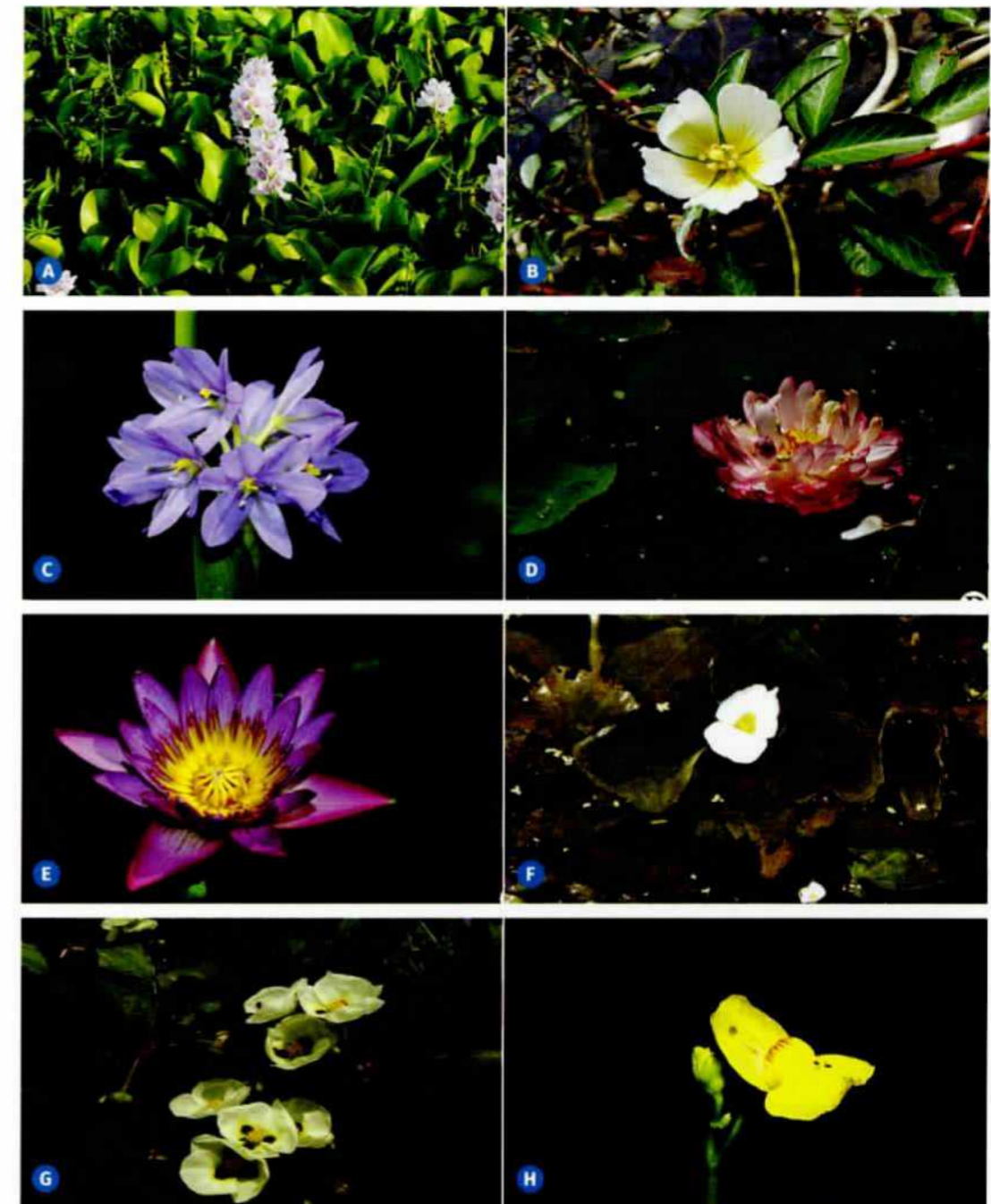


Plate 3:

- A. *Eichhornia crassipes* (Mart.) Solms;
- B. *Ludwigia adscendens* (L.) H. Hara;
- C. *Monochoria vaginalis* (Burm.f.);
- D. *Nelumbo nucifera* Gaertn.;
- E. *Nymphaea nouchali* Burm.f.;
- F. *Ottelia alismoides* (L.) Pers.;
- G. *Sagittaria montevidensis* Cham & Schldt.;
- H. *Utricularia aurea* Lour.



Plate 4: (Moist herbs)



Plate 4:

- A. *Aeschynomene aspera* L.;  
 B. *Alternanthera philoxeroides* (Mart.) Griseb;  
 C. *Commelina benghalensis* L.;  
 D. *Cyanotis axillaris* (L.) D. Don ex Sweet;  
 E. *Eclipta prostrata* (L.);  
 F. *Enydra fluctuans* DC.;  
 G. *Ipomoea aquatica* Forssk.;  
 H. *Phyla nodiflora* (L.) Greene

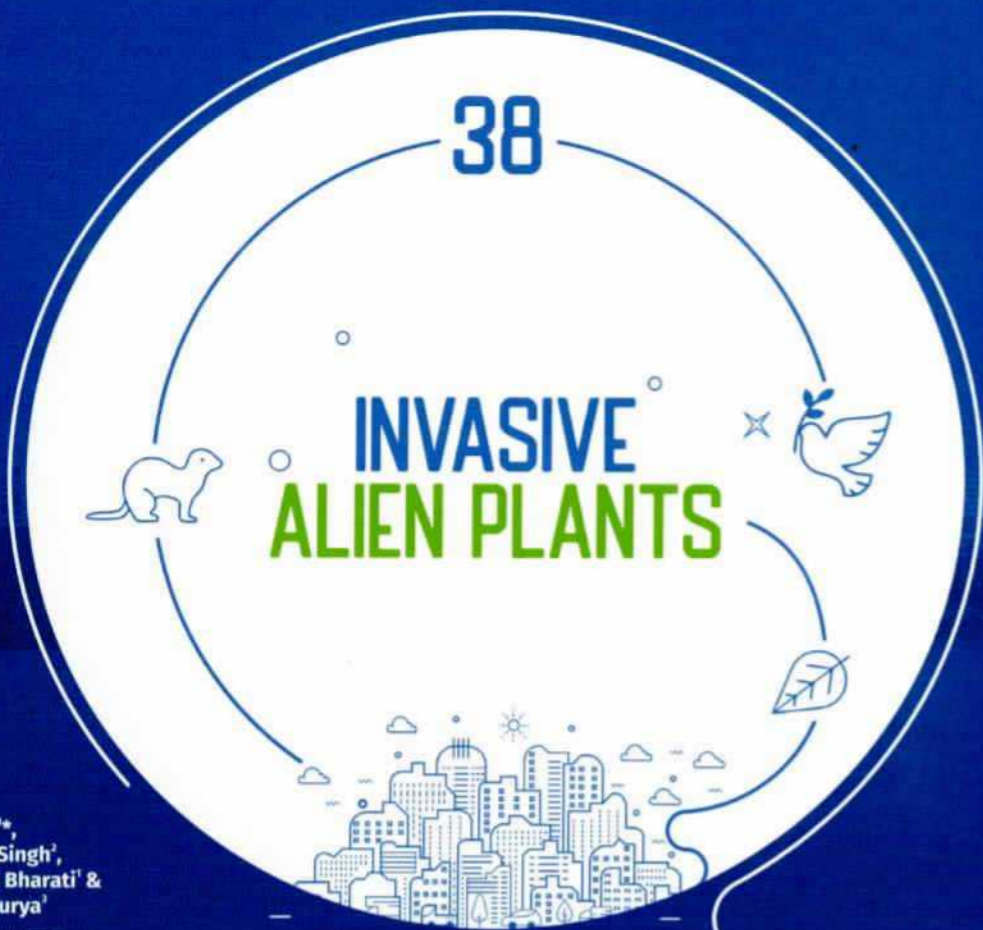
## DISCUSSION

Wetlands are one of the most vulnerable ecosystems in the world, since it can be easily converted to other type for the human requirement like agriculture, aquaculture, real estate, or any other developmental activities. Today this valuable natural asset is highly threatened due to the phenomenon of urbanization. A rapid urbanization in the eastern fringes of Kolkata has led to the unplanned conversion of wetlands into urban habitations. After the development of Salt Lake City and the construction of Eastern Metropolitan Bypass road, this eastern neighbourhood of Kolkata has become well connected with the Kolkata city and the expanding pressure of the urbanization has created the EKW a hotspot for land promoters leading to changes in the pattern of land use. If the change occurs to a significant extent then there will be simultaneous threat on the existing sewage and rainwater disposal practices of the city of Kolkata and the livelihood options available to local people through wastewater aquaculture. The rich floral and faunal diversity of this wetland is also under immediate threat of habitat destruction which will lead to species extinction.

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## ABSTRACT

The present study is carried out for the survey and documentation of the invasive alien vascular plants of East Kolkata Wetlands. A total of 61 invasive alien species under 50 genera and 29 families were recorded. The study is based on field observations, survey of published literature and consultation of herbarium depositions.

### Keywords

Invasive Alien Species, Vascular Plants, East Kolkata Wetlands



## INTRODUCTION

Biological invasion is considered as one of the important reasons for economic and environmental destruction across the world (Simberloff, 2011). It is considered as an important threat for the decrease and loss of the native biodiversity. With steady increase in human movement and global trade, the intensity of biological invasion has been increasing in all ecosystems and landscapes (Shreshta, 2016). Invasive species enters into a new ecosystem by native or through human activities, establishes itself well in the new habitat and spread aggressively, causing serious threat to the native species. The transport and exchange of biological resources, especially plants across the world was practised by humans for several centuries. As defined by IUCN (2020) "An alien species is a species introduced outside its natural past or present distribution". If this species establishes well in the natural or semi-natural ecosystems or the new habitat, it becomes a threat to the native biodiversity. These invasive species are rapidly multiplying and aggressively invading the world's flora and fauna and is recognised as a primary cause of global biodiversity loss second only to that of habitat destruction and ecosystem degradation (Mooney and Hobbs, 2000; Reddy et al., 2008).

Invasive alien species often have much increased water usage, compared with native vegetation (Calder and Dye, 2001). Due to their rapid growth and propagation, they compete with the native flora by occupying the habitat and exploiting the nutritional and hydrological resources. They cause biodiversity loss in the region, including species extinctions, change in hydrology and fluctuation. Invasive species are a major obstacle for the conservation and sustainable use of biodiversity, with significant unwanted impacts on the goods and services which are provided by ecosystems (Raghubanshi et al., 2005). Invasive plant species also threaten the development through their impact on agriculture, fisheries forestry and natural eco systems which play an important role in the livelihoods of peoples in developing countries (Kumar and Prasad, 2014). About 40% of the plants recorded in the Indian flora are alien, of which nearly 25% of plants are invasive (Raghubanshi et al., 2005). Over the last few decades, the study of species invasions has gained more attention worldwide and many studies are focussed on mapping their distribution, measuring the ecological and economic impacts to develop efficient management approaches (Thapa et al., 2018).

A total of 173 species belonging to 117 genera under 44 families were listed as invasive alien plant species in India (Reddy et al., 2008). The present study has been carried out to document the invasive alien species in East Kolkata Wetlands (EKW), a RAMSAR site of international significance, unique for its wise use of sewage water for agriculture and fish farming.

## MATERIAL AND METHODS

Intensive field surveys were conducted during different seasons, covering different habitats such as water canals, agricultural fields, road sides, waste lands, dumping yards, freshwater ponds, river banks etc in the East Kolkata Wetlands. The information available in the literature and in herbarium specimens housed at the Central National Herbarium (CAL) was also consulted. The native range of occurrence of the invasive plants has been recorded from online databases (wensp.science.kew.org; gbif; tropicos etc.) and available literature (Reddy et al., 2008). Plants were categorised based on their life forms such as herb, undershrub, shrub, climber and tree. The habitat where the species occurs was also recorded. The invasive species of vascular plants occurring in East Kolkata Wetlands are enumerated alphabetically with currently accepted scientific name, followed by standard abbreviation of authors name, family name, common name, life form and nativity of the species. Photographs are provided for some of the common invasive alien species occurring in the EKW for easy identification.





## RESULTS

A total of 61 taxa belonging to 50 genera and 29 families have been recorded as invasive alien in the flora of East Kolkata wetlands (Table 1, Plates 1-3). Among these, dicots are represented by 51 taxa from 41 genera and 23 families and monocots are represented by 9 taxa belonging to 8 genera and 5 families. Pteridophytes are represented by one species. Among the 61 Invasive alien plant taxa recorded, 6 species namely, *Mikania micrantha*, *Lysiloma latisiliquum*, *Lantana camara*, *Imperata cylindrica*, *Eichhornia crassipes* and *Salvinia molesta* are included in the list of 100 of the world's worst invasive alien species (Lowe et al., 2000). Herbs dominates the invasive flora with 41 taxa (67%) followed by undershrubs 12 taxa (20%), shrubs 4 taxa (6%), climbers 3 taxa (5%) and tree 1 taxon (2%). The families with highest number of Invasive alien taxa in EKW are Asteraceae (9 taxa) which is followed by Euphorbiaceae (5 taxa), Solanaceae (4 taxa), Malvaceae (4 taxa) and Poaceae (4 taxa). The families Amaranthaceae, Caesalpiniaceae, Capparaceae and Convolvulaceae are represented by 3 taxa each.

In terms of nativity of the species recorded, majority of the plants belong to tropical American origin, 37 taxa, (59%) followed by Tropical South American, 10 taxa (15%), Tropical African, 6 taxa (10%) and West Indies, 3 taxa (5%). Temperate South America, Brazil and Europe are represented by one taxon each.

**Table 1:** Invasive Alien Species (vascular plants) of East Kolkata Wetlands

Sl. No.	Plant Name	Family	Common Name	Habit	Nativity
1.	<i>Ageratum conyzoides</i> (L.) L.	Asteraceae	Goat weed	Herb	Tropical America
2.	<i>Alternanthera paronychioides</i> A.St.-Hil.	Amaranthaceae	Smooth joy weed	Herb	Tropical America
3.	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Amaranthaceae	Alligator weed	Herb	Tropical America
4.	<i>Argemone mexicana</i> L.	Papaveraceae	Prickly poppy	Herb	Tropical Central & South America
5.	<i>Blumea lacera</i> (Burm.f.) DC.	Asteraceae	Lettuce-leaf Blumea	Herb	Tropical America
6.	<i>Calotropis gigantea</i> (L.) R. Br.	Asclepiadaceae	Crown flower	Shrub	Tropical Africa
7.	<i>Celosia argentea</i> L.	Amaranthaceae	Wool flower	Herb	Tropical Africa
8.	<i>Chloris barbata</i> Sw.	Poaceae	Peacock plume grass	Herb	Tropical America
9.	<i>Chrozophora rottleri</i> (Geiseler) A. Juss. ex Spreng.	Euphorbiaceae	Suryavarti	Undershrub	Tropical Africa
10.	<i>Cleome gynandra</i> L.	Capparaceae	Wild Spider flower	Herb	Tropical America
11.	<i>Cleome rufosperma</i> DC.	Capparaceae	Fringed spider flower	Herb	Tropical America
12.	<i>Cleome viscosa</i> L.	Capparaceae	Dog mustard	Herb	Tropical America
13.	<i>Corchorus aestuans</i> L.	Tiliaceae	East Indian mallow	Undershrub	Tropical America
14.	<i>Croton bonplandianus</i> Baill.	Euphorbiaceae	Bonpland's Croton	Undershrub	Temperate South America
15.	<i>Cyperus difformis</i> L.	Cyperaceae	Rice sedge	Herb	Tropical America



Sl. No.	Plant Name	Family	Common Name	Habit	Nativity
16.	<i>Datura metel</i> L.	Solanaceae	Thorn apple	Herb	Tropical America
17.	<i>Echinochloa colona</i> (L.) Link	Poaceae	Shama millet	Herb	Tropical South America
18.	<i>Echinochloa crus-galli</i> (L.) P.Beauv.	Poaceae	Barnyard millet	Herb	Tropical South America
19.	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	False daisy	Herb	Tropical America
20.	<i>Eichhornia crassipes</i> (Mart.) Solms*	Pontederiaceae	Water hyacinth	Herb	Tropical America
21.	<i>Euphorbia heterophylla</i> L.	Euphorbiaceae	Wild Poinsettia	Undershrub	Tropical America
22.	<i>Euphorbia hirta</i> L.	Euphorbiaceae	Snake weed	Herb	Tropical America
23.	<i>Euphorbia indica</i> Lam.	Euphorbiaceae	Snake weed	Herb	Tropical South America
24.	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	Round leaf bind weed	Herb	Tropical America
25.	<i>Grangea maderaspatana</i> (L.) Poir.	Asteraceae	Madras carpet	Herb	Tropical South America
26.	<i>Hyptis suaveolens</i> (L.) Poit	Lamiaceae	American mint	Herb	Tropical America
27.	<i>Imperata cylindrica</i> (L.) Raeusch.*	Poaceae	Cogon grass	Herb	Tropical America
28.	<i>Ipomoea carnea</i> Jacq. subsp. fistulosa (Mart. ex Choisy) D.F. Austin	Convolvulaceae	Bush morning glory	Shrub	Tropical America
29.	<i>Ipomoea obscura</i> (L.) Ker Gawl.	Convolvulaceae	Obscure morning glory	Climber	Tropical Africa
30.	<i>Lantana camara</i> L.*	Verbenaceae	Wild sage	Shrub	Tropical America
31.	<i>Ludwigia adscendens</i> (L.) H. Hara	Onagraceae	Water primrose	Herb	Tropical America
32.	<i>Ludwigia perennis</i> L.	Onagraceae	Paddy clove	Herb	Tropical Africa
33.	<i>Lysiloma latisiliquum</i> (L.) Benth.*	Mimosaceae	Horse tamarind	Tree	Tropical America
34.	<i>Malachra capitata</i> (L.) L.	Malvaceae	Brazil jute	Undershrub	Tropical America
35.	<i>Malvastrum coromandelianum</i> (L.) Garcke	Malvaceae	False mallow	Undershrub	Tropical America
36.	<i>Mecardonia procumbens</i> (Mill.) Small	Scrophulariaceae	Baby jump-up	Herb	Tropical North America
37.	<i>Melochia corchorifolia</i> L.	Sterculiaceae	Chocolate weed	Undershrub	Tropical America
38.	<i>Mikania micrantha</i> Kunth*	Asteraceae	Mile-a-minute	Climber	Tropical America
39.	<i>Monochoria vaginalis</i> (Burm.f.) C. Presl	Pontederiaceae	Oval leaf pond weed	Herb	Tropical America



Sl. No.	Plant Name	Family	Common Name	Habit	Nativity
40.	<i>Nicotiana plumbaginifolia</i> Viv.	Solanaceae	Tex-mex tobacco	Herb	Tropical America
41.	<i>Oxalis corniculata</i> L.	Oxalidaceae	Indian sorrel	Herb	Europe
42.	<i>Parthenium hysterophorus</i> L.	Asteraceae	Congress weed	Herb	Tropical North America
43.	<i>Passiflora foetida</i> L.	Passifloraceae	Stinking passion flower	Climber	Tropical South America
44.	<i>Peperomia pellucida</i> (L.) Kunth	Piperaceae	Rat's ear	Herb	Tropical South America
45.	<i>Pilea microphylla</i> (L.) Liebm.	Urticaceae	Gun powder plant	Herb	Tropical South America
46.	<i>Pistia stratiotes</i> L.	Araceae	Water lettuce	Herb	Tropical America
47.	<i>Portulaca oleracea</i> L.	Portulacaceae	Purslane	Herb	Tropical South America
48.	<i>Ruellia tuberosa</i> L.	Acanthaceae	Menow weed	Herb	Tropical America
49.	<i>Salvinia molesta</i> D.S. Mitch.*	Salviniaceae	Kariba weed	Herb	Brazil
50.	<i>Scoparia dulcis</i> L.	Scrophulariaceae	Sweet broom weed	Herb	Tropical America
51.	<i>Senna alata</i> (L.) Roxb.	Caesalpiaceae	Roman candle	Shrub	West Indies
52.	<i>Senna obtusifolia</i> (L.) Irwin & Barneby	Caesalpiaceae	Sickle senna	Undershrub	Tropical America
53.	<i>Senna occidentalis</i> (L.) Link	Caesalpiaceae	Coffee weed	Undershrub	Tropical South America
54.	<i>Sida acuta</i> Burm.f.	Malvaceae	Morning mallow	Undershrub	Tropical America
55.	<i>Solanum americanum</i> Mill.	Solanaceae	Nightshade	Herb	Tropical America
56.	<i>Solanum torvum</i> Sw.	Solanaceae	Turkey berry	Undershrub	West Indies
57.	<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	Node weed	Herb	West Indies
58.	<i>Tridax procumbens</i> (L.) L.	Asteraceae	Mexican daisy	Herb	Tropical Central America
59.	<i>Typha domingensis</i> Pers. (= <i>T. angustata</i> Bory. & Choub.)	Typhaceae	Cat tail	Herb	Tropical America
60.	<i>Urena lobata</i> L.	Malvaceae	Bur mallow	Herb	Tropical Africa
61.	<i>Xanthium strumarium</i> L.	Asteraceae	Cocklebur	Undershrub	Tropical America

\* - Species included in the list of 100 of the world's worst invasive alien species (Lowe et al., 2000).

Plate 1: (Invasive Alien Species)

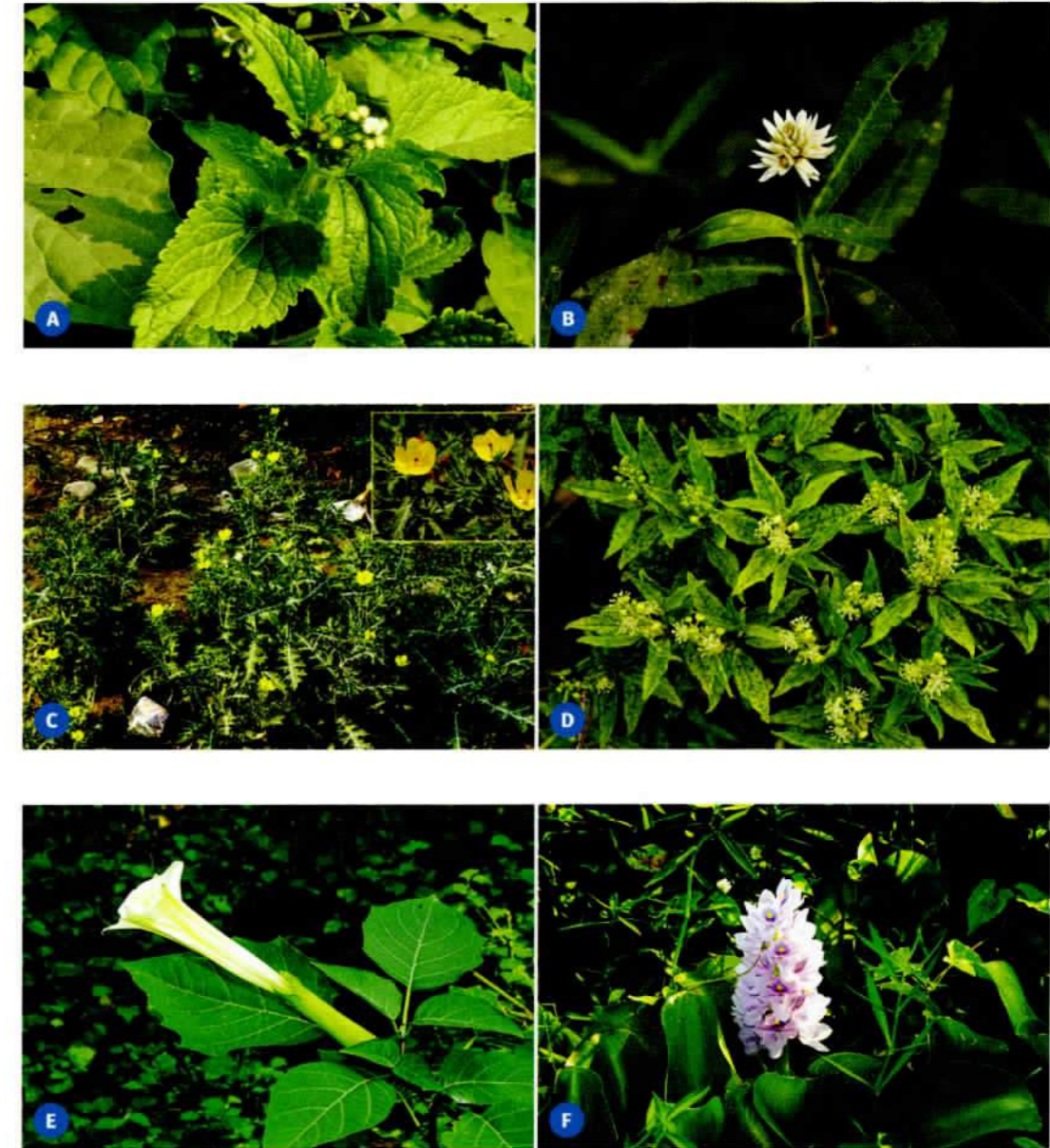


Plate 1:

- A. *Ageratum conyzoides* (L.) L.;
- B. *Alternanthera philoxeroides* (Mart.) Griseb.;
- C. *Argemone mexicana* L. Flower close up (inset);
- D. *Croton bonplandianus* Baill.;
- E. *Datura metel* L.;
- F. *Eichhornia crassipes* (Mart.) Solms



Plate 2: (Invasive Alien Species)



Plate 2:

- A. *Euphorbia heterophylla* L.;
- B. *Hyptis suaveolens* (L.) Poit.;
- C. *Ipomoea carnea* Jacq. subsp. *fistulosa* (Mart. ex Choisy) D. F. Austin.;
- D. *Lantana camara* L.;
- E. *Ludwigia adscendens* (L.) H. Hara.;
- F. *Mikania micrantha* Kunth; Inflorescence close up (inset)

Plate 3: (Invasive Alien Species)



Plate 3:

- A. *Oxalis corniculata* L.;
- B. *Parthenium hysterophorus* L.;
- C. *Passiflora foetida* L.;
- D. *Senna alata* (L.) Roxb.; Inflorescence close up (inset)
- E. *Synedrella nodiflora* (L.) Gaertn.;
- F. *Xanthium strumarium* L.





## DISCUSSION

Biological invasion has emerged as a new environmental threat across the world causing loss of biodiversity resulting in species extinction, change in native vegetation and hydrology, ecosystem services and economic development. These species are a serious challenge to conservation and sustainable use of biodiversity causing significant negative impact on the goods and services delivered by the ecosystem. Species inventory at regular intervals covering different seasons and mapping of the invasive species should be carried out to effectively monitor the extent of invasion. Management of these invasive species requires eradication, strict quarantine of further introduction of potentially invasive alien species and regular monitoring. Comprehensive awareness programmes should be held among the local people and the management strategies should be designed focussing on research to categorise the alien species according to the threat and rate of spread.

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