

## Macrophytes and their ecosystem services from natural ponds in Cachar district, Assam, India

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Received 17 March 2015, revised 04 May 2016, updated 08 June 2016

The present study deals with the macrophytes of four natural ponds near Barambaba temple in Cachar district of Assam, North-East India and uses. A total of 45 species of macrophytes belonging to 24 families were recorded. Emergent growth forms were most dominant. Their ecosystem services as medicinal (26%), livestock fodder (22%), vegetables (15%), fish food (10%), decoration (9%), religious (7%), herbal (3%), poultry feed (2%), insect repellent (2%), fencing (2%), fuel (1%) and organic farming (1%) have been recorded. The judicious management of rich diversity of macrophytes and their uses can promote sustainable utilization of aquatic plants in this region.

**Keywords:** Assam, Cachar district, Macrophytes, Pond, Ecosystem services, *Bhojpuri* community

**IPC Int. Cl.<sup>8</sup>:** A61K 36/00

Macrophytes found in aquatic ecosystem are known as hydrophytes, and provide an optimal environment for the colonization of different types of macrophytes with tremendous ecological significances and thus furnishes numerous ecosystem services besides being the respiratory of many other specific ecosystems. Macrophytes are vital components of aquatic and wetland ecosystems<sup>1</sup> sustaining oxygenation of water<sup>2</sup>, productivity and nutrient recycling<sup>3</sup>. Various types of macrophytes - emergent, submerged, free floating and rooted floating are generally observed in an aquatic ecosystem. Ponds are integral component of the village ecosystem and are extensively used in various ways for subsistence. Such wetlands differ functionally from large lakes with regards to littoral structure and productivity. Despite their small size they contain a significant aquatic biodiversity. Essentially primary producers of the aquatic ecosystems, they provide a substratum for algae, shelter for benthic fauna and breeding ground for fishes, macro invertebrates and other animals<sup>4</sup>. They not only constitute an important source of food and medicine but also provide livelihood for the marginalized people<sup>5</sup>. Loss of native biodiversity impairs the productivity and sustainability of ecosystems<sup>6</sup> leading to socio-economic and environmental impacts, especially in developing

countries of Asia and Africa<sup>7</sup>. Literature is replete with researches on the ecology, diversity, floristic composition and distribution of macrophytes in different freshwater bodies of India and abroad. The ecology of aquatic macrophytes of Cachar Haor and macrophytic diversity in certain wetlands of Barak valley region in Assam has been reported<sup>8,9</sup>. Some macrophytes were documented from temple ponds in Cachar district of Assam<sup>10</sup>. Aquatic macrophyte of Laokhowa wildlife sanctuary, Assam, India was studied<sup>11</sup>. Usage of herbal home remedies of traditional medicine among the indigenous *Khasi* tribe of East Khasi hill district of Meghalaya has been reported<sup>12</sup>. Diversity of fresh water macrophytic vegetation of 6 rivers of the state of West Bengal was reported<sup>13</sup>. Utilization of aquatic macrophytes in freshwater ecosystem has been studied<sup>14</sup>. In particular, they deliver a range of important ecosystem services to human society<sup>15</sup>. Recent studies on diversity of aquatic macrophytes of Aligarh, Uttar Pradesh, India recorded thirteen species of macrophytes. Interestingly no free floating macrophytes were reported from this area<sup>16</sup>. Study of invasive plants in China provides valuable information for the management of freshwater habitats<sup>17</sup>. Ponds, both natural and artificial, are abundant in Cachar district harbouring variety of macrophytes thus occupying a significant position in the socio-cultural-economic milieu of this region. The present work was therefore

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undertaken to investigate macrophyte diversity and uses of some natural pond ecosystem.

### Materials and methods

Collection of macrophytes has been made from four ponds adjoining Barambaba temple in Silcoorie village, Cachar district, Assam. The survey and interview of the local people was made during the month of June 2012 to November 2012. Two fortnightly visits to the field were made every month. The study site is located about 15km away from the district town, Silchar, at 24°43'45.54" latitude, 92°47'17.83" longitude, and 36m altitude above sea level. The area of the ponds ranged approximately from 280 – 350 m<sup>2</sup>. The climate is subtropical, warm and humid during the summer (June-August) and the lowest temperature is generally recorded during December-January. The average humidity ranges from 70% during winter to 90% during rainy season. The district received about 3200-3500 mm rainfall during the study year. Maximum rainfall is observed during the months from May to August.

Macrophytes were collected from 4 selected ponds randomly. Samples were brought to laboratory, washed, wrapped with tissue paper and dried. Each macrophyte was laid on a white chart paper and photographs were taken. Afterwards, the collected plant specimens were dried and herbarium specimens were prepared. A total of 45 plant specimens macrophytes have been identified and deposited at the Department of Ecology and Environmental Science, Assam University, Silchar, Assam with voucher specimen numbers. Identification of the macrophytes were made using standard keys<sup>18</sup>.

Information was collected from 50 people of different families including three traditional healers residing nearby, using semi-structured questionnaires in the field. The informants were mostly daily wage earners and illiterate. The number of male respondents was 30 and female 20. The age of the males was in the range of 40-60 yrs and those of females were 20-50 yrs. Majority of the people residing in this area belong to *Bhojpuri* community

with few being Bengali engaged in small economic activities such as fishing, shop-keeping and tea gardens, etc. The respondent's interviews were taken after obtaining prior informed consent (PIC). Local plant names, parts used as food, mode of preparation, disease treatment, religious purpose, fish feed, animal fodder were recorded. Water samples were collected in triplicate and analyzed for pH, conductivity ( $\mu\text{S}/\text{cm}$ ), alkalinity (mg/l), free CO<sub>2</sub> (mg/l), DO (mg/l) and TDS (mg/l) using standard methods<sup>19,20</sup>.

### Results

Physico-chemical properties of 4 ponds during June 2012 to November 2012 were recorded (Table 1). The pond water pH ranged from 6 to 6.5 indicating mild acidic nature. Conductivity ranged from 217.94 to 250.69 ( $\mu\text{S}/\text{cm}$ ). Alkalinity varied from 21.4 to 24 (mg/l). Free CO<sub>2</sub> ranged from 6.3 to 8.5 (mg/l), DO ranged from 6.30 to 6.80 (mg/l) and TDS varied from 45.85 to 55 (mg/l). During the present study, a total of 45 species belonging to 24 families were recorded (Fig. 1 a-l). Emergent growth forms were found to be highest in this study area. The local people use the ponds for multiple activities such as bathing, washing, pisciculture, religious rites, etc. On collating the informant's input, it is found that the macrophytes offer a variety of utility services, viz. medicinal purposes, livestock fodder, vegetables, decoration, religious purposes, fish feed, poultry feed, organic farming, witches herbal (which the local people believe, protect from evil spirit), fuel, fencing and insect repellent.

### Plant uses

Abbreviations: HSN: Herbarium Specimen Number, LN: Local name

*Alternanthera sessilis* (L.) R.Br. exDC.; (Amaranthaceae); LN: *Ghumbhagi*; HSN: AUS/ECOL/JR-TM 001- 12 June 2012

Habitat: Partly floating and partly emergent.

Uses: Flowers (5gm) are crushed and the juice is mixed with ghee (2-5gm) and applied twice a day for mouth ulcer treatment.

Table 1—Physico-chemical properties (mean $\pm$ SD) of the four ponds

Parameters	Pond 1	Pond 2	Pond 3	Pond 4
pH	6.29 $\pm$ 0.18	6 $\pm$ 0.17	6.34 $\pm$ 0.28	6.5 $\pm$ 0.11
Conductivity ( $\mu\text{S}/\text{cm}$ )	217.94 $\pm$ 21.31	225.92 $\pm$ 28.55	250.69 $\pm$ 10.01	220.73 $\pm$ 28.67
Alkalinity (mg/l)	23.71 $\pm$ 2.71	24 $\pm$ 2.24	21.4 $\pm$ 3.58	23.37 $\pm$ 2.17
Free CO <sub>2</sub> (mg/l)	7.77 $\pm$ 1.91	8.14 $\pm$ 1.14	8.5 $\pm$ 1.82	6.3 $\pm$ 0.38
DO (mg/l)	6.80 $\pm$ 0.84	6.67 $\pm$ 0.15	6.30 $\pm$ 0.14	6.37 $\pm$ 0.45
TDS (mg/l)	45.85 $\pm$ 11.24	49.89 $\pm$ 18.23	53.14 $\pm$ 17.09	55 $\pm$ 10.96

*Bergia capensis* L.; (Elatinaceae); LN: *Heicha*; HSN: AUS/ECOL/JR-TM 002 - 12 June 2012

Habitat: Submerged or floating.

Uses: The leaf is crushed (25-35gm) and applied on the sole, palm and head to get relief from burning sensation after delivery. Leaves are consumed as vegetable with fish.

*Canna* sp.; (Cannaceae); LN: *Babada*; HSN: AUS/ECOL/JR-TM 003- 15 June 2012

Habitat: Emergent.

Uses: Whole plants are used for ornamental purpose.

*Centella asiatica* (L.) Urban; (Apiaceae); LN: *Thankuni*; HSN: AUS/ECOL/JR-TM 004- 16 June 2012

Habitat: Floating or emergent.

Uses: Whole plant crushed (~60-80 gm) and the juice is used in empty stomach for stomach pain, fever, ulcer and dysentery.

*Ceratophyllum demersum* L.; (Ceratophyllaceae); LN: *Panichowla*; HSN: AUS/ECOL/JR-TM 005- 12 June 2012

Habitat: Submerged, free-floating.

Uses: The water extract of leaf (10 ml) is used in treatment fever. Whole plant is used as livestock fodder.

*Colocasia esculenta* (L.) Schott; (Araceae); LN: *Kochu*; HSN: AUS/ECOL/JR-TM 006- 10 Nov 2012

Habitat: Emergent or partly submerged.

Uses: Leaf (~10 gm) is crushed and applied externally to heal skin abscess that develops on the surface of the skin. Stem is consumed as vegetable.

*Colocasia* sp.; (Araceae); LN: *Sita kochu*; HSN: AUS/ECOL/JR-TM 007- 10 Nov 2012

Habitat: Emergent.

Uses: Plants are used for home decorating purpose.

*Cynodon dactylon* (L.) Persoon; (Poaceae); LN: *Dubba*; HSN: AUS/ECOL/JR-TM 008- 13 Aug 2012

Habitat: Emergent.

Uses: The leaf (5gm) with three seeds of rice is ground and is mixed with milk (250 ml) and taken twice a day for relief from stomach pain during menstruation.

*Cyanotis axillaris*(L.) Sweet; (Commelinaceae); LN: *Ghash*; HSN: AUS/ECOL/JR-TM 009-10 Aug 2012

Habitat: Emergent.

Uses: Whole plant part is used as livestock fodder.

*Cyanotis* sp.; (Commelinaceae); LN: *Maspakra*; HSN: AUS/ECOL/JR-TM 010- 11 July 2012

Habitat: Emergent.

Uses: Whole plant (~20 gm) is crushed and paste applied to heal burning sensation on sole and palm.

*Cyperus platyphyllus* Roemer et Schultes; (Cyperaceae); LN: *Arikhata*; HSN: AUS/ECOL/JR-TM 011- 14 Aug 2012

Habitat: Emergent.

Uses: The crushed leaf is applied to heal cuts and wounds. The plant is also used in livestock fodder.

*Cyperus tenuispica* Steudel; (Cyperaceae); LN: *Milighash*; HSN: AUS/ECOL/JR-TM 012- 09 Aug 2012

Habitat: Emergent.

Uses: Whole plant part is used in livestock fodder by the local people.

*Eclipta alba* (L.) Hasskarl; (Asteraceae); LN: *Bhangreiya*; HSN: AUS/ECOL/JR-TM 013- 11 Sep 2012

Habitat: Emergent.

Uses: Flowers used in temple offerings.

*Eichhornia crassipes* (Mart.) Solms-Laub.; (Pontederiaceae); LN: *Germani*; HSN: AUS/ECOL/JR-TM 014- 8 July 2012

Habitat: Submerged or free floating.

Fish food: Roots are used as fish feed.

Organic farming: The plant compost is used as green manure in organic farming.

*Eragrostis unioides* (Retz.) Nees ex Steudel; (Poaceae); LN: *Thoga*; HSN: AUS/ECOL/JR-TM 015- 16 Sep 2012

Habitat: Emergent.

Uses: The plant is used in livestock fodder.

*Fimbristylis littoralis* Gaud.; (Cyperaceae); LN: *Panighash*; HSN: AUS/ECOL/JR-TM 016- 22 Aug 2012

Habitat: Emergent.

Uses: Whole plant is used in livestock fodder.

*Fimbristylis miliacea* (L.)Vahl; (Cyperaceae); LN: *Gilgha*; HSN: AUS/ECOL/JR-TM 017- 18 Nov 2012

Habitat: Annual sedge.

Uses: Whole plant part is used in livestock fodder.

*Hydrilla verticillata* (L.f.) Royle; (Hydrocharitaceae); LN: *Panighash*; HSN: AUS/ECOL/JR-TM 018- 21 July 2012

Habitat: Submerged.

Uses: Whole plant is used as fish feed.

*Hygroryza aristata* (Retz.) NeesexWrightet Arn.; (Poaceae); LN: *Baramasighash*; HSN: AUS/ECOL/JR-TM 019- 14 Aug 2012

Habitat: Emergent.

Uses: The plant is used in livestock fodder.

*Ipomoea aquatic* Forssk.; (Convolvulaceae); LN: *Kolamani*; HSN:AUS/ECOL/JR-TM 020- 17 Oct 2012

Habitat: Rooted floating.

Uses: Stem and leaves are consumed as vegetable and whole plant is used in livestock fodder.

*Ipomoea fistulosa* Martius ex Choisy; (Convolvulaceae); LN: *Ripuji*; HSN: AUS/ECOL/JR-TM 021- 19 Oct 2012

Habitat: Emergent.

Uses: The plant is grown surrounding rural homes for fencing and also used as fire wood by the local people.

*Kyllinga brevifolia* Rott.; (Cyperaceae); LN: *Mothaghash*; HSN: AUS/ECOL/JR-TM 022- 10 July 2012

Habitat: Emergent.

Uses: Whole plant are used in livestock fodder.

*Kyllinga melanosperma* Nees; (Cyperaceae); LN: *Ghash*; HSN: AUS/ECOL/JR-TM 023- 07 June 2012

Habitat: Emergent.

Uses: The plant is used in livestock fodder.

*Leersia hexandra* Swartz; (Poaceae); LN: *Tatughas*; HSN: AUS/ECOL/JR-TM 024- 19 Oct 2012

Habitat: Emergent.

Uses: The plant is used in livestock fodder.

*Lindernia anagallis* (N.L. Burman) Pennell; (Scrophulariaceae); LN: *Roshini phul*; HSN: AUS/ECOL/JR-TM 025- 18 Oct 2012

Habitat: Emergent.

Uses: Whole plant is used in ornamental purpose.

*Lindernia rotundifolia* (L.) Alston; (Scrophulariaceae); LN: *Roshini phul*; HSN: AUS/ECOL/JR-TM 026- 22 Nov 2012

Habitat: Emergent.

Uses: Plant is used in ornamental purposes.

*Lindernia* sp.; (Scrophulariaceae); LN: *Siroita*; HSN: AUS/ECOL/JR-TM 027- 16 June 2012

Habitat: Emergent.

Uses: The water extract of leaf (10 ml) is used in fever. The plant has ornamental value.

*Ludwigia adscendens* (L.) H.Hara; (Onagraceae); LN: *Helencha*; HSN: AUS/ECOL/JR-TM 028- 15 June 2012

Habitat: Rooted floating.

Uses: Water extract of tender shoot (10ml) is taken in empty stomach to reduce stomach pain in dysentery. Stem and leaves are consumed as vegetable.

*Ludwigia perennis* L.; (Onagraceae); LN: *Junia*; HSN: AUS/ECOL/JR-TM 029-19 Aug 2012

Habitat: Emergent.

Uses: The crushed leaf mixed with water (~20 ml) is used twice a day to cure fever. The plant is also used for ornamental purposes.

*Marsilea minuta* L.; (Marsileaceae); LN: *Jhunpata*; HSN: AUS/ECOL/JR-TM 030-19 Aug 2012

Habitat: Free floating leaves.

Uses: The crushed leaf mixed with little water (~20ml) is used in dysentery treatment.

*Monochoria hastata* (L.) Solms-Laub.; (Pontederiaceae); LN: *Plogatu*; HSN: AUS/ECOL/JR-TM 03219 June 2012

Habitat: Emergent or partly submerged.

Uses: The crushed leaf (2-3) is applied directly to treat boil. Young shoot is consumed as vegetable.

*Monochoria vaginalis* (N.L.Burman) Kunth; (Pontederiaceae); LN: *Patabahar*; HSN: AUS/ECOL/JR-TM 033-18 Aug 2012

Habitat: Emergent or partly submerged.

Uses: The water extract rhizomes (~20ml) is taken twice a day for curing chest pain.

*Nelumbo nucifera* Gaertn.; (Nelumbonaceae); LN: *Sada podha*; HSN: AUS/ECOL/JR-TM 034- 19 Aug 2012

Habitat: Submerged, floating or emergent leaves.

Uses: Leaf juice (~5ml) is mixed with milk (200ml) and given to lactating mother to produce more milk. Seeds are consumed raw. Flowers used in temple offerings and religious rituals.

*Nymphaea pubescens* Willd.; (Nymphaeaceae); LN: *Lal podha*; HSN: US/ECOL/JR-TM 035-11 June 2012

Habitat: Submerged or floating.

Uses: Rhizomes with root is consumed as vegetable. Flowers used in temple offerings and religious rituals.

*Nymphoides macrosperma* R.Vasudevan (Nair); (Menyanthaceae); LN: *Bera ghash*; HSN: AUS/ECOL/JR-TM 036- 19 Nov 2012

Habitat: Deeply rooted and floating leaves.

Fish food: Roots are used as fish feed.

Uses: Stalk is consumed as vegetable. Flowers and leaves are used in temple offerings.

*Oldenlandia brachypoda* A.P.De Cand.; (Rubiaceae); LN: *Saidpakra*; HSN: AUS/ECOL/JR-TM 037-19 Nov 2012

Habitat: Emergent.

Uses: Leaf and fruits (~20-35 gm) paste is applied in sole and palm 2-3 times a day during delivery for relief from burning sensation.

*Ottelia alismoides* (L.) Persoon; (Hydrocharitaceae); LN: *Gangkola*; HSN: AUS/ECOL/JR-TM 038-19 Nov 2012

Habitat: Rooted floating or submerged.

Uses: Fruits are cooked with fermented fish or fresh prawn.

*Paspalum conjugatum* Bergius; (Poaceae); LN: *Bina ghash*; HSN: AUS/ECOL/JR-TM 039- 17 Oct 2012

Habitat: Emergent.

Uses: It is believed that three leaf put in trinket and when wore across arm or neck can prevent newly born baby getting frightened.

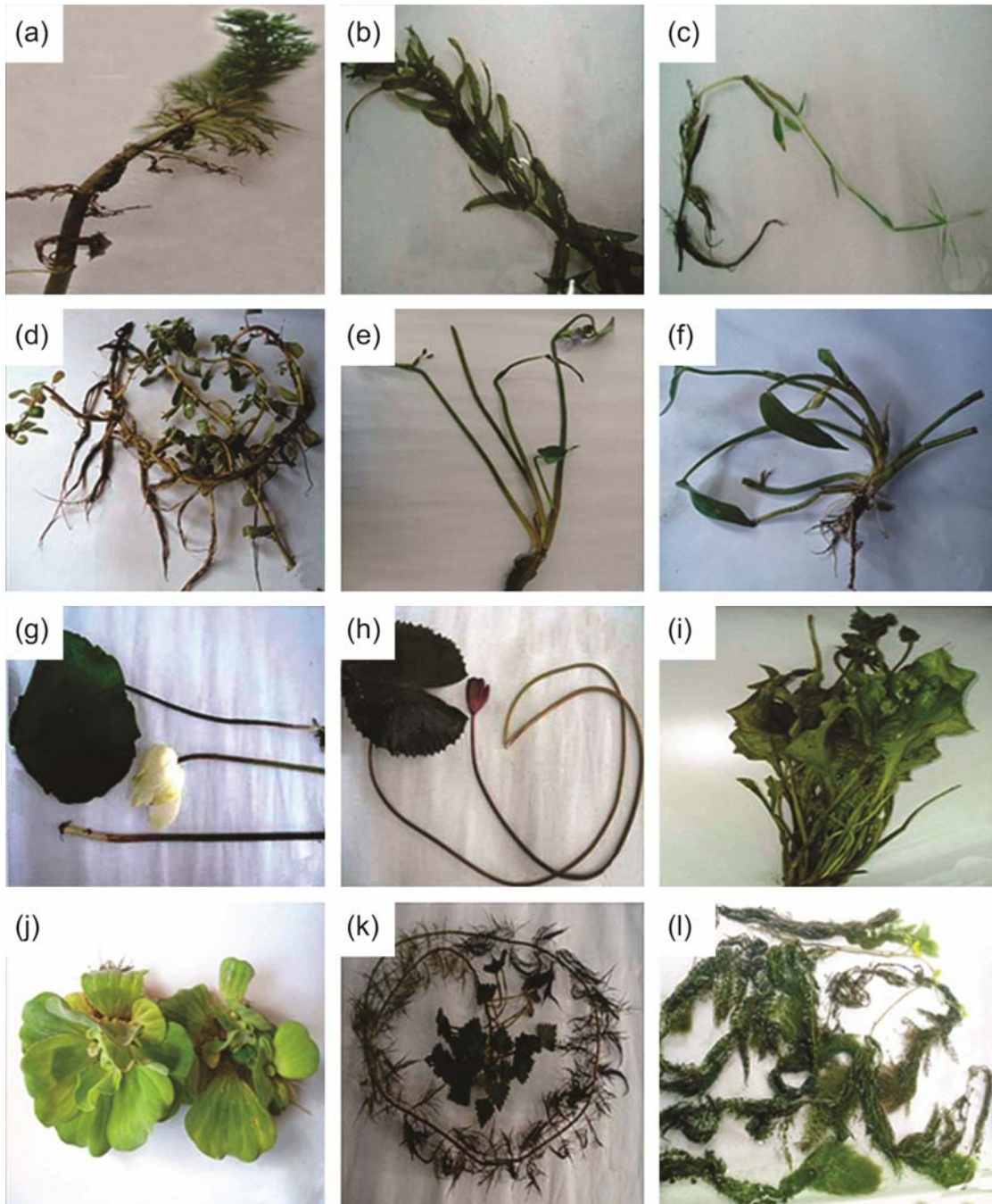
*Pistia stratiotes* L.; (Araceae); LN: *Kachuripana*;  
HSN: AUS/ECOL/JR-TM 040- 29 June 2012

Habitat: Free floating.

Uses: The roots (~2-5 gm) are chewed thrice a day for one week to get relief from tooth-ache. Whole plant is used as poultry feed.

*Polygonum barbatum* (L.) Sensulato; (Polygonaceae);  
LN: *Mirchaghash*; HSN: AUS/ECOL /JR-TM 041-  
28 July 2012

Habitat: Emergent.



Figs. 1(a-l); Fig.a-*Ceratophyllum demersum*; Fig. b-*Hydrilla verticillata*; Fig. c- *Hygroryza aristata*; Fig. d *Ludwigia perennis*; Fig. e- *Monochoria hastata*; Fig. f- *Monochoria vaginalis*; Fig. g- *Nelumbo nucifera*; Fig. h- *Nymphaea pubescens*; Fig. i- *Ottelia alismoides*; Fig. j- *Pistia stratiotes*; Fig. k- *Trapa natans*; Fig. l- *Utricularia aurea*

Uses: The whole plant is crushed and used as insect repellent.

*Pycneus stramineus* (Nees) C.B. Clarke; (Cyperaceae); LN: *Ghash*; HSN: AUS/ECOL/JR-TM 042-25 July 2012

Habitat: Emergent.

Uses: The plant part is used in livestock fodder.

*Salvinia* sp.; (Salviniaceae); LN: *Got pata*; HSN: AUS/ECOL/JR-TM 043- 20 Aug 2012

Habitat: Free floating.

Uses: Whole plant is used as livestock fodder. Roots are used as fish feed.

*Trapa natans* L. var. *bispinosa* (Roxb.) Makino; (Typhaceae); LN: *Singarapata*; HSN: AUS/ECOL/JR-TM 044-20 Aug 2012

Habitat: Submerged bottom rooted .

Uses: The crushed leaf mixed with little water (~20 ml) is used twice a day by lactating mother to produce more milk. Seeds are consumed raw or boiled.

*Utricularia aurea* Lour.; (Lentibulariaceae); LN: *Germanjori*; HSN: AUS/ECOL/JR-TM 045-19 Sep 2012

Habitat: Submerged.

Uses: Whole plant is used in temple offerings. It is believed that hanging these macrophytes in the corner of the house can protect from ghost and other evils spirit. Roots and leaves are used as fish feed.

## Discussion

Interaction with the local people revealed traditional knowledge associated with each of the macrophyte being reported herein. *Alternanthera sessilis* is recommended by the local people for healing mouth ulcer whereas in South Odisha (India) this plant is used as vegetable and fodder<sup>21</sup> and in treatment of chronic congestion of the liver in *Ayurvedic* medicine in Sri Lanka<sup>22</sup>. A variety of *Centella* sp. is found in India which is consumed as raw or boiled vegetables. In the present study, *Centella asiatica* was found to be used in the treatment of dysentery. Similar traditional knowledge was noted for this medicinal plant from North-Kamrup district of Assam<sup>23</sup>. *Centella asiatica* was also reported to be used by the local people of Sri Lankan region for its food and nutritional value<sup>24</sup> and the paste of its leaves is used to treat furuncle in Korea communities<sup>25</sup>. *Ceratophyllum demersum* was mentioned as an antipyretic and in scorpion sting in Cooch Behar, West Bengal, India<sup>26</sup>. Local people in this region consumes aquatic plants, viz. *Colocasia esculenta*, *Ipomoea aquatica*, *Nelumbo nucifera*, *Nymphaea pubescens*, *Monochoria hastata*, *Ottelia*

*alismoides*, *Trapa natans*, *Ludwigia adscendens* were consumed as raw, boiled or fried vegetables. Similar observations were made from habitual uses of the wetlands of South Odisha<sup>21</sup>. People of *Zeiling* tribe of Nagaland have been reported to consume *Centella asiatica*, *Colocasia esculenta* as a vegetables<sup>27</sup>.

Macrophytes play an important role in lifecycle of aquatic organisms including fishes due to their large size. Fishes feed on aquatic macrophytes for their growth<sup>28</sup>. *Eichhornia crassipes*, *Hydrilla verticillata*, *Ludwigia adscendens*, *Mimulus orbicularis*, *Nymphoides macrosperma*, *Pistia stratoites*, *Utricularia aurea* were described as a traditional fish feed. Similar results were documented from other places in India<sup>29</sup>. The local villagers of Silcoorie mentioned *Pistia stratoites* for curing tooth ache besides use in poultry feed. In South Odisha, the paste of the whole plant, *Ludwigia adscendens* used in skin diseases and leaf juice of *Pistia stratoites* mixed with coconut oil are prescribed for treating skin diseases such as leprosy, eczema<sup>30</sup>. Young leaves and petioles of *Eichhornia crassipes*, rich in carotene are also used as vegetables in Hazaribagh district of Jharkhand<sup>31</sup>. The extract of *Alternanthera sessilis* is known to cure eye troubles and whole plant boiled of *Ludwigia adscendens* is used in fever, cold cough and decoction of plants have been mentioned for curing dysentery<sup>31</sup>. Young leaf juice of *Ipomoea aquatica* is taken in the night as purgative and decoction of leaf in purification of blood<sup>28</sup>. The whole plant paste of *Lindernia anagallis* along with black pepper is prescribed for gonorrhoea<sup>30</sup>. *Eichhornia crassipes* ash is used for organic farming in Nigeria<sup>14</sup>. Leaf juices of *Nelumbo nucifera* and *Trapa natans* are prescribed to lactating mothers to increase breast milk – a traditional knowledge gained in the present survey is hitherto unknown for these plants. Traditional knowledgebase of many of these macrophytes in food, religious rituals and treatment of diarrhea and dyspepsia were noted from Mau district, Uttar Pradesh<sup>32</sup>.

*Eclipta alba*, *Nelumbo nucifera*, *Nymphaea pubescens*, *Nymphoides macrosperma* and *Utricularia aurea* found in the present ponds are considered as sacred plants by the local villagers. The species *Eclipta alba* is used in temple offerings in this part while in West Bengal, Cooch Behar district, the plant is known for its use in hair oil and medicine for both human and animals<sup>26</sup>. Animals consume the aquatic plants directly or fed by the local people after harvesting from the surrounding area. Fifteen species

belonging to seven families of macrophytes, viz. *Ceratophyllum demersum*, *Colocasia esculenta*, *Cyanotis axillaris*, *Cyperus platyphyllus*, *Cyperus tenuispica*, *Eragrostis unioides*, *Fimbristylis littoralis*, *Fimbristylis miliacea*, *Hygroryza aristata*, *Kyllinga brevifolia*, *Kyllinga melanosperma*, *Leersia hexandra*, *Mimulus orbicularis*, *Pycnus stramineus*, *Salvinia* sp. were used as fodder.

Majority of these macrophytes belongs to emergent types. *Leersia hexandra*, found in Nigerian freshwater ecosystem, has also been reported to be used as livestock fodder<sup>14</sup>. *Hygroryza aristata* grains are consumed by the economically weaker sections in India<sup>18</sup>. Traditional healers interviewed in the present work believed that the two species *Paspalum conjugatum* and *Utricularia aurea* can serve to protect from evil spirit. *Nymphaea pubescens* rhizomes are used as vegetables in this region while elsewhere the flowers, petioles and rhizomes are used as traditional medicine<sup>4</sup>. Among macrophytes, *Cynodon dactylon* were used in treatment of jaundice in Tumkur district of Karnataka, India<sup>33</sup>, crushed leaf with polished rice in the form of pills is used for herbal treatment of leucorrhoea in the villages of Manas National Park, India<sup>34</sup> and tea is used as a diuretic in Deliblato Sands, Serbia, South East Europe<sup>35</sup>. A large numbers of macrophytic species in river Narmada has been attributed to alkaline pH and enhanced dissolved oxygen level<sup>36</sup>.

In the present work, all four categories of ecosystem services have been noted for 45 macrophytes. It is quite interesting to note that the traditional knowledge associated with a macrophyte in a particular place varies significantly from those known from other areas. The traditional knowledgebase and cultural practices of the local communities also differed depending on geographic locations.

Traditionally macrophytes play a more important role in rural areas in comparison to urban area. The macrophytes provide livelihood for the marginalized people of the rural communities. The macrophytes in aquatic ecosystems serve to clean the water body for house whole uses, rearing fishes, etc. Exchange of information and sharing the importance of the various macrophytes with the local people and other NGO'S can be very beneficial in the context of conservation and sustainable uses. Systematic investigation on the macrophytes diversity and their ecosystem services from different aquatic bodies of the region will not only augment the traditional knowledge base but also

pave way for sustainable management of such ecosystems. Such natural pond ecosystems supporting varied macrophytic growth and the traditional knowledge of the villagers need to be protected and conserved through a joint participatory management approach.

### Conclusion

The emergent growth forms were most dominant of all the macrophytes. Their multifarious traditional use as bioresource in this region has been identified. Macrophytes such as *Nelumbo nucifera*, *Nymphaea pubescens* and *Utricularia aurea* were considered as sacred plants. Systematic investigation on the macrophytic diversity and their ecosystem services of other pond ecosystem from different parts of the region will not only augment the traditional knowledge base but also pave way for sustainable management of these ecosystems. Such natural pond ecosystems supporting varied macrophytic growth and the traditional knowledge of the villagers need to be protected and conserved through a joint participatory management approach.

### Acknowledgement

One of the authors (TM) thanks University Grants Commission, New Delhi, India for research fellowship. The author thanks to Sitakanta Das (age 45 yrs, Silcoorie village), Gauri Kanta Das (age 35 yrs, Silcoorie village) and traditional healer Ratna Dev (age 50 yrs, Silcoorie village) and the local villagers adjoining the study area for their consent and sharing valuable information.

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