

Survey of useful wetland plants of South Odisha, India

Malaya K Misra*, Anima Panda & Deenabandhu Sahu

Ecology & Floristic Laboratory, PG Department of Botany, Berhampur University, Berhampur - 760007, Odisha, India
E-mail: malayakmisra@rediffmail.com, malayamisra.botany@gmail.com

Received 17.08.10, revised 24.12.10

The paper reports useful wetland plants (except medicinal plants) of South Odisha, a part of the Eastern Ghats region, India. The survey was conducted during 2005-2008 and the collected specimens were deposited in the Herbarium of the Botany Department, Berhampur University (BOTB). Ethnobotanical data were collected through interview with elderly people of the area. The result revealed that 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 uses (16 species). Out of the total taxa, 38 species are Dicotyledons under 30 genera and 8 families, and 21 species are Monocotyledons under 15 genera and 13 families. Two species belong to Pteridophytes. Conservation of wetland and wetland plants is suggested.

Keywords: Wetland, South Odisha, Useful plants, Food plants.

IPC Int. Cl.⁸: A61K 36/00, E02B 3/18, A47G 19/26, A47J 39/02, C05F 3/00, A01C 3/00, A23N, A47J, A23L 1/00

Almost all freshwater bodies and wetlands are rich source of human sustenance and culture. An enormous corpus of indigenous knowledge systems and technology had grown based on these freshwater ecosystems. In many provinces in India, local inhabitants traditionally use wetland plants in their day to day life for food, fodder and medicine against the diseases they suffer from or for making different types of household products or for art works for sustenance. A significant number of wetland plants can be considered as bio-resources. There are major and minor plant resources harvested from the wetlands of rural India. All these have significant socio-economic value.

Wetland and aquatic plants provide bio-resources for direct economic use as well as play important ecological role in the ecosystem function including decontamination of polluted waters¹⁻⁷. Sculthrope⁸ while reviewing the traditional uses of aquatic plants stated that 'the aquatic plant resources have limited economic value in the modern world'. Attempts have been made by some researchers from different parts of India to collect ethnobotanical information on wetland plants⁹⁻¹⁵.

In Odisha, Das *et al.*¹⁶ enumerated the traditional uses of wetland plants of eastern Odisha, but information on uses of wetland plants of South Odisha is not well documented except for the wetland medicinal plants¹³.

In the present communication, an attempt has been made to collect information on the uses of wetland plants available in south Odisha except for the wetland medicinal plants¹³. This is a part of the project undertaken to survey and evaluate the wetland plant biodiversity and resources of South Odisha during 2005-2008.

Study site

Odisha state in the eastern part of India consists of 30 districts, out of which 7 districts, viz. Ganjam, Gajapati, Rayagada, Koraput, Nawrangpur, Malkangiri and Kandhamal are in the southern part with a diversified geographical status extending from coast to interior mountainous areas (Fig. 1). This region constitutes a part of the Eastern Ghats of India.

Many wetlands such as lagoons, creeks, numerous natural and man made lakes, reservoirs and ponds are distributed in these districts. Total wetland area of the state is 348205 ha in post-monsoon and 294068 ha in pre-monsoon period while South Odisha consists of

*Corresponding author



Fig. 1 – Map of the study area.

49528 ha in post monsoon and 36965 ha in pre-monsoon period, which are 14% and 12%, respectively of the total state wetland area¹⁷. These wetlands are rich in plant resources. Traditionally, the local inhabitants have been using wetland plant resources for various household uses.

All the districts of South Odisha are rural based and the communities collecting the plant bioresources are *Keuta, Kandra, Pana, Bauri, Sauntia, Matia, Kampomatia, Nayak, Gouda, Reddika, Kandha or Pradhan*. Most of these communities are economically backward and collection of plant resource is their seasonal (secondary) occupation. Primary occupation is daily wage labour and/or cultivation. In past, the *Matia* and *Kampomatia* communities totally depended on mat preparation, however, presently because of lack of proper market facilities they depend on other occupation for their livelihood. Due to industrialization, urbanization, unmanaged exploitation, and also removal of plant materials for fish culture, many of the useful wetland plants of the area are vanishing rapidly.

Methodology

For the present study, wetland areas of seven districts of South Odisha under study were visited four times a year (May, August, October, February) to each district; extending 10-12 days for each visit during 2005-2008 to collect information on the useful wetland plants and their distribution in the study area. The elderly people of different communities were identified and were interviewed during this study

period to collect information about the plants and their uses. More than 20 informants were consulted to collect the information.

The four methods of basic interview that are used commonly by field ethno-botanists were adapted for this study. They involved open-ended and semi-structural interviews which are used in qualitative data collection and structured interviews and questionnaire, which are used for quantitative analysis¹⁸. In the present study, questionnaire was developed to collect the information such as the name of the plant, parts used, methods of collection of plant parts, method of use, etc. As most of the tribal and rural people are illiterate, structural interviews were conducted by putting a series of predetermined questions. The data collected in this study is based on the first hand information. The referred plant specimens were collected in the company of at least one elderly person to make sure that the correct plant has been collected. The collected plant specimens were processed, dried and herbarium specimens were prepared. The specimens were identified with the help of the local floras. The plants are enumerated alphabetically as per their botanical name along with family (in parenthesis), local *Odia* names (O), method of collection of plant parts and uses. Voucher specimens of the collected plant species were deposited in the Herbarium of the P.G. Department of Botany, Berhampur University (BOTB).

Results

The information collected on traditional uses of the wetland plants of South Odisha (except the medicinal plants) are described in this paper. Medicinal uses of the wetland plants of South Odisha are reported by Panda & Misra¹³.

From time immemorial local inhabitants have been using wetland plants for various purposes. Most of the wetland plant products are used after collection.

This study provides information on 61 wetland plant species under 47 genera and 23 families. Of these 38 species are Dicotyledons under 30 genera and 8 families and 21 species are Monocotyledons under 15 genera and 13 families. Two species belong to Pteridophytes.

It is observed that, 25 wetland species are used as food, 23 as fodder, 7 for mat and basket making, 5 as thatching material, 2 as fuel, 5 as organic manure and 11 for miscellaneous purposes. Most of the wetland food plants are used as leafy vegetable.

The wetland plants and their uses in South Odisha are listed below:

Acorus calamus L., Araceae, O. *Bacha*

The rhizome is collected and after removal of the bark cut into small pieces and sun dried for 4 - 5 days for preservation. The leaves are also sun dried and preserved.

- 1 The dried leaves are used as insecticide for preservation of pulses.
- 2 5 - 10 g of dried rhizome is used to clear water.
- 3 Fresh juice of rhizome is added to country liquor 'mohuli' as a flavouring agent.

Aeschynomene aspera L. and ***A. indica*** L., Fabaceae, O. *Sola*

The soft opalescent, white stems of both the species are collected during October and November and left for sun drying on the bank of the water course or on the courtyard. The dried stem looks white and is lighter in weight and locally called *sola*.

- 1 After removal of the bark, the pith is used for making art works such as toys, artificial flowers, models and sunhats (Fig. 2a, b, c).
- 2 The toy boats are prepared by joining together 8-9 cut pieces of the stem (12-15 cm) with fine bamboo sticks followed by painting with different colours and sold in the market on the occasion of *Kartika Purnima* - a Hindu festival. In the early morning of *Kartika Purnima*, the womenfolk and children sail the toy boats in water (tanks, rivers, lakes, sea).
- 3 Artificial crowns are made out of *sola* (pith) and palmyra palm (*Borassus flabellifer*) leaves. Chains (*Vaskaramala*) are also prepared out of *sola*, which are used in the Hindu marriages, thread ceremonies and other religious functions.
- 4 Large stem pieces are tied to the fishing nets as floating material.
- 5 Plant is used as fodder and fuel.
- 6 Ash prepared by burning the stem is used for the preparation of gunpowder in making crackers.
- 7 The nitrogen fixed by the plants within the root nodules enriches the soil with nitrogen.

Alternanthera philoxeroides (Mart.) Griseb., Amaranthaceae, O. *Ghodamadaranga*

The stem and leaves are given to pigs and used as a green manure.

Alternanthera sessilis (L.) R. Br. ex DC., Amaranthaceae, O. *Madaranga saga*

The tender apical shoots of the plant are pinched and are used as leafy vegetable. Also the plant is used as fodder.

Aponogeton undulatus Roxb., Aponogetonaceae, O. *Kesrukanda*, *Chireigudi*

The starchy bulbils that are collected in early winter are consumed as raw and also after cooking.

Aponogeton natans (L.) Engl. & Krause, Aponogetonaceae

The starchy bulbils are eaten as raw and also as vegetable.

Arundo donax L., Poaceae

- 1 The mature dried culms (canes) are widely used as handles of long brush for house roof cleaning, fishing rods and handle of bags, walking sticks and fish traps.
- 2 Canes are used for making flutes, which are sold in local fairs (Fig. 3).

Azolla pinnata R.Br., Azollaceae, O. *Azola*

The whole plant is used as bio-fertilizer in the rice fields (for its nitrogen fixing capacity) (Fig. 4).

Bacopa monnieri (L.) Penn., Scrophulariaceae, O. *Brahmi*

The tender shoots collected from unpolluted areas during July to October and are eaten as supplementary leafy vegetable.

Boerhavia chinensis (L.) Asch. & Schweinf., Nyctaginaceae

The tender leaves are eaten as leafy vegetable.

Centella asiatica (L.) Urban, Apiaceae, O. *Thalkudi*, *Brahmi*

The fresh leaves are collected in early morning and are cooked as leafy vegetable.

Coix aquatica Roxb., Poaceae

Chains are prepared out of the seeds of the plant by the tribal community (*Kondha*) of Koraput district.

Commelina benghalensis L., Commelinaceae, O. *Kanissera*

Fresh young leaves and tender shoots collected in the morning from the margin of ponds are used as a supplementary leafy vegetable.

Colocasia esculenta (Linn.) Scott., Araceae, O. *Banasaru*

Tubers of the plant collected during November and December by removing the upper soil layer are used as vegetable.

Cyperus alopecuroides Rottb., Cyperaceae, O. *Santara*

- 1 The inflorescence stalk and leaves are used for the preparation of mats (locally called *santara pati*) that are used in Hindu marriage and thread ceremony. Usually old men and women are engaged in mat weaving. Rope prepared out of screw pine (*Pandanus fascicularis*) prop root fibre is used in mat preparation (Fig. 5).
- 2 Mats are also used as packing material for transport of leafy plates made out of *siali* (*Bauhinia vahlii*) and *sal* (*Shorea robusta*) leaves.
- 3 Dried leaves and inflorescence stalks are used for thatching of houses and cattle sheds.

Cyperus corymbosus Rottb., Cyperaceae, O. *Sitala*

The flowering stalks harvested during August to December are dried and are used for the preparation of small fine mats locally called *Chatei*. A special type of frame is used for this mat weaving.

Cyperus imbricatus Retz., Cyperaceae

Mats are prepared out of the inflorescence stalk and leaves for household uses. The methods of mat waving and collection of plant material are similar to that of *Cyperus alopecuroides* (*Santara*).

Cyperus pangorei Rottb., Cyperaceae

The harvested flowering stalks are sun dried for about 15 days and fine mats, bags, baskets and household decorative materials are prepared out of this dried plant material. The mat weaving frame is locally called *Khata*.

Echinochloa crusgalli (L.) P. Beauv., Poaceae, O. *Dhera*

Grains are eaten by the poor people during scarcity and vegetative parts used as fodder before flowering.

Echinochloa stagnina (Retz.) P. Beauv., Poaceae

Grains are eaten during scarcity and plant is used as fodder.

Eichhornia crassipes (Mart.) Solms-Laub., Pontederiaceae, O. *Bilatidala*

- 1 The plant is used as pig fodder.
- 2 The plant compost is applied as green manure in crop fields.

Eleocharis dulcis (Burm.f.) Henschel, Cyperaceae, O. *Kanaka*

The tuber is a good source of food for the pigs.

Glinus oppositifolius (L.) A. DC., Molluginaceae, O. *Pita sago*

Whole plant is widely used as leafy vegetable.

Hydrolea zeylanica (L.) Vahl, Hydrophyllaceae, O. *Langulia*

The plant is taken as a supplementary food by the local poor people.

Hydrilla verticillata (L.f.) Royle, Hydrocharitaceae, O. *Chingudiadala*

- 1 It is a good source of food for the fishes (herbivorous), used in pisciculture.
- 2 Plants are used as storing and packing material for live crab marketing.
- 3 Used as organic manure.

Hygrophila auriculata (Schum.) Heine., Acanthaceae, O. *Koelekha*

The tender leaves are eaten as leafy vegetable.

Ipomoea aquatica Forssk., Convolvulaceae, O. *Kalama sago*

The fresh young shoots and leaves are consumed as leafy vegetable (Fig. 6).

Ipomoea carnea Jacq., Convolvulaceae, O. *Amari*

- 1 The dried stems are used as fuel wood by the local poor.
- 2 Due to its water resistance property, the stems are used to fix fishing nets in deep water for 2–3 days.
- 3 The stems are used for fencing of courtyards and home gardens and also for making cattle and goat sheds.

Isachne globosa (Thumb.) Kuntze, Poaceae

The whole plant is used as green manure.

Limnophila indica (L.) Druce, Scrophulariaceae, O. *Keralata*

Leaves are used as leafy vegetable.

Marsilea quadrifolia L., Marsileaceae, O. *Sunsunia*

Widely used as leafy vegetable.

Monochoria hastata Solms - Laub., Pontederiaceae, O. *Kaupana*

The young inflorescence is cooked as vegetable.

Nelumbo nucifera Gaertn., Nymphaeaceae, O. *Padma / Kamala* (Fig. 7)

- 1 In late winter or early summer the creeping rhizomes (locally called *mrunala*) of the Lotus plant, which are embedded under mud, are collected. The rhizome (*mrunala*) is widely used as vegetable by the rural and urban people and is marketed. The rhizomes are sun dried and stored for later consumption.
- 2 The large circular leaves are used as leafy plates and as packing material for the marketed flowers and fishes.

3 Mature flower buds are collected and are marketed primarily near Hindu temples as the Hindus offer it to God and Goddess in many religious occasions.

4 The dried ripe hard dark brown seeds (or carpel) are used as beads for the preparation of rosary, used by Hindus for sacred purpose. Seeds are jointed together by copper or silver wire or thread. The immature seeds are eaten as raw.

Neptunia oleracea Lour., Mimosaceae,
O. *Panilajakuli*

The tender leaves are taken as leafy vegetable.

Nymphaea nouchali Burm., Nymphaeaceae,
O. *Nilakain*

1 The rhizomes locally called *madhi* are eaten after boiling.

2 Flowers are used for ornamental and sacred purposes by Hindus.

Nymphaea pubescens Willd., Nymphaeaceae,
O. *Rangakain*

1 The rhizome (*madhi*), petioles and peduncles are consumed as food.

2 The roasted seeds (called *leuda*) are eaten occasionally.

3 The flowers are used for sacred and ornamental purposes.

Oryza rufipogon Griff., Poaceae, O. *Balunga*

1 The grains are eaten by the local poor and plants used as fodder.

Oryza sativa L., Poaceae, O. *Dhana*

Cultivated throughout Odisha for its grains and the residual plant materials are used as fodder.

Ottelia alismoides (L.) Pers, Hydrocharitaceae,
O. *Panikunduri*

Local people eat lower part of the flower as raw or as vegetable.

Phragmites karka (Retz.) Trin. ex Steud., Poaceae,
O. *Noto*

2 The mature and dry culms (canes) are used in making musical instrument and are sold in the local fairs / market.

3 Mats and baskets are also prepared out of the culms.

Pistia stratiotes L., Araceae, O. *Borajhanji*

Plant is used as duck and pig food.

Polygonum barbatum L., Polygonaceae

The leaves are eaten as leafy vegetable.

Polygonum glabrum Willd., Polygonaceae

The tender leaves are eaten as leafy vegetable.

Saccharum spontaneum L., Poaceae,
O. *Tandi/Payal*

1 The young shoots are used as fodder.

2 The whole plant is used for thatching of houses and cattle sheds.

3 The flowering culms are used for making ropes.

Scirpus grossus L. f., Cyperaceae,
O. *Santara/Beduan*

The dried inflorescence stalks along with leaves are used to prepare mats for household uses. This is the poor man's cushion as it gives a spongy action due to the presence of air spaces inside the stalk. The method of collection of plant material and procedure of mat weaving is similar to that of *Cyperus alopecuroides* (*Santara*).

Sesbania javanica Mig., Fabaceae, O. *Kathosola*

Plant is used as green manure as it contains high amounts of nitrogen.

Trapa natans L. var. *bispinosa* (Roxb.) Makino,
Trapaceae, O. *Pani singada*

The fruits are taken as raw as well as after cooking. The flour prepared from the mature nut is taken at the time of scarcity.

Typha angustata Bory & Chaub., Typhaceae,
O. *Hanglal/Paulula*

Whole plant is used as thatching material for sheds and huts.

Vetiveria zizanioides (L.) Nash, Poaceae, O. *Bena*

1 The plant is used for thatching of house and cattle shed (Fig. 8).

2 The shiny, yellow inflorescence stalk is used for making baskets and wall hanging decorative materials.

3 The aromatic roots are woven into mats, mostly used as screen (*khas-khas*) and when wetted it emits sweet fragrance.

Besides, twelve species such as *Cyperus cephalotes* Vahl (Cyperaceae), *Echinochloa colona* (L.) Link, *Hygroryza aristata* (Retz.) Nees ex Wight & Arn. *Hymenachne acutigluma* (Steud.) Gilliland, *Ischaemum rugosum* Salisb., *Leersia hexandra* Sw., *Panicum paludosum* Roxb. *Paspalidium flavidum* (Retz.) A. Camus, *Paspalidium punctatum* (Burm.f.) A. Camus, *Paspalum distichum* L., *Pseudoraphis spinescens* (R.Br.) Vickery, *Sacciolepis interrupta* (Willd.) Stapf in Oliver (Poaceae) are used as fodder in the region.



Figs 2a-c – 8—(a) *Aeschynomene aspera*: (b) Making of toy boat: (c) *Solo* in crown & chains; Fig. 3 – Flutes made up of *Arundo donax*; Fig. 4 – *Azolla pinnata* used for nitrogen source; Fig. 5 – Collection & mat preparation of *Cyperus alopecuroides*; Fig. 6 – Collection and sale of *Ipomoea aquatica*; Fig. 7 – Use of different parts of *Nelumbo nucifera* and Fig. 8 – Collection of *Bena* and its uses in basket making and thatching.

Discussion

Wild aquatic plants are collected by the local poor people as a means of livelihood and source of income¹⁹⁻²⁰. Aquatic plants play an important role in the lifecycle of fish. Some plants (e.g *Lemna* sp.) are eaten directly by the fishes²¹. *Azolla pinnata*, a free-floating fern, is widely used as a biofertilizer for rice crop in the area. *Azolla pinnata* is also used as a biofertilizer for rice production in China²². Application of *Azolla* in rice field once before transplanting and twice after transplanting increased the plant height, tillering, grain and straw yield significantly more than applying 60 kg N/ha as urea and showed greater effect on soil fertility²³. Culture of *Azolla pinnata* in transplanted rice fields as an intercrop controlled some weed growth up to 50%²⁴. Similarly, *Sesbania javanica*, which is used as green manure, is rich in nitrogen and other nutrients that enrich the soil with nutrients.

Many of the aquatic plants, both above and belowground, are used as fodder by the cattle, pig, goat and sheep. These aquatic plants are rich in nutrients that help in secondary production of meat and milk. For example, young shoots of *Alternanthera sessilis* are nutritious and increase the flow of milk in cattle. *Echinochloa crus-galli* and *Eichhornia crassipes* are rich in protein while *Alternanthera philoxeroides* is rich in iron.

Aquatic plant resources provide some traditional occupation to the local inhabitants. This occupation may be seasonal or annual and provides monetary income to the local inhabitants. The *sola* (pith) toy boats generate good income during the festive months. As *sola* pith material can be stored for longer time, if proper market is created for the *solo* decorative materials, it can provide employment and income to the local people through out the year. In West Bengal, besides hat preparation *solo* is used for the preparation of other decorative artwork. *Sola* charcoal is employed elsewhere in making gun powder and fire work, and for firing pottery²⁵.

In India, the tribal and rural people traditionally use about 9500 wild plants for various purposes such as medicine, food, fodder, fuel, fibre, essence, culture and other miscellaneous purposes²⁶. Out of these about 3900 wild plants are used as food that are mostly consumed during emergency²⁷. Consumption pattern of wild food plants depends mostly upon their availability in nature. It is established that most of the wild food plants are rich in nutrients and vitamins²⁷.

Some of these wild food plants contain phytochemicals that provide health benefit, and prevent diseases and physiological disorders in humans. For example, in the present study, *Alternanthera sessilis*, taken as leafy vegetable, increases the flow of bile in the intestine stimulates lactation in nourishing mother and helps in the treatment of leucorrhoea¹³. *Bacopa monnieri*, a leafy vegetable, is useful against epilepsy, head reeling, asthma and constipation¹³. *Centella asiatica*, a potherb helps in the treatment of headache, madness, cold and cough, and enhances memory power¹³. *Commelina benghalensis*, taken as food, is also helpful in constipation and rheumatic pain. *Echinochloa crus-galli* grains are nutritionally rich containing both macro- and micronutrients²⁸ (Wlth of Ind Vol 3). *Ipomoea aquatica* rich in protein (15.2 %) is a good source of minerals and vitamins especially carotene²⁸. Moreover, it acts as a blood purifier and cure gonorrhoea¹³. Protein (24-36%) and mineral rich *Marsilea* plant is important for human nutrition. Protein is a growth promoter and helps in maintenance and repair of body tissue. The rhizome of *Nymphaea* spp. contains rich starch and medicinally used against diabetes, dysentery, leucorrhoea, piles and dyspepsia¹³.

The rhizomes of lotus plant are rich in starch and carpels, which are considered more nutritive than cereals²⁹ are consumed as food/vegetable in the Asian countries. Moreover, different parts of the lotus plant are used as medicine¹³. The flowers, torus and creeping rhizomes (*mrunala*) of lotus plant that are consumed raw in the area, provide supplementary food to the local poor. Moreover, the dry seeds of lotus can be stored for longer period that are used for rosary. Although it is a beneficial business, the occupation could not spread, because the processing knowledge is localized with some communities. In Utter Pradesh and West Bengal, lotus seeds are sold in the market as a vegetable in the name *Kamal gatta*²⁰. Although raw creeping rhizomes (*mrunala*) are widely consumed as food, in some areas sun dried rhizomes are also consumed. Development of proper storage method for raw creeping rhizomes can help establish small-scale industry for making starchy rhizome chips in the area. Besides wild populations, lotus is cultivated in large quantities for the sacred flowers in West Bengal²⁰. The rhizome of the *Nymphaea nouchali* plants are

sold in the market as vegetable in Uttar Pradesh, and leaves are used as livestock feed in Andhra Pradesh²⁹.

Dried stored plant materials particularly the inflorescence stalk of *Cyperus* species are used for mat weaving throughout the year. Mat weaving and *solo* pith works provide occupation to the experienced old persons as it involves less labour but needs expertise. Cultivation of mat plants, particularly *C. pangorei* is extensively observed in West Bengal and to some extent in Odisha and Tamil Nadu²⁰.

Use of some available plant material is not known to the local people. For example, *Arundo donax* is used in pulp industries in other states of India¹⁹, but is not known to the people in South Odisha. *Eichhornia crassipes* compost is applied as manure in cultivation in the study area; however, dried plants of *Eichhornia crassipes* are used as a bed material for mushroom cultivation in Phillipines³⁰. *Ludwigia adscendens* is used as a medicinal plant in this region, but the soft tender shoots and leaves are used as food in Assam³¹. Pal & Nimse¹² reported *Hydrilla verticillata* for its medicinal and food value that are not known to the local people of the study area.

The freshwater bodies not only provide commercial products but also supply some of the life saving products. Grains of aquatic grasses (*Echinochola crusgalli*, *E. stagnina*, *Oryza rufipogon*), rhizomes (*Aponogeton undulates*, *Nelumbo nucifera*, *Nymphaea pubescens* *Colocasia esculenta*), seeds (*Nelumbo nucifera*, *Nymphaea pubescens*), buds (*Monochoria hastate*, *Ottelia alismoides*) and leaves (*Alternanthera sessilis*, *Commelina benghalensis*, *Glinus oppositifolius*, *Hydrolea zeylanica*, *Hygrophila auriculata*, *Ipomoea aquatica*, *Marsilea* spp.) of aquatic plants provide subsidiary food to the local poor during starvation or scarcity. Das *et al.*⁶ reported the uses of 105 species under 41 families from eastern Odisha, which include some of the tree and mangrove species. However, in this study, 61 species are reported as useful by the local people. As elsewhere, wetlands of South Odisha provide large amount of fodder for various animals, which help maintain the livestock.

The authors are of the view that there are many plants in South Odisha that can be commercially exploited. Some awareness programs could be carried out in this rural area about the commercial uses of the aquatic plant products.

Conclusion

Aquatic bioresources are not explored well in the past and presently the wetlands/aquatic ecosystems are destroyed and/ or vanishing rapidly due to various reasons. Thus, the plant bioresources are depleting rapidly jeopardizing the livelihood of the poor wetland dependent people. Therefore, measures for conservation of wetlands and wetland resources should be taken up on priority by different government and non-government organizations involving the stakeholders for the benefit of humanity.

Acknowledgment

The authors are thankful to the local people, particularly to the informants for their kind cooperation in providing information on various uses of the wetland plants of the study area. We are thankful to the Ministry of Environment and Forests, Government of India for financial support.

References

- 1 Body C E, Freshwater plants: a potential source of protein, *Econ Bot*, 22 (1968) 359-368.
- 2 Body C E, Vascular aquatic plants mineral nutrient removal polluted waters, *Econ Bot*, 24 (1970) 95-103.
- 3 Body C E, Utilization of aquatic plants, In: *Aquatic vegetation and its uses and control*, edited by DS Mitchell, (UNESCO, Paris), 1974, 107-114.
- 4 Kitho S, Shiomi N & Uheda E, The growth and nitrogen fixation of *Azolla filiculoides* Lam. in polluted water, *Aquat Bot*, 46 (1993) 129-139.
- 5 Mann C J & Wetzel R G, Loading and utilization of dissolved organic carbon from emergent macrophytes, *Aquat Bot*, 53 (1996) 61-72.
- 6 Valentine A N, Wolfe L N, Darrell E R, Steven C M & Chuhua W, Use of aquatic plants and algae for decontamination of waters polluted with chlorinated alkanes, *Int J phytoremed*, 1 (3) (1999) 203-226.
- 7 Pandit A K, Role of macrophytes in aquatic ecosystem and management of freshwater resources, *J Environ Manag*, 18 (1984) 73-88.
- 8 Sculthrope C D, *The biology of aquatic plants*, (Edward and Arnold, London), 1967.
- 9 Jha V N, Gupta A N K, Dutta R N, Jha U N, Misra R K & Saraswati K C, Utilization and conservation of *Euryale ferox* Salisbury in Mithila (North Bihar), India, *Aquat Bot*, 39 (1991) 295-314.
- 10 Jha V N & Jha A, Plants utilized as supplementary vegetables in Darbhanga district of North Bihar, *J Appl Biol*, 3(1-2) (1993) 13-15.
- 11 Seshavatharam V, Traditional use and problem of noxious growth, In: *Ecology and management of aquatic vegetation in the Indian subcontinent*, edited by Gopal B, (Kluwer Publ., Netherland), 1990, 201-218.

- 12 Pal D K & Nimse S B, Little known uses of common aquatic plant, *Hydrilla verticillata* (Linn. f.) Royle, *Nat Prod Rad*, 5(2) (2006) 108-111.
- 13 Panda A & Misra M K, Ethno-medicinal survey of some wetland plants of South Orissa and their conservation. *Indian J Trad Knowl*, 10 (2) (2011) 296-303.
- 14 Trivedy R K, Water hyacinth for control, biogas, paper pulp, animal feed and manure, *Environ Ecol*, 1 (1983) 139-141.
- 15 Gopal B & Sharma K P, Aquatic weed control versus utilization, *Econ Bot*, 30 (1979) 340-346.
- 16 Das H S, Panda P C & Patnaik S N, Traditional uses of wetland plants of eastern Orissa, *J Econ. Tax Bot, Add Ser*, 12 (1996) 306-313.
- 17 Garg J K, Singh T S & Murty T V R., *Wetlands of India*, (Space Applications Centre, ISRO, Ahmadabad, India), 1998.
- 18 Martin G J, *Ethnobotany: A methods manual*, (Chapman and Hall, London), 1995.
- 19 Cook C D K, *Aquatic and wetland plants of India*, (Oxford Univ. Press, Oxford), 1996.
- 20 Ghosh S K, *Illustrated aquatic and wetland plants in harmony with mankind*, (Standard Literature, Kolkata), 2005.
- 21 Mbagwu I G & Adeniji H A, The nutritional content of duckweed (*Lemna paucicostata* Hegelm) in Kainji area, Nigeria, NIFFR Ann. Report. 1988.
- 22 Maltby E, Waterlogged wealth: why waste the world's wet places?, (International Institute for Environmental Development & Washington, Earthscan Publications, London), 1986.
- 23 Singh A L & Singh P K, Comparative studies on different methods of *Azolla* utilization in rice culture, *J Agric Sci*, 107 (1986) 273-278.
- 24 Satapathy K B & Singh P K, Control of weeds by *Azolla* in rice, *J Aquat Plant Manag*, 23 (1985) 40-42.
- 25 Dastur J F, *Useful plants of India and Pakistan*, (B Porevala, Bombay), 1964.
- 26 Anonymous, Ethno-biology in India: A status report, all India coordinated research project on ethno-biology, (Ministry of Environment and Forests, Government of India, New Delhi), 1995.
- 27 Jain A K & Tiwari P, Nutritional value of some traditional edible plants used by the tribal communities during emergency with reference to central India, *Indian J Trad Knowl*, 11 (1) (2012) 51-57.
- 28 Anonymous, the Wealth of India- A Dictionary of Indian Raw Materials and Industrial Products. 1st supp ser, Raw Material, (National Institute of Science Communication & Information Resources, CSIR, New Delhi), vol 3 (D-I) 2002. 46.
- 29 Anonymous, the Wealth of India- A Dictionary of Indian Raw Materials and Industrial Products. 1st supp ser, Raw Material, (National Institute of Science Communication and Information Resources, CSIR, New Delhi), vol 4 (J-Q), 2003, 214-215.
- 30 Ratchance K, Water hyacinth, Abstracts No. 12, (Applied Scientific Research Cooperation, Thailand), 1972.
- 31 Bora H R & Pandey A K, Less known wild food plants of Assam, *J Econ Tax Bot, Addl ser*, 12 (1996) 357-358.