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Status of Water Quality and Macrophytes Diversity of Thimmanayaka Lake, Western Ghats Range

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Abstract The study was carried out for a period of one year (2016—2017) to assess the water quality and macrophytes diversity of Thimmanayaka Lake, Kavaledurga, Shimoga (Dist). Physico-chemical analysis of water samples were carried out for 3 seasons and recorded the values for the following parameters such as temperature, pH, dissolved oxygen (DO), phosphate and nitrate level. The results of the physico-chemical parameters in summer season found to be high. Mean values of Alkalinity (52.77±4.82 mg/l) and Hardness (58.68 ±9.45 mg/l) were recorded. Similarly different species of macrophytes were collected and identified. The diversity of macrophytes were recorded and observed that the dominance of following species namely *Nymphoides aquatic* (84%), *Trapa bispinosa* (L) Roxb. (81.33%), *Drosera burmanni* (96.67%), *Polygonum barbatum* L.(74.67%), *Carnivore plant, Drosera burmanni* (96.67%) and *lpomea aquatica* (90.67%). The study concludes that rare and endemic macrophytes species diversity were recorded.

Keywords Macrophytic diversity, Water quality status, Thimmanayaka Lake, Western Ghats.

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Introduction

Water quality status is very important to understand the aquatic ecosystem. Therefore in order to understand the water quality and supported rich diversity of macrophytes, the present study have been carried in Thimmanayaka Lake, Thirthahalli taluk, Western Ghats region. Macrophytes are the main primary producers and contribute high biomass which plays very important role in wetland ecosystems (Pereira et al. 2012). The study of aquatic macrophytes is important in order to understand function of aquatic ecosystem. Therefore, it is important to understand the mechanisms that sustain macrophytes diversity in lakes and wetlands (Takamura et al. 2003, Ahmad et al. 2015).

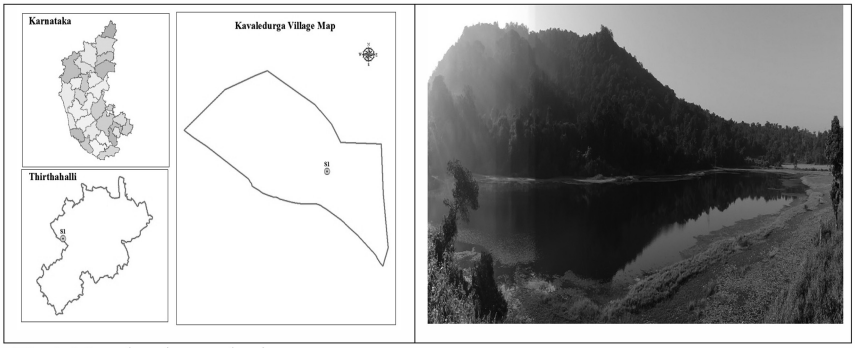

Fig. 1. Map showing study site.

Materials and Methods

Study area

Thimmanayaka Lake is located near Kavaledurga, lies between Lat 14°25′59′′–14°26′41′′N and Long 75°6′43′′–75°25′28′′ E. Which is very famous and historical place called as Kavaledurga fort which is also known as Bhuvanagiri Durga. The lake is located within the midst of the forest and one side is hilly area (Fig.1). Water is used for both drinking and agricultural purpose. The minimum and maximum temperature recorded 18°C and 36°C. The source of water impounding the water tank is from the monsoonal run off from the surrounding catchments areas. The average annual rainfall in the area is about 1500 mm.

Methodology

Water samples were collected at monthly intervals for a period of one year during (November 2016—October 2017). For physico-chemical characteristics and macrophytic diversity. The physico-chemical parameters of water such as surface water temperature, pH, conductivity, total dissolved solids (TDS), total alkalinity, nitrate, phosphate, chloride, dissolved oxygen, calcium, hardness, magnesium, turbidity and salinity was analyzed using standard methods described by (APHA 1998) (Fig.2).

Aquatic macrophytes were collected from the selected sites and preserved for identification. Different types of macrophytes were collected from the lake and identified up to species level with the help of books and manuals (Cook 1996). The abundance of macrophytes were studied by using quadrat study.

Results and Discussion

Physico-chemical properties

Water temperature is one of the most important ecological factors which controls the physiological behavior and distribution of organisms (Sonowal and Baruah 2017). Table 1 show physico-chemical values recorded. Water temperature of Thimmanayaka Lake was observed between 26.99±4.64°C to 37.92 ±1.44°C. High temperature results in increase rate of bio-chemical activity of the micro-biota, plant respiratory rate, which pushes up in oxygen demand (Bhatnagar and Devi 2013). pH values ranged between 5.7±0.41 to 6.53 ± 0.41. The lowest pH was observed in summer and highest pH was recorded

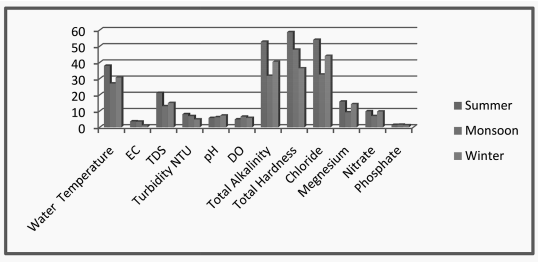

Fig.2. Graphical representation of water quality.

Table 1. Mean values (Mean ± SD) of physico-chemical parameters of Thimmanayaka Lake during the study period from (November 2016—October 2017).

Physico-chemical parameters	Summer	Monsoon	Winter
Water temperature	37.92±1.44	26.99±4.64	30.69±1.42
EC	3.59±0.81	3.43±4.4	1.07±0.56
TDS	21.18±2.92	12.97±3.04	14.94±1.72
Turbidity NTU	8.03±2.61	6.85±0.62	4.8±2.24
pH	5.7±0.41	6.19 ±0.97	7.21±0.54
DO mg/l	4.83 ±0.47	6.53±0.41	5.72±0.6
Total alkalinity	52.77 ±4.82	31.68±9.38	40.3±3.93
Total hardness	58.68±9.45	47.83±12.89	36.33±4.23
Chloride	53.96±5.3	32.47±7.25	43.98±8.4
Megnesium	15.81±2.84	9.2 ± 2.37	14.22±1.81
Nitrate	9.83±0.76	6.88 ±1.56	9.7 ±2.44
Phosphate	1.41±0.19	1.53±0.41	1.19±0.62

in winter.

Dissolved oxygen shows the range between 4.83±0.47 to 6.53±0.41. Lowest DO was recorded during monsoon and highest DO was found in winter. Oxygen is required by aquatic biota and DO level varies in regular interval and seasonally and influenced by phytoplankton, light availability, nutrients present, temperature, salinity, water movement, partial pressure of atmospheric oxygen in relation to water and

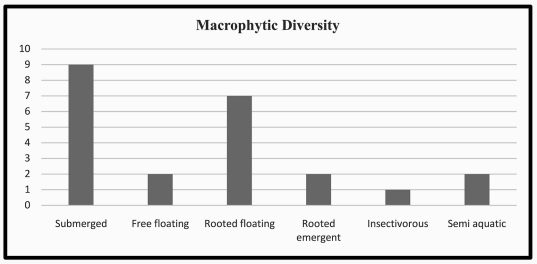

Fig. 3. Graphical representation of macrophytes diversity.

Table 2. Frequency percentage distribution of aquatic macrophytes during the study period (Nov 2016—Oct 2017).

Macrophytes recorded	Families	Seasonal frequency percentage distributions Summer	Monsoon	Winter	Total	Frequency %	Total percentage distribution
Submerged							
Hydrilla verticillata	Hydrocharitaceae	13	12	10	35	23.33	2.161828
Rotala rotundifolia	Lythraceae	15	16	14	45	30.00	2.779494
Utricularia vulgaris	Lentibulariaceae	14	7	11	32	21.33	1.976529
Chara sp.	Characeae	12	9	9	30	20.00	1.852996
Myriophyllum intermedium DC.	Haloragaceae	10	6	9	25	16.67	1.544163
Ottelia alismoides	Hydrocharitaceae	12	11	13	36	24.00	2.223595
Myriophyllum heterophyllum	Haloragaceae	10	15	10	35	23.33	2.161828
Eleocharis geniculata (L.) R & S	Cyperaceae	18	17	15	50	33.33	3.088326
Limnophila indica (L.) Druce	Scrophulariaceae	7	6	5	18	12.00	1.111797
Free floating							
Pistia stratiotis	Araceae	21	23	21	65	43.33	4.014824
Azolla pinnata	Salviniaceae	14	17	12	43	28.67	2.65596
Rooted floating							
Nymphae rubra	Nymphaeaceae	31	18	23	72	48.00	4.44719
Nymphaea stellata	Nymphaeaceae	31	33	36	100	66.67	6.176652
Nymphoides aquatica	Menyanthaceae	41	46	39	126	84.00	8.405604
Nhymphoides peltata	Menvanthaceae	18	26	24	68	45.33	3.088326
Nymphoides indica	Menvanthaceae	12	16	18	46	30.67	2.84126
Nelumbo nucifera	Nelumbonaceae	25	26	30	81	54.00	5.003088
Trapa bispinosa (L.) Roxb	Lythraceae	35	28	59	122	81.33	8.138759
Rooted emergent							
Cyperus	Cyperaceae	12	14	12	38	25.33	2.347128
Typha latifolia L.	Typhaceae	12	12	15	39	26.00	6.176652
Insectivorus							
Drosera burmannii	Droseraceae	45	49	51	145	96.67	8.956146
Semi aquatic							
Polygonum barbatum L.	Polygonaceae	35	37	40	112	74.67	6.917851
Ipomea aquatica	Convolvulaceae	43	47	46	136	90.67	8.400247
						1079.33	102.6%

decomposition rate (Kumar et al. 2017).

The range of chloride values shows 32.47±7.25 to 53.96 ±5.3. It indicates lowest in monsoon and highest in summer. It has been suggested that chloride content also shows slightly increased. Increase in chloride level in the water during winter was observed due to water level reduced in the lake. On the other hand less chloride content also recorded during monsoon due to dilution of water. The chronic standard of chloride for aquatic life is 230 mg/l (MPCA 2010,Thapa and Saund 2012). Alkalinity ranged from 31.68 ± 9.38 to 52.77 ± 4.82.

Nitrate is the eutrophication causing nutrient leading to extensive algal and other phytoplankton growth. In present study, in buffer zone, nitrate concentration of water was observed between 6.88±1.56 to 9.83± 0.76. Lowest being in monsoon and highest being in summer.

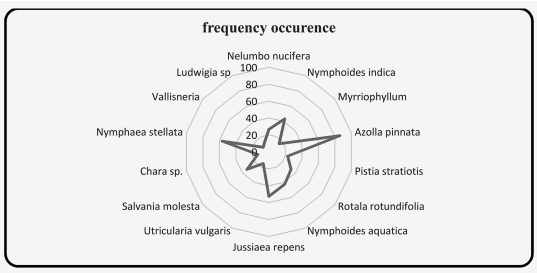

Fig. 4. Graphical representation of frequency distribution of macrophytes.

Fig. 5. a. *Drosera burmanni* b. *Nymphaea peltata* c. *Eriocaulon sexangulare* L. d. *Nymphoides aurantiacum* (Dalz.) *Kuntze* e. *Ottelia alismoides* (L.) Pers. f. *Nymphoides cristata* (Roxb.) *Kuntze* g. *Utricularia gibba* h. *Nymphaea nouchali* i. P*olygonum barbatum* L.

Total dissolved solids may have an influence on the acceptability of the water in general. TDS of water was observed between 12.97 ± 3.04 to 21.18 ±2.92. In buffer zone, lowest TDS was recorded monsoon and highest was recorded in pre-monsoon. The conductivity in water was maximum in winter (3.59 ±0.81 mS) and minimum in spring (1.07 ± 0.56 mS). It is a measure of buffering capacity of the water. The turbidity ranged from 4.8±2.24 to 8.03±2.61 in Thimmanayaka Lake. Indicated lowest in winter and slightly increased in summer.

The phosphate ranged from 1.19±0.62 mg/l to 1.53 ±0.41 mg/l. The maximum value of phosphate during monsoon was observed due to surface runoff receiving waste water from agricultural runoff. The lower value of phosphate in summer month may be due to more uptake of phosphate for abundance of macrophytes (Kumar et al. 2014).

The magnesium ranged from 9.2 ± 2.37 mg/l to 15.81 ±2.84 mg/l. Magnesium value shows lower in monsoon and higher at summer season. The total hardness showed lowest in winter 36.33±4.23mg/l and highest during summer 58.68 ±9.45 mg/l. Total hardness levels were high in the lake ecosystem compared to river systems and canals (Vincy et al. 2012). A better understanding of wetland ecosystem macrophytes diversity and water chemistry study is necessary for further conservation of water bodies.

Percentage distribution of macrophytes

The percentage distribution of aquatic macrophytes shows total 12 macrophyte species were recorded from littoral and sub-littoral zones of the lake macrophytes such as *Pistia stratiotis* (5.9%) and *Azolla pinnata* (28.67%) was dominant on all the sampling stations. Similarly, *Nymphae rubra* (48.00%), *Nelumbo nucifera* (54.00%), *Nymphaea stellata* (66.67%), *Nymphoides aquatic* (84.00%), *Nymphoides indica* (30.67%), *Nhymphoides peltata* (45.33%) recorded from all the sampling stations. The rooted emergent shows dominant such as *Cyperus* sp. (25.33%) and *Typha latifolia* L. (26.00%), *Ipomea aquatic* (90.67%). Submerged plants such as *Hydrilla verticillata* (23.33%). *Rotala rotundifolia* (30.00%), *Myriophyllum intermedium* DC (16.67%) *Chara* sp. (20.00%). *Utricularia vulgaris* (21.33%), *Ottelia alismoides* (24.00%), *Myriophyllum heterophyllum* (23.33%), *Eleocharis geniculata* (L.) R & S (33.33%) and *Limnophila indica* (L.) Druce (12.00%) species shows common (Fig. 3, Table 2).

The insectivorus plant *Drosera burmanni* (96.67%) also recorded in the littoral zone. Semi aquatic plants such as *Polygonum barbatum* L. (74.67%) and *Ipomea aquatica* (90.67%) occurred in some of the sites throughout the seasons. Total 23 species were identified in comprises of free floating, rooted floating, submerged , emergent, semi aquatic and insectivorus plants. Highest number of macrophytes recorded in winter. The study results highlighted that presence of macrophytes diversity mainly due to both ecological, water and sediment nutrient level for the suppport of abundance and diversity noticed in Thimmanayaka Lake shows less anthropogenic activities (Fig.4).

Conclusion

Thimmanayaka Lake located in a natural forest area surrounded by forest and agriculture lands. The physico-chemical properties of water indicates acidic pH, high TDS, nitrates and phosphates. This water body supported good diversity of birds due to continuous water availability and food source. The study confirmed that the aquatic macrophytes are directly linked with water quality and nutrients level in a lake.Thus proper steps is to be taken to conserve in the natural ecosystem in order to save the endemic aquatic flora and fauna in a less disturbed water body.

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