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A Review of Research on Wetlands and Macrophytes Diversity with Respect to World and India

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ABSTRACT: A general review on the major studies in wetlands with respect to World and different states in India. It also dealt with the studies on the Macrophytes diversity of India.

Keywords: Macrophytes, flora, wetland, diversity, review.

INTRODUCTION

Wetlands are locations where land intersects with water. Wetland serves as the intermediary area between genuine aquatic environments and land habitats; it is a broad term for the various types of moist habitats where the soil remains wet for part of the year, though not continuously saturated. This indicates that a wetland is not entirely aquatic or terrestrial. Wetlands are among the planet's most crucial and most endangered freshwater resources.

Wetlands do not have an internationally agreed-upon definition or classification. According to Dennison *et al*. (1993), wetlands lack a formal widely accepted definition among ecologists, managers, and government regulators due to their complexity and wide range of traits. Wetland is not a unique habitat, but rather synonymous with watery substratum. Mitsch & Gosselink (1986) observed that the definition of a wetland is determined by the objectives and field of interest of the users, resulting in multiple definitions from geologists, soil scientists, hydrologists, biologists, ecologists, sociologists, economists, political scientists, and public health scientists.

According to Ramsar convention (1971), “Wetlands are transitional zones which occupy intermediate position between the dry land and open water”. Article 1 states that “wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters". Article 2 states that “wetland areas may incorporate riparian and coastal zones adjacent to the wetlands and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands.”

Odum (1971) later characterized wetlands as a "ecotone between terrestrial and aquatic ecosystems". According to Cowarding *et al*. (1979), “wetlands are areas that are inundately surface or ground water with a frequency sufficient that support plants and animals which depends on saturated or seasonally saturated soil conditions for their growth and reproduction”. According to Niering (1985), wetlands are "an area in which water controls both the environment and the associated biota of an area”. Tinner (1999), defined wetland as, “A wet habitats including marshes, swamps, bogs, fens and similar areas”. According to Alam & Chowdhury (2003), “Wetlands are low-lying ecosystems where the groundwater table is always at or near the surface”.

Similarly, there is no universally agreed classification of wetland types as wetlands comprise a complex range of ecosystems. Bangladesh consist five types of wetlands *viz*: a) saltwater wetlands ii) freshwater wetlands iii) palustrine wetlands iv) lacustrine wetlands and v) manmade wetlands (Islam, 2010). According to Akonda (1989), there are 3 major classes of wetlands in Bangladesh-a) Saltwater wetlands (subclasses-i) Marine ii) Estuarine iii) Lagoonal) b) Freshwater wetlands (subclasses-i) Riverine ii) Lacustrine iii) Palustrine) and c) Manmade wetlands.

Recently, Xing & Niu (2019) suggested a two-tier hierarchical classification of wetlands based on satellite time series; levels 1 and 2 have two and ten categories, respectively, with four types of natural wetlands and one type of man-made wetland.

WETLANDS OF THE WORLD

Wetlands cover 7% of the earth's surface (Butler, 2010). Worldwide, wetland environments span 917 million hectares (Lehner & Döll 2004). According to Davidson *et al*., (2018) & RCW (2018), Asia accounted for the majority (31.8%) of worldwide wetland area, followed by North America (27.1%), Latin America and the Caribbean (15.8%), Europe (12.5%), Africa (9.9%), and Oceania (2.9%).

WETLANDS IN INDIA

Though, India supports unique and diverse wetland habitats, India is still lacking a well-developed classification system to classify wetlands. Generally there are 3 main types of wetlands in India-a) Inland wetland (marshes, ponds, lakes, fens, rivers, flood plains and swamps) b) Coastal wetland (mangroves, saltwater marshes, estuaries, lagoons, coral reefs, sea grass beds) c) Man-made wetlands (fish ponds, saltpans, rice fields, reservoirs, ditches, canals). These wetlands are located across various geographical areas, from the Himalayas to the Deccan plateau. Wetlands cover 1-5% of India's overall geographical area. In India, the largest area of wetlands is in Bihar, followed by Uttar Pradesh, while Gujarat has the least wetland coverage.

Champion & Seth (1968) recognized various types of wetland forests in India. Gopal & Krishnamurthy (1992) classified the mangroves wetlands variously. Cowardin (1979) classified wetlands into 5 systems, based on their hydrological, ecological and geological characteristics: marine (coastal wetlands), estuarine (deltas, tidal marshes and mangrove swamps), riverine (along rivers and streams), lacustrine (lakes) and palustrine ('marshy'- marshes, swamps and bogs); and 120 subclasses. During an inventory of Asian wetlands, the IUCN identified 22 kinds of wetlands without a logical basis (Scott, 1989). Dugon (1990) categorized wetlands into 3 primary categories: a) salt watered wetlands b) Fresh watered Wetlands and c) Man-made wetlands; each category is further sub-divided into 13, 17 and 9 sub-classes. Gopal & Sah (1995) modified classified wetlands into two basic classes: a) Tidal wetlands and b) Inland wetlands; and 12 subclasses.

Another fascinating and distinct freshwater swamp forest ecosystem is known as "Myristica swamps," characterized by its predominance of tree species from the Myristicaceae family, particularly various Myristica species. "Myristica swamps" are located exclusively in the lower altitudes of the southern Western Ghats in Kerala and Tamil Nadu, situated alongside gently flowing streams.

Wetlands in India covered an area of around 58.3 million hectares (Woistencroft *et al*., 1989; WWF and AWB, 1993). India has a total of 27,403 wetlands, which occupy 18.4% of the country area excluding rivers (Bandyopadhyay & Mukherjee 2005). SAC (2011) identified a total of 2,01,503 significant wetlands in India.

According to Pardikar (2020), India contains 62,466 wetlands, which account for 3.83% of the classified forest area; 37 wetlands in India have been classified as Ramsar sites of international importance, with a total area of 1,067,939 hectares. As of March 17, 2025, India boasts 89 Ramsar sites, with the latest inclusions being Sakkarakottai Bird Sanctuary, Therthangal Bird Sanctuary, Khecheopalri Wetland, and Udhwa Lake.

WETLAND AND AQUATIC ECOSYSTEM AND FLORA

Wetlands are the world's most biologically productive and economically valuable ecosystems (RCW, 2018), performing hydrological, biogeochemical, and ecological functions at local and global scales (Bwangoy *et al*., 2010). Wetlands are the world's greatest carbon storage (Joosten *et al*., 2016). Wetland ecosystems mitigated flood and storm-related environmental hazards (CBD, 2015). Wetlands provide numerous benefits to coastal systems globally (Janowsky *et al*., 2019). Wetlands are among the most productive ecosystems in the world comparable to rain forests and coral reefs (Chinnadurai *et al*., 2006). Wetlands provide drinking water, food, and livelihood security for 3 billion people worldwide (Joshi, 2017). Wetlands provide essential habitat for many aquatic birds, mammals, amphibians & reptiles, fishes, molluscas, flies, moths, butterflies, crab and shrimps (Chandra *et al*., 2020).

Wetland ecosystems are among the most significant environments on Earth, supporting a diverse range of aquatic and terrestrial species (Jeppesen *et al*., 1997). Wetlands can host both aquatic and terrestrial species (Chowdhury & Das 2013). Plants that thrive in wetlands are referred to as 'Hydrophytes' (Tinner, 1991). Evidence of the first wetland plans dates back to the Ordovician period (485.4 million to 443.8 million years ago) (Karmakar, 2021). Macrophytes are essential components of a wetland ecosystem. A macrophyte is an aquatic plant that is huge enough to be seen with the naked eye. According to Gopal (1995), macrophytes are a wide range of aquatic plants, including enormous filamentous algae, emergent reeds and cattails. Chambers *et al*., (2008) defined macrophyte as, "an aquatic photosynthetic organisms that live in permanent, temporary and ephemeral inland waterbodies and watercourses, visible in naked eyes, may be submerged, floating or up through the water surface". Macrophytes are aquatic, non-woody plants that are greater than microscopic size (Joshi, 2017) and can be found floating, submerged, or protruding from water (Jadhav, 2016). Macrophytes include macroalgae of the divisions Chlorophyta, Xanthophyta and Rhodophyta and the blue green algae or Cyanobacteria, Bryophyta, Pteridophyta and Spermatophyta (Chambers *et al*., 2008). Macrophytes are at the bottom of the food chain for heterotrophic organisms (Bakker *et al*., 2016), which can improve water quality (Rejmánková, 2011), indicate the degree of damage in the ecosystem and serve as a bio-indicator of water pollution (Tripathi & Shukla 1991). Aquatic plants are key components of the wetland ecosystem; they are herbaceous or occasionally shrubby in character, grow quickly, and interact with human activities in a variety of ways (Raja *et al*., 2015). According to Sculthorpe (1967), due to indistinguishable aquatic habitats from terrestrial ones, it is very difficult to exactly define aquatic plants. According to Cook (1996), aquatic plants are those whose photosynthetically active sections are permanently or partially submerged in water, or float on the water's surface.

C.D.K. Cook (1996) in his book "Aquatic and Wetland Plants of India" classified the aquatic and wetland plants of India into nine categories: i) Helophytes ii) Haptophytes iii) Tenagophytes iv) Plankton v) Rosulate vi) Vittate vii) Pleustophytes viii) Epihydates

and ix) Hyperhydates. He has excluded Rheophytes and Mangroves and aquatic and wetland plants occuring in the Himalayas but do not extend south to the Indus-Gangetic plain or into Peninsular India from his book. Based on habitat preference, Adhikari & Babu (2008) categorized wetland plants in three broad types- i) Aquatic ii) Seasonally inundated shore and iii) Upland.

Aquatic plants belong to more than 100 families worldwide, about 7.5% of dicotyledonous and 11% of monocotyledonous, consisting less developed protective and conductive tissues comparable to mesophytes and xerophytes (Les *et al*., 1995). Aquatic vascular plants account for just approximately 1% of overall floristic diversity (Chambers *et al*., 2008). Aquatic plants, or macrophytes, provide thick vegetation in freshwater lakes (Meyer *et al*., 2019), which are critical components of freshwater ecosystems (Bornette & Puijalon, 2011). Aquatic macrophytes are ecosystem engineers (Kuipers *et al*., 2016), providing habitat and food for aquatic invertebrates (Harper *et al*., 1995), as well as shelter and spawning sites for many fish. Aquatic or wetland plants play crucial roles in wetland biogeochemistry by actively and passively circulating elements or heavy metals (Jha *et al*., 2016). Macrophytes provide structural variability and resources (food, protection, refuge, and oviposition sites) to aquatic biota (Ocon *et al*., 2013). The abundance and diversity of macrophytes are important features of a wetland (Adhishwar & Choudhary, 2013). Aquatic and wetland plant diversity is a sustainable life support system around the globe (Bandyopadhyay & Mukherjee 2005). Poor people rely on aquatic plants for sustenance and economic value (Ghosh, 2005).

Macrophytes have recently been recognized as biological quality elements in the Water Framework Directive 2000/60/EC (WFD, 2000), which have a significant impact on the environment (Madsen *et al*., 2001). Red Lists typically include few aquatic vascular plant species (Chemeris *et al*., 2019). These species have low diversity, endemism, and wide geographical ranges due to the beneficial effects of aquatic habitats in temperate latitudes (Chambers *et al*., 2008).

WETLAND AND MACROPHYTES STUDIES WORLDWIDE

Chambers *et al*. (2008) studied the global diversity of aquatic macrophytes in freshwater and represented about 2614 species (Pteridophyta and Spermatophyta) in c. 412 genera of 88 families.

Yan (1983) studied the higher water plants of China. Leach & Osborne (1985) documented the freshwater plants of Papua New Guinea. In Australia, Benson & Jacobs (1994) recorded 110 plant species from Monaro lakes. Hrivank *et al*. (2006) studied the distribution and plant mass of aquatic macrophytes and their relation to environmental conditions in the submontane-colline Slatina river in Slovakia and reported only 8 vascular plants, 3 mosses and group algae filamentosae are frequent. Pestana *et al*. (2024) catalogued a total of 72 aquatic macrophytes belonging to 49 genera and 31 families in eastern Maranhao.

Bangladesh

Chakraborty & Mirza (2007) identified a total number of 12 species of macrophytes belonging to 12 genera and 10 families from Gharia beel. Sobhan *et al*., 2012 studied the biodiversity of Tanguar Haor (a Ramsar site of Bangladesh) and enumerated 104 plant species under 88 genera and 51 families (4 pteridophytes and 100 angiosperms). Islam (2015) reported the ecosystem services of Chalan beel and reported 13 medicinal herbs and plants. Sultana *et al*. (2021) recorded 30 aquatic plant species under 20 families from Satla beel of Barishal district. Hossain *et al*. (2022) explored the occurrence of 964 species of vascular plants under 607 genera and 147 families in coastal district of Bagerhat; Pteridophytes are composed of 32 species under 22 genera of 14 families and Gymnosperms of 7 species under 6 genera and 5 families whereas Angiosperms are comprised of 693 species of 450 genera and 99 families of Magnoliopsida (dicotyledons) that represent 71.89% of the flora, and 232 species belonging to 129 genera under 29 families of Liliopsida (monocotyledons) that constitute 24.07% of this flora.

WETLAND AND MACROPHYTES STUDIES IN INDIA

Duthie (1903-1929), Agharkar (1923), Biswas & Calder (1936), Almedia (1941 & 1942), Deb (1976), Subramanyam (1962), Cook (1990), Cook (1996) etc. have studied on the aquatic and wetland vascular plants of India. Swapna *et al*. (2011) discussed the medicinal and edible aspects of more than 70 aquatic and wetland plants of India.

Union Territory of Ladakh

Ambrish *et al*. (2024a) recorded the floristic diversity of Tsokar Lake including about 193 species belonging to 38 families (37 angiosperms and 1 gymnosperm); this include 135 species of dicots, 57 species of monocots and 1 species of gymnosperm. Later Ambrish *et al*., (2024b) studied the floristic diversity of Tso Moriri lake contains around 105 species belonging to 26 families (25 angiosperms and 1 gymnosperm); out of these 54 species belong to dicots, 50 species are of monocots and 1 species of gymnosperm.

Union Territory of Jammu & Kashmir

Shah *et al*. (2019) reported a total of 234 macrophytic species; the emergent macrophytes had the highest diversity, followed by rooted floating leaf-type, sub-merged and free-floating. Dogra *et al*., (2024a) listed the floristic diversity of Hokera Ramsar Site contains around 63 species belonging to 31 families (25 angiosperms, 3 gymnosperms and 3 pteridophytes); out of these, 28 species belong to dicots, 25 species are monocots, 4 species are gymnosperms and 6 species are pteridophytes. Later Dogra *et al*. (2024b) surveyed the Hygam wetland conservation reserve and documented 75 taxa of angiosperms (49 dicots and 26 monocots), 2 gymnosperms and 13 species of pteridophytes. Dogra *et al*. (2024c) recorded 52 species belonging to 26 families (22 angiosperms, 1 gymnosperm and 3 pteridophytes) from Shallbugh wetland conservation reserve; out of these 26 species belong to dicots, 19 species sre of monocots, 1 species of gymnosperm and

6 species of pteridophytes. Floristic diversity of Surinsar-Mansar lakes contains around 104 species belonging to 42 families (39 angiosperms, 1 gymnosperm and 2 pteridophytes); out of these, 81 species belong to dicots, 19 species to monocots, 1 species of gymnosperm and 3 species of pteridophytes (Dogra *et al*., 2024d). Dogra *et al*. (2024e) surveyed the floristic diversity of Wular lake that contains around 61 species belonging to 30 families (25 angiosperms, 2 gymnosperms and 3 pteridophytes); out of these 30 species belong to dicots, 21 species are of monocots, 3 species of gymnosperm and 7 species of pteridophytes.

Himachal Pradesh

Dey *et al*. (2021) documented for the first time the diversity of vascular plants of Chandra Tal and Suraj Tal, two high altitude wetlands (HAWs) spanning the cold desert region of Lahul-Spiti, showing the occurrence of 188 species and 1 variety distributed among 97 genera and 29 families; only one species, *Ephedra intermedia* Schrenk & C.A. Mey. is a gymnosperm, and the other 187 species are angiosperms; of the angiosperms, Asteraceae is the dominant family, consisting of 27 species and one variety in 17 genera; among the species, 6 are classifed as threatened, 17 species are native, and two species (*Eritrichium nanum* (L.) Gaudin and *Ranunculus trivedii* Aswal & Mehrotra) are endemic to the Himalayan region. Devi (2022) documented the traditional uses of medicinal and aromatic plants used for different purposes by the inhabitants residing near the wetlands of Ghumarwin Tehsil of District Bilaspur. Patil (2024) recorded 148 species belonging to 84 genera and 32 families from Chandertal wetland; out of these 2 species under 2 genera and 2 families belong to pteridophytes whereas 2 species under 1 genus and 1 family belong to gymnosperms, the remaining 144 species under 81 genera and 28 families belong to angiosperms. Brijesh Kumar *et al*., (2024) identified 317 taxa belonging to 251 genera of 104 families from Pong Dam lake; of which 263 species under 215 genera and 75 families belong to angiosperms, 1 species belongs to gymnosperms, 12 species under 10 genera and 8 families to pteridophytes and 41 species under 25 genera and 20 families belonging to algae. Later Brijesh Kumar *et al*., (2024) recorded 407 plant taxa belonging to 313 genera of 119 families from Renuka wetland; of which 357 species under 273 genera and 90 families belonging to angiosperms, 12 species under 9 genera and 7 families to pteridophytes, 5 species under 5 genera and 3 families belonging to bryophytes and 33 species under 26 genera of 19 families are of algae.

Uttrakhand

Adhikari & Babu (2008) recorded a total of 178 plant species from Baanganga wetland near Bishenpur which flows in Idrishpur-Chakheri forest block of Haridwar district; of which 40 species were hydrophytes, 122 species on moist shores and 117 species in upland habitat. Singh (2024) observed 281 plant taxa belonging to 212 genera and 105 families from Asan Conservation Reserve; dicots are represented by 161 taxa under 130 genera belonging to 58 families & monocots are represented by 63 taxa under 43 genera belonging to 15 families, pteridophytes are represented by 9 taxa under 6 genera belonging to 5 families, the bryophytes are represented by 9 species under 9 genera belonging to 8 families, while algae is represented by 39 taxa under 24 genera belonging to 19 families.

Punjab

Kandwal *et al*. (2024) recorded 458 plant species belonging to 328 genera under 111 families from Beas Conservation Reserve; of these 348 taxa under 257 genera and 82 families belonging to dicotyledons and 98 taxa under 61 genera and 21 families belonging to monocotyledons of angiosperms, 12 taxa under 10 genera and 8 families belong to pteridophytes. Sagarwal *et al*. (2024) surveyed the floristic diversity of Harike lake and recorded 364 taxa including 2 sub-species belonging to 282 genera and 98 families; of these 357 species including 1 sub-species belonging to angiosperms (295 dicotyledons & 62 monocotyledons), 3 species under 3 genera and 3 families to gymnosperms and 4 taxa of pteridophytes belonging to 4 genera and 3 families. Joshi & Singh (2024) documented 186 plant taxa belonging to 158 genera and 73 families; of these 131 taxa under 116 genera and 51 families belonging to dicots and 48 taxa under 36 genera and 17 families belonging to monocots, 7 taxa under 6 genera and 5 families belong to pteridophytes; Poaceae is the dominant family (14 species) followed by Asteraceae (11 species) and Cyperaceae (8 species). Bhattacharyya & Singh (2024) identified a total of 154 plant species belonging to 131 genera under 61 families; of these 111 species under 94 genera and 42 families belonging to Dicotyledonous plants & 22 species under 21 genera and 8 families belonging to Monocotyledonous plants, 3 species belonging to 3 genera and 3 families representing pteridophytes, 18 species belonging to 13 genera under 8 families are algae. Ghosh & Singh (2024) studied the floristic diversity of Nangal Wildlife Sanctuary and recorded 186 species belonging to 160 genera and 82 families; of these 135 species are angiosperms, 50 species are algae and 1 species to Lichen. Sagarwal & Singh (2024) listed 162 plant taxa including 4 sub-species and 1 variety from Ropar wetland and its environs; of these, 67 species under 58 genera belonging to 34 families of dicotyledons and 58 species under 35 genera belonging to 10 families of monocotyledons, pteridophytes are represented by 4 species and 1 sub-species under 5 genera of 3 families, while 27 algal species belong to 9 genera and 7 families.

Haryana

Based on different publications and herbarium records, Puneet Kumar (2024) recorded a total of 94 plant taxa under 79 genera belonging to 39 families from Bhindawas Wildlife Sanctuary, the largest wetland in this state; this include 1 species of pteridophyte, 82 species (in 68 genera) of dicotyledons and 11 species (in 10 genera) of monocotyledons. Debta & Singh (2024) reported that Sultanpur National Park consists of 177 plant taxa belonging to 151 genera and 70 families; among them the dicotyledonous plants represent 126 taxa under 109 genera belonging to 43 families while the monocot is represented by 28 taxa under 23 genera belonging to 9 families, pteridophytes are represented by 2 taxa under 2 genera belonging to 2 families while

algae are represented by 21 species under 17 genera belonging to 17 families.

Assam

Pagag & Borthakur (2012) enumerated 55 species of wild edible plants from wetlands in Lakhimpur district. Das (2013) studied the diversity of angiospermic macrophyte flora of aquatic and wetland vegetation in Kamnrup didtrict and identified 128 species belonging to 100 genera and 50 families. Abujam *et al*. (2014) recorded a total of 42 macrophytes under 34 genera and 28 families from Maijan wetland, upper Assam. Hazarika & Borthakur (2014) recorded the occurrence of 174 vascular plant species belonging to 60 families in Nagaon district; of which 42 families with 63 genera and 97 species included in the class Dicotyledons and 14 families with 50 genera and 72 species belong to the class Monocotyledons; the pteridophytic plants rerepresented by only 4 families with 5 genera and 5 species. Bujarbarua (2015) represented 123 species of phanerogams from Umananda river island in the Brahmaputra river, Guwahati, Assam. Chanu *et al*., (2022) studied on 34 aquatic macrophytes belonging to 17 orders, 19 families, and 27 genera of Borbila and Silsako wetland. Talukdar (2017) recorded 140 species of macrophytes in pre-monsoon and 60 species in winter from Jharokh wetland. Gogoi *et al*. (2024) studied the floristic diversity of Deepor Beel, that contains a total of 430 species of angiosperms belonging to 306 genera and 98 families and 11 species of pteridophytes belonging to 10 genera and 9 families.

Manipur

Jain *et al*. (2007) recorded 43 aquatic/ semi-aquatic medicinal plants from wetlands of Manipur that are used in herbal remedies; 20 plants are regularly used as vegetables in Manipur and among them 13 are sold in the market. Devi *et al*. (2023) collected 30 aquatic plants from the Imphal valley; most of the collected plants are consumed as daily food items, but some are used for specific remedial purposes in the treatment of certain types of ailments and diseases like cough, fever, ulcer, piles, diarrhoea, jaundice, skin diseases, rheumatic pain, diabetes, hypertension, urinary troubles, body pain, respiratory problems, urinary problems, cardiovascular diseases, etc. Meitei & Odyuo (2024) listed a total of 312 species belonging to 200 genera and 72 families from Loktak lake; 300 species of angiosperms (196 dicots, 104 monocots), 1 species of gymnosperm, 10 species of pteridophytes and 1 species of bryophytes are recorded.

Mizoram

Kottaimuthu *et al*. (2024) recorded a total of 95 vascular plants belonging to 84 genera representing 48 families from Pala wetland; among the 93 species of angiosperms dicots are represented by 63 species and 56 genera within 37 families and the monocotyledons are represented by 30 species and 26 genera within 9 families and the pteridophytes are represented by only 2 species.

Tripura

Taran & Deb (2017) studied the ecosystem services of Rudrasagar lake, Tripura (a lake with high cultural value for its traditional and historical importance) to provide an economic valuation (provisional and cultural services) of this lake; a total of 19 plant species along with their uses were listed that are connected with local people. Later, Deori *et al*., (2024) reported around 304 taxa under 118 genera and 63 families belonging to angiosperms, pteridophytes and algae, from Rudrasagar lake.

Rajasthan

Verma & Khan (2014) carried out a field survey of aquatic plants in jhunjhunu district and identified 15 aquatic angiospermic plant belonging to 11 families. Joshi (2018) prepared a floristic account of 113 species of vascular aquatic and wetland plants belonging to 90 genera and 50 families from the wetlands of Kota district. Meena & Rathore (2023) represented 112 species of angiosperms belonging to 101 genera and 50 families from the wetlands of Karauli district. Through literature survey as well as herbarium study by Deroliya *et al*. (2024) revealed that the Keoladeo National Park harbours 410 species, 1 sub-species and 4 varieties belonging to 266 genera and 78 families of angiosperms. Arigela *et al*., (2024) listed a total number of 175 taxa of plants including angiosperms, gymnosperms and pteridophytes from Sambhar lake.

Gujarat

Maitreya (2015) presented 37 species of hydrophytes belonging to 34 genera and 23 families from pond near Chiyada village, Bavla. Singh & Meena (2024) documented 230 species and infraspecific taxa belonging to 127 genera of 64 families from Khijadia Wildlife Sanctuary. Patel *et al*. (2023) identified a total of 43 macrophytes in Pardi wetland, Valsad district; out of the 43 macrophyte species 40 were recorded as angiosperms, 2 as pteridophytes and 1 as macroalgae. Anil Kumar *et al*. (2024) reported that Nalsarovar wetland has around 162 taxa of angiosperms of which 116 taxa belong to dicotyledons while 46 taxa belong to monocotyledons. Purohit *et al*. (2024) reported that the floristic diversity of Thol lake Wildlife Sanctuary include 201 species, 1 sub-species and 1 variety belonging to 54 families. Kumari *et al*. (2024) reported that the floristic diversity of Wadhvana wetland contains total 208 species of flowering plants distributed in 50 families of dicotyledons having 163 species and 13 families of monocotyledons having 45 species.

Madhya Pradesh

Major works on Marshes, Swamps, ponds, and riversides vegetation of Madhya Pradesh were surveyed by Maheswari (1960), Unni (1967) and Kaushik (1969). Jadhav (2016) enumerated 109 angiospermic species belonging to 84 genera and 57 families from the wetlands of Malwa region of Madhya Pradesh and Rajasthan. Garg & Tiwari (2024) reported 221 angiosperms species and 3 pteridophytic species from Bhoj wetland. Maurya *et al*. (2024b) reported that Sakhya Sagar wetland include a total of 58 species of angiosperms under 44 genera and 19 families; out of these dicotyledons comprise 26 species belonging to 20 genera and 11 families and monocotyledons comprise 32 species belonging to 24 genera and 8 families. Later Maurya *et al*. (2024c) surveyed the floristic diversity of Sirpur wetland and identified 190 plant taxa of different groups distributed over 118 genera belonging to 48

families; among them, the dicotyledonous plants represent 94 taxa under 70 genera belonging to 32 families while the monocot is represented by 96 taxa under 48 genera belonging to 16 families.

Maharashtra

Major works on hydrophytes of Maharashtra were done by Mirashi (1954); Mirashi (1957); Mirashi (1958); Puri & Mahajan (1958). Gaikwad *et al*. (2004) prepared data on aquatic flowering plants of 303 species, 2 sub-species and 6 varieties belonging to 145 genera and 73 families of south-western Maharashtra. Manohar & Shyam (2014) surveyed the aquatic macrophyte diversity in Yavatmal district and enumerated 15 species of plants belonging to 11 families. Deshmukh *et al*. (2016) identified 48 aquatic macrophytes belonging to 37 genera and 28 families from Asolamendha reservoir of Chandrapur district. Shende *et al*. (2016) identified 61 species of aquatic macrophytes belonging to 47 genera and 32 families from Mul lake from Mul taluka of Chandrapur district. Deshmukh *et al*. (2017) documented 57 aquatic macrophytes belonging to 32 families and 46 genera from Mohabala lake from Bhadrawati Tahsil of Chandrapur district. Bhaisare (2020) found 88 plant species of hydrophytes in Lakhani village, Bhandara district. Kamble & Mondal (2024) revealed the occurrence of 428 species belonging to 290 genera and 82 families in Lonar lake; angiosperms are represented by 382 species under 262 genera and 61 families, gymnosperms with 1 species, pteridophytes with 2 species under 2 genera and 1 family and algae 41 species under 25 genera and 19 families. Floristic diversity of Nandur Madhameshwar is represented by 635 species of angiosperms belonging to 412 genera under 106 families; dicots represented by 466 species under 324 genera of 84 families and monocots with 169 species under 88 genera of 22 families (Chandore *et al.*, 2024).

Goa

Dubey (2024) found 126 plant taxa in Nanda lake and its adjoining areas in Quempem Taluka consisting of 124 angiosperms (104 dicots, 20 monocots) and 2 pteridophytes.

Karnataka

Hydrophytes and marsh plants of Mysore City were documented by Bhashkar & Razi (1973). Ayesha & Parameswara (2021) revealed the presence of 6 macrophytic species of 6 genera and 6 families in summer season of Kamsagar lake, Channagiri Taluk, Davanagere. Sarkar *et al*. (2024) listed a total of 161 species of vascular plants under 150 genera and 72 families from Ranganathittu Bird Sanctuary; out of total 161 species 6 species belong to pteridophytes under 6 genera and 5 families and 155 species belong to angiosperms under 144 genera and 67 families.

Andhra Pradesh

Sastry & Rao (1973) documented 257 species of coastal Andhra Pradesh. Rama Rao *et al*. (2014) prepared a checklist of 48 aquatic macrophyte species of 26 families in Lower Manair Dam at Karimnagar district. Rasingam & Harikrishna (2024) enumerated a total of 200 plant species belonging to 156 genera and 56 families from Kolleru Lake; among the 200 species 199 species are angiosperms and 1 species is pteridophyte.

Telengana

Odelu (2014) recorded 110 macrophyte species of 84 genera and 41 families from four freshwater ecosystems of Ellandhakuta and its surrounding villages, Karimnagar district; of these 24 from Dicotyledons, 14 Monocots, 2 from Pteridophyta, 1 from Algae; Poaceae was the most dominant families with 14 species followed by Cyperaceae (10species), Asteraceae(9), Euphorbhiaceae (7), and Twenty five families were represented by one species each. Swamy *et al*., (2016) surveyed the aquatic and wetland plants of Pocharam lake (lifeline for the wildlife of the entire Pocharam Wildlife Sanctuary), Medak district and reported the occurrence of 110 species of hydrophytes belonging to 80 genera and 37 families of angiosperms; dicotyledons comprise 62 species belonging to 43 genera and 26 families while monocotyledons comprise 48 species belonging to 37 genera and 11 families; the dominant family is Poaceae (16 spp.) followed by Cyperaceae (15 spp.), Leguminosae (8 spp.), Asteraceae (8 spp.) and Hydrocharitaceae (4 spp.); they reported 14 species viz., *Acmella paniculata* (Wall. ex DC.) R. K. Jansen, *Alternanthera philoxeroides* (Mart.) Griseb., *Cleome chelidonii* L.f., *Cyperus alopecuroides* Rottb., *Cyperus bulbosus* Vahl, *Glossostigma diandrum* (L.) Kuntze, *Limnophyton obtusifolium* (L.) Miq., *Scleria rugosa* R. Br., *Smithia conferta* Sm., *Utricularia caerulea* L., *Utricularia bifida* L., *Utricularia polygaloides* Edgew., *Utricularia scandens* Benj. and *Vigna aconitifolia* (Jacq.)Marechal as a new additions to the flora of Medak district; the 110 species are further divided into five morpho-ecological groups *viz.*, Emergent anchored (54 spp.), Wetland (39 spp.), submerged anchored/sub-merged (7 spp.) and Floating (5 spp.), Floating leaved anchored (5 spp.).

Kerala

Sujana & Sivaperuman (2008) studied on flora of Kole wetlands, Thrissur and a total of 140 species belonging to 23 families of Dicotyledonos and 11 families of Monocotyledons and 5 families of water fern were recorded. Vijayan *et al*., (2015) identified 12 species of mangroves belonging to 8 genera and 6 families from south-west coast of Kerala. Sujana *et al*. (2024) reported that the floristic diversity of Sasthamkotta Lake contains around 174 taxa belonging to 130 genera and 51 families; out of these 2 species under 2 genera and 2 families belong to pteridophytes whereas 172 species under 128 genera and 49 families belong to angiosperms.

Tamil Nadu

In Tamilnadu, Dhatchanamoorthy *et al*. (2013) recorded a total of 45 aquatic angiosperm species belonging to 31 genera and 21 families, from Hetsha lake, Villupuram district. Raja *et al*. (2015) documented 144 wetland angiosperms along with their family and growth habit from Pudukkottai district. Subramanian *et al*. (2020) enumerated the diversity and distribution of 59 hydrophytes of 25 families in point Calimere Wildlife and birds sanctuary. Manikandan *et al*. (2024) documented the floristic diversity of Chitrangudi Bird Sanctuary that include 81 species belonging to 69 genera and 32 families; among which 66 species belonging to 57 genera and 28 families are

dicotyledons, 14 species belonging to 11 genera and 3 families are monocotyledons and it also include 1 species of pteridophyte. The islands of Gulf of Mannar Biosphere Reserve harbor 274 angiospermic taxa belonging to 196 genera in 66 families (Nithya *et al*., 2024). Hameed *et al.* (2024a) the flora of Kanjiramkulam Bird Sanctuary harbours a total number of 84 flowering plant species belonging 70 genera in 34 families. Later Hameed *et al*. (2024b) reported that the flora of Koonthankulam Bird Sanctuary comprises 96 taxa of vascular plants belonging to 76 genera in 37 families, of which 92 taxa belonging to 73 genera and 35 families asre flowering plants, and the remaining 4 taxa belonging to 2 families are pteridophytes. V. Sampat Kumar (2024a) listed a total of 306 species of angiosperms belonging to 246 genera and 72 families from Karikili Bird Sanctuary; out of these 250 species under 201 genera under 58 families are dicots whereas 54 species under 43 genera and 12 families belong to monocots, 2 species belonging to 2 genera and 2 families are pteridophytes. Later V. Sampat Kumar (2024b) identified a total of 253 species of angiosperms belonging to 218 genera and 66 families from Vedanthangal Bird Sanctuary; out of these, 205 species under 176 genera under 54 families are dicots and 48 species under 42 genera and 12 families belong to monocots, besides these, 2 pteridophytes belonging to 2 families with 1 genus and species are reported. A total of 164 angiosperm species have been documented from Pallikaranai marsh reserve belonging to 122 genera and 48 families (Jayanthi & Karthick 2024); of which dicotyledon flora comprises of 119 species under 91 genera and 39 families while the monocotyledon flora includes of 46 species under 31 genera and 9 families. Karthigeyan *et al*. (2024c) listed a total of 120 species of angiosperms belonging to 115 genera and 52 families from the Pichavaram mangroves; among these 105 species under 91 genera belonging to 44 families are dicots whereas 15 species under 14 genera and 8 families belong to monocots; among these a total of 12 species belonging to 9 genera and 7 families are true mangroves. Kaliamoorthy *et al.* (2024 a) reported that the floristic diversity of Point Calimere Wildlife and Bird Sanctuary contains 291 species under 242 genera and 83 families; among these 264 species under 217 genera and 69 families are dicotyledons and 26 species under 25 genera and 13 families are monocotyledons and pteridophyte include 1 species under 1 genera and 1 family. Later Kaliamoorthy *et al*. (2024b) studied the floristic diversity of Udayamarthandapuram Bird Sanctuary, and identified 101 species under 98 genera and 45 families; among which 88 species under 80 genera and 37 families are dicotyledons and remaining 13 species under 12 genera and 8 families are monocotyledons. Kaliamoorthy *et al.* (2024c) reported that Vaduvur Bird Sanctuary include 107 species under 88 genera and 39 families; out of these 95 species under 77 genera and 36 families are dicotyledons and remaining 12 species under 11 genera and 3 families are monocotyledons. The flora of Suchindram Theroor Wetland Complex comprises 319 taxa of vascular plants belonging to 220 genera in 72 families, of which 312 taxa belonging to 215 genera and 69 families are flowering plants, and pteridophyte are represented by 7 taxa belonging to 5 genera in 3 different families (Murugesan *et al*., 2024). The vascular flora of the Vellode Bird Sanctuary supports 133 taxa belonging to 119 genera in 55 families, including 132 flowering plant taxa belonging to 118 genera in 54 families, and 1 species of pteridophyte (Sharief *et al*., 2024). Arisdason *et al*. (2024) reported that the flora of Vembannur wetland comprises 233 taxa of vascular plants belonging to 172 genera in 68 families of which 227 taxa belonging to 168 genera and 65 families are flowering plants, and pteridophytes are represented by 6 taxa belonging to 4 genera in 3 families.

Uttar Pradesh

Mishra & Maurya (2002) reported 36 species from Kunwarpur wetland and 66 species from Gujar wetland of Jaunpur. Narain (2006) reported that Hamirpur and Mahoba districts have 120 aquatic plant species of 88 genera and 48 families. Narain & Mishra (2008) recorded 179 aquatic angiosperms belonging to 97 genera and 49 families from Bundelkhand region. Narain & Singh (2008) listed 101 aquatic and marshy angiosperms species of 70 genera and 40 families along with their ecological classification, family, habit and phenology from Sarsainawar wetland of Etawah district. Ranjan (1996) enumerates 80 aquatic, marshy and wetland flowering plants belonging to 36 families, of Lalitpur district. Misra & Sharma (2009) reported 164 aquatic angiospermic species belonging to 104 genera and 54 families in Gola Gokarannath tehsil in Lakhimpur Kheri district; among the total species 95 are dicots and 89 are monocots. Kumar & Narain (2010) surveyed Salona Tal and its adjoining wetlands and documented 193 angiosperm species belonging to 118 genera. Mishra & Narain (2010a) enumerated 119 species belonging to 42 families from Bakhira wetland. Pandey & Pandey (2010) recorded useful values, rather than food and medicine, of 43 plant species belonging to 34 genera and 22 families from aquatic and wetland habitats of Varanasi district. Singh & Narain (2012) provided the account of 119 aquatic and wetland macrophytes of 78 genera and 45 families from Keetham lake. Misra & Mohan (2013) studied the floral diversity of Malaka-Harahar wetland, Allahabad and identified 27 plant species of which 20 species are strictly found in aquatic habitat, while 5 found on moist shores and 2 species slightly in upland habitats. Jha *et al*. (2014) enlisted 10 economically important emergent macrophytes belonging to 7 families, growing in wetlands of Mithila region of North Bihar. Mishra & Narain (2014b) studied the aquatic and marshy angiospermic diversity of Eastern Uttar Pradesh and listed 201 species belonging to 115 genera of 50 families; among them 107 were dicot species belonging to 65 genera of 33 families while 94 species were monocot belonging to 50 genera of 17 families. Das & Maurya (2015) recorded a total of sixty five algal taxa belonging to class Cyanophyceae, Chlorophyceae, Euglenophyceae, Dinophyceae, Xanthophyceae and Bacillariophyceae from the wetland area of Vikramshila Gangetic Dolphin Sanctuary, Bhagalpur. Sameul & al. (2022) recorded 48 species belonging to 43 genera and 25 families from Gander Taal in Deoria district; out of

which 42 species belong to Dicot , 5 species belong to Monocot and 1 species belongs to Pteridophytes. Singh *et al*. (2023a) recorded 94 aquatic and marshland angiosperms under 71 genera over 40 families from Semara Taal, Siddharth Nagar. Singh *et al*. (2023b) have reported 221 species out of 169 genera during the floristic survey of angiosperms of Suraha Tal Bird Sanctuary, Balia. Mishra *et al*. (2024a) reported that Bakhira Wildlife Sanctuary, the largest natural flood plain wetland of this state supports 114 plant species and 45 species of fishes. Later Mishra *et al*. (2024b) documented a total of 97 angiosperms from Saman Bird Sanctuary and adjascent areas, of these 54 species belong to dicotyledons while 43 species belong to monocotyledons. Further Mishra *et al*. (2024c) listed 110 taxa belonging to 70 genera and 42 families from Sur Sarovar wetland, of which 55 taxa belonging to 43 genera and 27 families are dicotyledons and 55 taxa belonging to 33 genera and 15 families are monocotyledons. Maurya *et al*. (2024a) reported that floristic diversity of Haiderpur wetland supports about 195 taxa of angiosperms of which 95 taxa belonging to dicotyledons while 100 taxa belong to monocotyledons. Garg (2024) surveyed Nawabganj Bird Sanctuary and recorded 189 species of angiosperms of which 87 species under 68 genera and 38 families were the alien invasives; of these the dicots were represented by 73 species and monocots by 14 species among which there were 64 herbs, 10 shrubs, 10 trees, 2 climbers and 1 twinner. Floristic diversity of Parvati Arga Bird Sanctuary were surveyed by Vineet Kumar Singh *et al*., (2024), that results about 283 species and 1 sub-species belonging to 73 families of vascular plants; out of these 5 species under 5 genera and 4 families belong to pteridophytes. Srivastava & Garg (2024) listed a total of 55 angiosperms and 2 pteridophytes from Samaspur Bird Sanctuary and adjacent areas, of these 42 species belong to dicotyledons while 13 species belong to monocotyledons.

Jharkhand

Verma *et al*., (2007) referred ethnomedicinal uses of 13 aquatic angiospermic plants from 7 districts of Jharkhand. Verma & Pandey (2008) conducted the floristic studies of aquatic and semi-aquatic angiosperms of Ratu Maharaja pond, Ranchi and enlisted a total number of 32 angiosperms belonging to 22 families and 26 genera; out of these 12 families belong to dicot having 12 genera and 16 species, whereas 10 families belong to monocot having 14 genera and 16 species. Mukherjee & Ghosh (2015) revealed a total of 215 aquatic and semi-aquatic angiospermic species, belonging to 128 genera distributed over 58 families, from Lohardaga. Kumari & Kumar (2015) revealed the presence of 62 species of aquatic plants belonging to 50 genera and 32 families in Kharkai river; out of them monocots comprise 29 species belonging to 23 genera and 12 families and dicots comprise 27 species belonging to 23 genera and 16 families and 6 species belonging to 4 genera and 4 families are Pteridophytes. Mukherjee & Kumar (2020a) reported a total of 48 aquatic and semi-aquatic angiosperms (37 genera over 27 families) of Kanke dam, Ranchi. Mukherjee *et al*. (2018) studied 6 aquatic plants of Asteraceae family under 6 genera in Jamatra district; out of which 5 are marginal and 1 emersed plant. Mukherjee & Kumar (2020b) studied the flora on aquatic and semi-aquatic angiosperms of major water bodies of Jharkhand and revealed the presence of 272 species, belonging to 157 genera, distributed over 67 families of angiosperm; out of 272 angiospermic species 137 are monocotyledons belonging to 80 genera and 23 families where as 135 taxa are dicotyledons belonging to 77 genera and 44 families. Sweety & Jha (2020) conducted a study in Basargadh pond at Ranchi and reported a total number of 15 hydrophytes.

Bihar

Braj Nandan Kumar & Choudhary (2010) identified 81 species of Chlorophyceae from Jagatpur wetland, Bhagalpur. Bhattacharya *et al*. (2011) enumerated 213 number of aquatic and wetland monocotyledons belonging to 79 genera under 22 families along with their phenology and different growth forms [Ephydate (13 spp.), Helophyte (70 spp.), Hyperhydate (40 spp.), Pleustophyte (13 spp.), Rosulate (10 spp.), Tenagophyte (51 spp.), & Vittate(16 spp.)]; the dominant families are Cyperaceae (80 spp.), Poaceae (50 spp.), Eriocaulaceae (15 spp.), Commelinaceae (10 spp.), Lemnaceae (8 spp.) and Hydrocharitaceae (8 spp.); out of 213 species, 153 species are common, 44 species are rare and 16 are occasional. Adhishwar & Choudhary (2013) studied the diversity and distribution of the freshwater macrophytes of Gogabil lake, Katihar and reported 137 species; among them 91 species are dicots, 42 species are monocots and 2 species each to algae and pteridophytes. Kumari & Kumar (2013) studied the aquatic plants of Gandak river and recorded 24 angiosperms. Alam (2014) revealed the occurrence of total 30 medicinally important wetland plant species under 27 genera and 19 families of East Champaran district. Jha *et al*. (2014) enlisted 10 economically important emergent macrophytes belonging to 7 families, growing in wetlands of Mithila region of North Bihar. Das & Maurya (2015) recorded a total of 65 algal taxa belonging to class Cyanophyceae, Chlorophyceae, Euglenophyceae, Dinophyceae, Xanthophyceae and Bacillariophyceae from the wetland area of Vikramshila Gangetic Dolphin Sanctuary, Bhagalpur. Maurya & Bharati (2019) surveyed the eco-sensitive zone of Nagi dam Bird Sanctuary and collected 194 species of angiosperms distributed in 154 genera and 57 families. Anand Kumar *et al*. (2020) published an annotated checklist 283 vascular plants belonging to 225 genera and 71 families from Udaipur Wildlife Sanctuary, West Champaran. Gautam *et al*. (2021) reported a total of 24 species of macrophytes belonging to 15 families from Manikamaun wetland, Muzaffarpur.

West Bengal

Significant works on aquatic macrophytes in Bengal were carried out by Biswas (1927); Kachroo (1959a & 1959b); Majumder (1965); Mitra *et al*. (1971); Dasgupta (1973); Mukhopadhyay (1987); Naskar & Biswas (1988); Dan & Mandal (1990); Naskar (1990); Ghosh *et al*. (1993); Ghosh (1994); Dutta *et al*. (2002). Bandyopadhyay & Mukherjee (2005) revealed that the aquatic and wetland plants of Koch Bihar district are

represented by 172 species of vascular plants under 91 genera belonging to 42 families, of which 25 families with 43 genera and 79 species included in the class Dicotyledons and 13 families with 44 genera and 89 species belong to the class Monocotyledons; the pteridopytic plants are represented by only 4 families with monotypic genus and species in each, highest number of aquatic species have been recorded in the family Cyperaceae (39 spp.) followed by Poaceae and Scrophulariaceae (20 spp. in each). Choudhury & Das (2010) recorded the occurrence of 115 species of angiosperms and 6 species of aquatic pteridophytes in different water bodies located in Maldah district. Chowdhury & Das (2011) studied the macrophytic diversity and community structure of Adh Soi wetland of Maldah district; a total of 228 species (223 angiospermic and 5 pteridophytic) belonging to 58 families and 152 genera were documented; the most represented families are Poaceae (26 spp.) followed by Cyperaceae (26 spp.), Asteraceae (21 spp.), Scrophulariaceae (22 spp.), Polygonaceae (8 spp.) and Euphorbiaceae (7 spp.); according to their life form 118 species belongs to Therophytes followed by Hemicryptophytes, Cryptophytes (Hydrophytes and Helophytes), Chamaephytes and Phanerophytes. Biswas *et al*. (2012) conducted a botanical survey on aquatic vegetation of Gossai Hat Beel, Moraghat range, Jalpaiguri forest division and enumerated a total of 176 species of Magnoliopsida covering 129 genera from 45 families; of these 44 species are fully aquatic and 132 species are marginal terrestrial. Chowdhury & Das (2013) listed around 351 vascular plant species from the wetlands of Maldah district. Chowdhury *et al.* (2014) documented a total of 109 species of Liliopsida covering 71 genera of 13 families and 21 species of Pteridophytes covering 16 genera of 14 families, from Gossaihat Beel, Jalpaiguri forest division; of these 38 species of monocots and 6 species of pteridophytes are truly aquatic. Chowdhury & Das (2014) recorded 258 species of vascular plants of 59 families from Hazar Takia palustrine of Central West Bengal. Mandal & Mukherjee (2014) observed 30 species of wetland angiosperms belonging to 21 families and 1 species of pteridophyte that are locally used for various purposes in Puruliya district; of these plants 11 species have excellent medicinal properties. Mondal & Roy (2014) conducted an environmental study of Ahiron Lake an oxbow lake of Ganges river, locally known as Chand Beel, situated Suti-I block of Murshidabad district; this study revealed that *Eichhornia crassipes* (Mart.) Solms, *Aeschynomene aspera* L., *Trapa natans* L., *Nymphaea pubescens* Willd., *Nymphoides hydrophylla* (Lour.) Kuntze, *Hydrilla verticillata* (L.f.) Royle, *Vallisneria spiralis* L., *Enydra fluctuans* Lour., *Ipomoea aquatica* Forssk., *Colocasia esculenta* (L.) Schott, *Echinochloa colonum* (L.) Link, *Hygroryza aristata* Nees, are the main floristic components of this wetland. Parveen *et al*. (2014) recorded 54 macrophytic species belonging to 48 genera under 29 families, from 'Chupisar' wetland in the eastern part of Burdwan district. Chowdhury *et al*. (2015) surveyed extensively for 12 years and accumulated rich and useful information like description, identification keys, phenology, distribution and uses of 18 species belonging to 5 genera of the family Lythraceae J. St.-Hilaire which are widely growing in different water bodies of West Bengal. Sen *et al*. (2015) found along the Bidyadhari stretch that there are 56 phytoplankton species under 8 algal classes. Chowdhury *et al*. (2016) proposed a checklist that includes the vascular flora of Gabgachi-Bhatia wetland complex of Maldah district; the work includes a total of 283 angiosperms and 6 pteridophytes. Chakraborty *et al*. (2016) revealed the traditional uses of 19 plant species belonging to 14 families to treat various diseases in South 24 Parganas. Das *et al*. (2016) listed 24 economically important aquatic plants of Katwa sub-division of Burdwan district; out of which 16 species belonged to Dicotyledons and 8 to Monocotyledons. From three selected wetlands viz. Babirbundh, Dewanbundh and Kalidaha jore of Puruliya district, Mandal & Mukherjee (2016) identified 36 species representing 11 genera of 14 species of 10 dicotyledonous families and 17 genera of 21 species of 10 monocotyledonous families and 1 genera of 1 species of 1 pteridophyte family. Chowdhury (2017) studied the phytoplankton diversity at Purbasthali Oxbow Lake also known as Chupi Char created by the Ganges river on its western bank, in Purba Bardhaman district; this study revealed the presence of 35 species of phytoplanktons, among which 5 species of Cyanophyceae, 20 species of Chlorophyceae and 10 species of Bascillariophyceae which is an indicator of productive ecosystem.

Mandal & Mukherjee (2017) studied the diversity of mcrophytes in 38 wetlands of Puruliya district and identified 36 rare species of angiosperms; among them 16 species belonging to 13 genera & 12 families are dicotyledonous and 20 species belonging to 14 genera and 7 families are monocotyledonous. Palit *et al*. (2017a) observed 46 species of macrophytes belonging to 23 families in Lalbandh wetland, Birbhum. Palit *et al*. (2017b) studied on grass flora covering 65 wetland areas of Birbhum district; the taxonomic study revealed the occurrence of 28 species of grass belonging to 18 genera; *Eragrostis* was the most dominant genus with four species, followed by Panicum and Digitaria, having three species each, Brachiaria, Echinochloa & Setaria with 2 species each. Jha (2022) visited 10 wetlands of Nadia district and documented 40 species of economically important plants of which 38 belong to Angiosperms and 2 belong to Pteridophytes. Bhanja *et al*. (2023) conducted a research to find the diversity of aquatic macrophytes in four selected block areas of Medinipur district and identified a total of 67 aquatic macrophytes under 54 genera belonging to 32 families; among them about 18% represents the floating macrophytes, 40% emergent, 8% sub-merged and 34% marginal. Mukherjee & Mandal (2023) recorded 66 species of vascular plants under 50 genera belonging to 27 families, from wetlands of North Dinajpur district. Karthigeyan *et al*. (2024a) reported 367 species of angiosperms, 1 species of gymnosperm, 9 species of pteridophytes, 16 species of bryophytes, 50 species of fungi and 129 species of algae from East Calcutta wetlands. Karthigeyan *et al*. (2024b) recorded a total of 705 species of angiosperms belonging to 467 genera

and 125 families from Sundarban wetland; among these 503 species under 340 genera belonging to 95 families are dicots whereas 202 species under 127 genera and 30 families belong to monocots.

Odisha

Das *et al*. (1994) represented a systematic account of 159 wetland plant species belonging to 109 genera and 58 families including 7 pteridophytes from coastal Odisha. 51 mangrove plant species and its associates were collected from Bhitarkanika wildlife sanctuary, Kendrapara district, Orissa by Pattanaik *et al*. (2008); among those plants, Rhizophoraceae members were recorded maximum in number (9 species) followed by Meliaceae (4) and Caesalpiniaceae (4). Misra *et al*. (2012) revealed 61 wetland plants under 47 genera and 23 families were under use by the local inhabitants for food (25 species), fodder (23 species), mat and basket weaving (7 species), thatching material (5 species), fuel (2 species) and other miscellaneous use (16 species). Mishra *et al*. (2016) found a total of 42 wetland plant species belonging to 36 genera and 27 families that have been used traditionally for edible purposes in Bhadrak district. Roy *et al*. (2016) surveyed the phytodiversity of Chilika Lake and enumerated a total of 374 species of vascular plants (81 species of monocots, 284 species of dicots and 9 species of Pteridophytes) under 276 genera and 96 families. Later Kar *et al*. (2016) collected and enumerated 79 angiosperms species belonging to 75 genera of 42 families, which have not been reported earlier from Chilika lake and its immediate neighbourhood. Subhadra *et al*. (2016) recorded 102 Hydrophytes belonging to 64 genera and 34 families in Bhubaneswar and its adjoining areas; among all the plants 8 species are submerged hydrophytes, 9 species are free floating, 9 species are fixed floating, 21 species are amphibious hydrophytes and 55 species are marshy hydrophytes. Sen & Behera (2018) enumerated the ethnomedicinal uses of 32 aquatic plants in Bargarh district of western Odisha. Dalasingh *et al*. (2019) revealed that a total of 60 species of hydrophytes belonging to 39 genera and 25 families were growing in different aquatic habitats of Puri district. Behera & Satapathy (2021) revealed the occurrence of 211 species of hydrophytes including 200 angiosperms, 10 Pteridophytes and 1 alga distributed in 134 genera and 61 families from Khordha district. Mohanty *et al*. (2023) recorded the folklore medicinal uses of 36 hydrophytes belonging to 22 families, in and around the 'Jagannath temple' of Puri. Sahoo *et al*. (2023) surveyed the seaweed diversity of Chilika lake and reported a total of 14 species which includes 8 species of Chlorophyceae and 6 species of Rhodophyceae. Panda *et al*. (2024a) recorded a total number of 248 species belonging to 174 genera and 57 families from Ansupa lake; out of these 8 species belong to pteridophytes whereas 240 species belong to angiosperms. Panda *et al*. (2024b) listed a total of 240 angiospermic taxa under 172 genera belonging to 77 families; 2 species of ferns under 2 genera, 2 species of bryophytes under 2 genera and 2 families along with 49 species of lichens belonging to 25 genera and 14 families from Bhitarkanika Mangroves. The floristic diversity of Hirakud reservoir and its adjoining areas by Debta *et al*. (2024) represented 456 plant taxa belonging to 310 genera under 115 families, distributed across Cyanoprokaryotes (59 species belonging to 28 genera and 14 families), Pteridophytes (10 species and 1 sub-species belonging to 9 genera and 9 families) and Angiosperms; out of total 383 angiosperms, dicots are represented by 312 taxa and monocots by 71 taxa. Chandramohan *et al*. (2024) reported Satkosia Gorge inhabits 221 plant species, belonging to 152 genera and 58 families; out of them 3 species under 3 genera and 2 families belong to pteridophytes whereas 218 species under 149 genera and 55 families belong to Angiosperms. Swamy *et al*. (2024) recorded the presence of 205 species belonging to 172 genera and 64 families of Angiosperms in Tampara Lake; the cryptogamic flora is represented by 52 species belonging to 37 genera under 22 families of Algae and a single fern.

Andaman & Nicobar Islands

Rasingam (2010) recorded a total of 62 aquatic and wetland plant species belonging to 46 genera and 29 families from Little Andaman Island.

CONCLUSIONS

Wetlands with natural flora and fauna promote ecotourism. However, wetlands' flora and fauna are threatened by the effects of climate change and human activities such as urbanization, deforestation, agriculture, overexploitation of wetland resources. Wetland ecosystems face worldwide danger, leading to the disappearance of native habitats for aquatic species. The deterioration of wetland habitats results in a decrease in groundwater levels. Contemporary spatial technology techniques, including remote sensing and GIS, are employed to evaluate and characterize wetlands. Consequently, precise mapping and monitoring of wetlands are essential to comprehend their functions, and it is urgent to evaluate the vascular plant diversity and resources of these areas before they disappear.

FUTURE SCOPE

Future attempts to extensive study of macrophytes diversity in other aquatic bodies and wetlands of India in reference to the different ecosystems is recommended.

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