

Keystone Functions of *Hydrilla verticillata*

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Submerged freshwater weed *Hydrilla verticillata* (L.f.) Royle, though considered a nuisance, is a cosmopolitan primary keystone species. If scientifically managed, *H. verticillata* would prove to be a ‘wonder keystone species’ in the world, to conserve the rapidly declining freshwater biodiversity.

Introduction

Biodiversity in our village ponds, agricultural lakes and in temple tanks, particularly the dragon flies, may flies, damsel flies, fishes, frogs and some water birds, have been rapidly disappearing, not only due to pollution from garbage, detergents, pesticides and due to drought, but largely due to the loss of aquatic vegetation, particularly *Hydrilla verticillata* (L.f.) Royle.

H. verticillata is a submerged aquatic plant in lentic freshwater ecosystems of the world, and is a highly controversial weed. It is popularly known as the water thyme, or the Indian star vine or Florida elodea. Each Indian language has multiple names for this weed, and some of the more common names are *samudra sokh* or *gudrisaag* in Hindi, *honagonne* or *pishachi thaavara* in Kannada, *ene-pael* in Malayalam, *kodi paasi* in Tamil, *poo naachu* in Telugu and *sheval* in Marathi. It is said to be a native of Sri Lanka, South India, Africa, Southeast Asia and Australia, but since the last half century it has been invading Europe and the United States too, where it is detested as an invasive weed, nuisance plant, pernicious aquatic weed and as naturalists’ curse, etc., all because its canopies in water interfere with game-fishing, boating and swimming. It was observed that this weed impacts freshwater habitats adversely in the United States [1]. However, in its native countries, it performs multiple ecosystem functions, such as keystone niches for attracting an enormous biodiversity and for cleansing the waters of heavy metal contamination, through bioremediation.

Keywords

Hydrilla verticillata, keystone species, invasive weeds, carbon sequestration, bioremediation, AVM disease.





Interestingly, *H. verticillata* is the only species for the genus *Hydrilla*, belonging to the family Hydrocharitaceae. *Halophila ovalis* (R.B.), a member of the same family, and closely related to *H. verticillata*, but inhabiting saline waters, discharges more or less the same ecosystem functions as *Hydrilla* does, in freshwaters.

Special Attributes of *Hydrilla*

The success of *H. verticillata*, as a cosmopolitan weed is because of its following special attributes:

- It multiplies by vegetative propagation, through broken fragments that float and get carried across by currents and floods, or through trade in ornamental fish which are stocked with *Hydrilla* for aeration, or through migrant water birds to whose feathers and feet the fragments may get attached, or by the horns of buffaloes that wallow in tropical shallow waters. Even bits of about 2–3 cm long, with just one node, can regenerate, growing at a fabulous rate of about 2 cm per day, with stems as long as 750 cm, and it can add a biomass of about 130 tonnes/acre/year.
- This weed resists herbicides, can tolerate oxygen depletion, low salinity of water and chemical pollution too.
- It bears root-tubers or rhizomes in the bottom sediment which are resistant to drought, so that it is really difficult to exterminate this weed totally.

Figure 1.(left) *Hydrilla* in aquarium.

Figure 2. (right) *Hydrilla* in pond.

Hydrilla verticillata performs multiple ecosystem functions, such as keystone niches for attracting an enormous biodiversity and for cleansing the waters of heavy metal contamination, through bioremediation.



H. verticillata is a producer and a primary keystone species, very hardy, as it is adaptable to waters of all the continents and is highly tolerant to a wide range of temperatures, from the freezing and sub-zero levels of the temperates, upto the warm waters of the tropics.

- Also, since this weed can survive without roots, as a floating vegetation, it is independent of the depth of water it inhabits.
- Above all, *H. verticillata* is a producer and a primary keystone species [2], very hardy, as it is adaptable to waters of all the continents and is highly tolerant to a wide range of temperatures, from the freezing and sub-zero levels of the temperates, up to the warm waters of the tropics.

Hence, *H. verticillata* is a cosmopolitan wonder keystone species.

Keystone Functions

Hydrilla verticillata is an excellent 'keystone niche' providing a variety of habitats as well as food-chains for diverse microbes, algae and micro- as well as macro-fauna. Since it is a cosmopolitan species, it is rather difficult to list the enormous diversity of species that it attracts, wherever it is distributed in the world. Hence the following account is chiefly relevant to India.

Keystone Habitat Modifier

H. verticillata is a 'keystone habitat modifier' or an 'ecosystem engineer' in lentic freshwater ecosystems.

- Epiphytes: Rich diversity of algae are attached to this weed.
- Epizoic Forms: An incredible 2000–3000 species of free-living microbes, like bacteria and diatoms are known to adhere to *Hydrilla*. It is this amazing diversity of microbes that are the chief attraction for all higher micro- as well as macro-fauna to the vicinity of this weed, establishing intricate food-webs. If only one cultures the microbes adhering to *Hydrilla* and looks at them under a microscope, can one realise the wonderful microbial diversity that it harbours.
- Sessile Epifauna: Some of the lower invertebrates like the colonial ciliates *Vorticella*, *Epistylis* and *Zoothamnium*, and hydroids like *Hydra* and *Obelia* and rotifers live attached to the *Hydrilla* leaflets.



- **Crawlers and Browsers:** If a bunch of *H. verticillata* is washed in a container of water, all the crawlers and browsers get dislodged. Planarians, *Tubifex* worms, ostracods, daphnids, estherids, the shrimp *Caridina nilotica* and snails like *Limnaea*, *Planorbis*, *Vivipara* and *Pila*, herbivorous bugs like *Nepa*, *Ranatra*, *Sphaeroderma*, *Notonecta* and *Belostoma* are some common forms from India [3].
- **Sheltering Fauna:** Fishes, tadpoles, frogs, snakes and tortoises take shelter amidst this bushy vegetation.
- **Water Birds:** Kingfishers, wagtails, pond herons and jacanas alight on these floating weeds and forage for their food organisms amidst the intricate mats of this weed. In the United States, a variety of ducks, the American Coots and the Common Moorhen [4] and also the Pied-billed Grebes [5] are attracted to this weed for foraging.

Thus, in each region of the world, this single species *H. verticillata* attracts a rich local biodiversity, and if we add up for all these regions, the total number of species would easily outrule the potential of all other keystone species like oysters and coral polyps, thus deserving to be ranked as the ‘cosmopolitan wonder keystone species’.

Keystone Prey

- **Foragers:** Grass carps (*Ctenopharyngodon idella*) feed voraciously on *H. verticillata*, and in fact, this carp is used for biological control of this weed [6]. This is a case of beneficial herbivory. Ducks, teals, dabchicks (grebes) and coots feed on its tender leaflets. Buffaloes and pigs graze on this weed, both in water as well as outside, when this weed is thrown ashore. *Hydrilla* from pristine waters is said to be a ‘green food’, rich in minerals and vitamins [7].
- **Plant-juice Feeders:** Water bugs feed by sucking the juices from the tender stems of *Hydrilla*.
- **Detritus:** Decomposing weeds of *Hydrilla* contribute to the

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Snails and fish attach their egg-masses to these weeds and fish spawn amidst them. Critically endangered water birds breed successfully on the Madhavaram Jheel in Chennai, India, thus helping to conserve these rare species of birds.

formation of detritus which worms, snails and fish relish as food.

Breeding Sites

Snails and fish attach their egg-masses to these weeds and fish spawn amidst them. Critically endangered water birds like the bronze-winged and the pheasant-tailed Jacanas, chiefly the latter, set their flat and flimsy nests on these floating weeds of *H. verticillata* and breed successfully on the Madhavaram Jheel in Chennai, India, thus helping to conserve these rare species of birds.

Auxiliary Ecosystem Functions

In addition to the aforesaid direct keystone functions performed by this cosmopolitan water weed *H. verticillata*, other important ecosystem functions that it performs render the ecosystem more conducive for a richer biodiversity to inhabit, even in degraded water bodies.

Carbon Sequestration

Earlier to the current practice of artificial aeration of aquaria which replaced live *H. verticillata* and other freshwater vegetation, this weed was invariably the chief aquarium plant, particularly in the tropics, proving its efficiency in oxygen release and carbon dioxide absorption.

The freshwater shrimp *Caridina nilotica* is often found in association with *H. verticillata*, perhaps for the oxygen that this weed releases, just as the juveniles of the tiger shrimp *Penaeus monodon* and adult *Penaeus semisulcatus* in India and in Southeast Asia are found attached to the closely related weed *Halophila ovalis* of the same family Hydrocharitaceae, but in saline waters.

During summers in the tropics, the spreading mats of *H. verticillata* cool the waters, particularly during the hot noontime, preventing the shallow waters from getting heated up, thus protecting the freshwater fauna.



Bioremediation

Aquatic plants are known to be ecological indicators of heavy metal contamination of the waters they inhabit. Like any other aquatic plant, *H.verticillata* also accumulates both by adsorption and resorption almost all heavy metals discharged from industrial and sewage effluents. Copper particularly, in low concentrations, is taken up efficiently by *Hydrilla* [8].

This bioremediation has manifold alerts for us, besides cleansing the waters for inhabitation by several delicate species. Although it is an inexpensive and efficient means of cleansing the waters from heavy metal contamination (pollution), and also a source for recovering heavy metals for reuse, the dangers of bioaccumulation (bioamplification) of these heavy metals at various higher trophic levels like fish and water birds have to be kept in mind, ecotoxicologically. Water birds like the American Coot (*Fulica americana*), which feed on this weed, are alleged to be acquiring the fatal neurological disease AVM (Avian Vacuolar Myelinopathy) through ingesting toxic cyanobacteria adhering to this exotic *H.verticillata* [9]. AVM may even be augmented by the heavy metal load in *Hydrilla*.

Threats to *Hydrilla* Survival

- *H.verticillata* is usually eliminated by managers of water bodies by manually collecting and throwing out boat-loads of them onto the shore, where buffaloes and pigs in India feed on them. Vast masses of *Hydrilla* in water may be foraged by herbivore fishes like the grass carp.
- In tropical countries, smaller ponds and irrigation tanks get totally dried up during summer, killing this weed, but yet the rhizomes in the bottom sediment may lie dormant and viable.
- Siltation by sewage-sludge, thermal pollution from hot industrial effluents, chemical pollution by herbicides, are the other reasons for the extermination of this weed.
- Over-harvesting *H. verticillata* for ornamental fish-trade, for

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Hydrilla needs to be conserved and should be scientifically managed to fully realise its manifold benefits.

utilising it in formulating fish-feed, or for composting it or for biogas generation, may also be the other reasons for the disappearance of this weed.

Summary

Hydrilla verticillata, though considered as a nuisance weed, discharges several positive ecosystem functions like carbon sequestration and bioremediation, apart from its amazing functions as a primary keystone species. Unlike coral polyps and oysters which are said to be the best examples of keystone species in the world, *Hydrilla* is a monospecific genus, not regional but global in its biogeographic distribution. It attracts the largest number of species. No doubt, *H. verticillata* can be rated as a ‘wonder keystone species’ in the world. Hence, it needs to be conserved, without prejudice, but should be scientifically managed to fully realise its manifold benefits to the degrading freshwater ecosystems in the world.

Suggested Reading

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