JUST AGRICULTURE
multidisciplinary e-Newsletter

Water Chestnut (*Trapa natans* L.): Therapy and Threats

Manoj Kumar Jena[1], Satikanta Sahoo[2] and Nibedita Sahoo[3]

[1]PG Research Scholar, Dept. of Entomology, Navsari Agriculture University, Navsari, Gujarat

[2] Jr. Lecturer, Dept. of Botany, N.C. (Autonomous) College, Jajpur, Odisha

[3] Junior Assistant, DSR Office, Jajpur Town, Jajpur, Odisha

ARTICLE ID: 043

Abstract

Water Chestnut, also known as horned water chestnut or water caltrop, is a rooted floating aquatic plant. It is cultivated and very popular because of its beneficial properties. It contains the nutrients like Carbohydrates, Proteins, Fats, Fibres and minerals like Ca, Fe, P, K, Na, S, Cu, Zn, Mn and Vit-C. Since, the fruits are rich in calcium and thus recommended by doctors for consumption for hypocalcaemic as well as bone fracture patients. The plant also possesses ethnomedicinal properties. It displaces native vegetation and limits navigation and recreation when it becomes abundant in an area. When the plant grows in excess it cuts light and decreases oxygen level and creates serious problems to other aquatic creatures. When the plant creates havoc in an area, different management practices mechanical, biological and chemical measures must be adopted to manage the weed before seed setting. Among natural enemies, *Galerucella birmanica* (Jacoby), *Galerucella nymphaeae* (L.), *Nanophyes japonica* (Roelofs) and *Nanophyes spp*. are most commonly used for long term management of this weed. Herbicides 2, 4-D and Glyphosate are used as a last resort to control this weed.

Introduction

According to Cook (1978), 30 species of *Trapa* are distributed in different parts of the world. *Trapa* species having four stout horns on the fruit most often are called *T. natans*. The two other commonly cultivated species in Asia, *T. bicornis* (Osbeck) and *T. bispinosa* (Roxburgh), have two horns. Unfortunately, an unrelated edible aquatic plant, *Eleocharis dulcis* (Burm.) Henschel, a sedge in the family Cyperaceae, also is called water chestnut. Among all the species of *Trapa*, *T. natans* is widely cultivated and commonly called water chestnut which is an annual plant introduced from Asia. Mostly it grows in fresh water habitats like, lakes, ponds, canals, marshes and other slow moving water bodies. It is cultivated by the farmers and the fruit is nutritious and sold in market. Among the fruits of aquatic plant it is the most important fruit and used in human consumption in India and China (Shalini *et al*. 2019). The details of *T. natans* including taxonomy, origin, uses, impacts and various management practices are briefly discussed in this chapter.

Area of Origin of Weed

Trapa natans is native to Western Europe and Africa to northeast Asia including eastern Russia, China and Southeast Asia, through to Indonesia (Voroshilov, 1982).

Taxonomy

JUST AGRICULTURE
multidisciplinary e-Newsletter

The plant belongs to the family Lythraceae and Order Myrtales and Class Magnoliopsida. The plant is a floating annual freshwater species differentiated in to root, stem and leaves. The stem is spreading and can grow up to 12-15 ft., spongy, buoyant and anchored to the bed. Leaf is triangular, toothed, floating, petiole is inflated and attached with the stem and arranged in a rosette. Flower is small, white coloured with four petal bloom in May-June. Fruit is a spiny black brown nut and looks like the shape of bats or buffalo heads. The fruit ripens in August-September. Seed can remain viable for up to 12 years.

Fig 1. *T. natans* plant

Fig 2. *T. natans* plant showing roots and stem

Fig 3. *T. natans* plant fruit

Fig 2. *T. natans* plant seeds

Uses

1. Food value

The fruit contains seed which is a nutritious and delicious. The seed is used as food. The seed contain nutrients like Carbohydrates, Proteins, Fats, Fibres and minerals like Ca, Fe, P, K, Na, S, Cu, Zn, Mn and Vit-C (Alfasane *et al.* 2011).

2. Medicinal value

In Ayurveda the plant is used to cure different diseases like stomach, genitourinary, liver, kidney and spleen infections. It is astringent, stomachic, bitter, diuretic, febrifuge and

JUST AGRICULTURE
multidisciplinary e-Newsletter

antiseptic (Shalini *et al*. 2019).Warm fruit paste is applied over the affected part to cure sciatica and back pain (Sen and Behera, 2018).

Nature of Damage

A. Economic damage

Trapa natans weed is difficult and expensive to control and if unmanaged can increase dramatically. When the plant occupies a site, most recreational activities such as swimming, fishing from the shoreline and the use of small boats are eliminated or severely impeded.

B. Ecological Threats

Trapa natans grows best in water that are nutrient rich and moderately alkaline. It can grow in water up to 5 m deep, but prefers shallow waters (0.3 to 2.0 m deep). Where *T. natans* is abundant, up to 50 rosettes can grow in 1 m^2, which enables it to cover the water with up to three layers of leaves. Heavy shade from *T. natans* suppresses both submersed and other floating plants. The weed's extensive clonal propagation ability enables it to successfully colonize and monopolize aquatic habitats. It is very difficult to control the plant as the seed can remain viable for a long time. It competes with native aquatic flora by cutting sunlight. It can reduce oxygen level and fishes become killed. When human body comes in contact with the spine of fruit, it pricks severely and gives extreme pain. Hence, the plant is considered as ecological threat.

Control of *T. natans*

A. Mechanical and Chemical Control

- Prevention of seed formation
- Destruction of small populations by hand pulling working from canoes or kayaks
- Destruction of large infestations by the use of mechanical harvesters or the application of aquatic herbicides
- Application of herbicides, 2,4-D and Glyphosate

It is much easier and less expensive to control newly introduced populations of *T. natans*. Early detection of introductions and a rapid control response are key to preventing high impact infestations. Regardless of treatment type, it should ideally take place before the fruit has ripened and dropped to the bottom forming a long-term seed bank. Because of the potential of unintentional spread of floating plant parts offsite, mechanical harvesting should be undertaken only by trained and certified equipment operators. Since water chestnut overwinters entirely by seeds that may remain viable in the sediment for up to 12 years, repeated annual control is critical to deplete the seed bank. Treatment generally is needed for five to twelve years to ensure complete eradication and can be very expensive. Potential negative impacts to non-target species and public perceptions regarding the use of chemicals in recreational waters have limited chemical control of *T. natans* except as a treatment of last resort, usually in still or sluggishly flowing water. Application of aquatic herbicides requires a licensed pesticide applicator and permit from environmental regulatory agency.

B. Biological Control

JUST AGRICULTURE
multidisciplinary e-Newsletter

Unfortunately, for large infestations of *Trapa*, i.e. too large to be controlled by hand-pulling, long-term mechanical and chemical control measures have proven to be impractical to provide an economically sustainable control. Therefore, a number of potential biological control agents are used for managing the *T. natans*. The most promising biocontrol species appears to be the leaf beetle *G. birmanica*. Unfortunately, *G. birmanica* may also attack native water shield *Brasenia schreberi* (J. Gmelin) (Cabombaceae), in addition to *Trapa*. Nymphuline pyralid moths also are common and at times damaging. It is also nonspecific. This host non-specificity nature of both the species can be problematic for use of the beetle and moths for biocontrol. Because of the possibility of sibling *Galerucella* species with different host plants, *G. birmanica* may warrant additional study. Two *Nanophyes* weevil *N. japonica* and *Nanophyes spp*., which feed in the floating leaf petioles, are found in Asia. They are thought to be specific to *Trapa* but are not observed to be damaging. Low density populations of polyphagous Homoptera, *Rhopalosiphum nymphaeae* (L.) and *Macrosteles purpurata* (Kuoh) are common. Chironomid midges *Chironomus spp.* also are frequently associated with the plants, but for the most part are filter feeders, not herbivores. One Italian weevil, *Bagous rufimanus* (Hoffmann), feeds within the fruit stalk and might be more damaging at higher than observed population levels.

Biology and Ecology of Key Natural Enemies

A. *Galerucella birmanica* and *G. nymphaeae* (Coleoptera: Chrysomelidae)

All life stages of the beetle *G. birmanica* (= *G. nipponesis* (Laboissiere)) are found on the upper leaf surfaces. The adults and larvae feed on the leaf blades of the plants. Young larvae scrape the upper surface of the leaves, while older larvae and adults consume the blade tissue, often leaving a skeletal leaf comprised of main veins. This beetle can be very damaging, causing whole mats of rosettes to be defoliated. There are several overlapping generations in most areas which enables the populations to rapidly increase. It is the most important pest of cultivated *Trapa* in China and India. The beetle eats and develops on unrelated plants, including *B. schreberi* which gives it its common Japanese name "junsai mushi" or *B. schreberi* insect. It also uses a floating *Polygonum spp.* (Polygonaceae) as a host plant in northern China. It is possible that *G. birmanica* can represent more than one species with different host plants even though it is a wellknown pest insect in Asia.

Sibling *Galerucella* species *G. nymphaeae* is the most apparent natural enemy of *T. natans* in Europe, occurring in all areas except Germany. This species is very similar to the Asian *G. birmanica*, with regard to appearance, life cycle, and manner of feeding. The beetle feeds on many different unrelated plants, including water lilies. This beetle is a holartic species and feeds on *T. natans* and unrelated plants.

B. *Nanophyes japonica* and Nanophyes spp. (Coleoptera: Curculionidae)

Two *Nanophyes* weevils attack the leaves of *Trapa spp*. in Asia. *N. japonica* is abundant in central Japan and the Nanjing area of China. The adults feed on the upper leaf blades and females lay eggs in the floating leaf petioles. The larvae feed and pupate within these spongy petioles. Attacked petioles are often reddish in color and frequently have indented areas where the eggs are laid. At times, particularly in smaller plants, the petiole

JUST AGRICULTURE
multidisciplinary e-Newsletter

becomes gall like, with thickened outer walls. Several larvae may occupy an attacked petiole. Blades of leaves with infested petioles are normal in color and appearance and infested plants produce many fruit, suggesting that the weevil does little damage.

Another unidentified *Nanophyes* species was found in the Harbin area of China and at Hinkanski in Russia. This weevil lays a single egg in the central vein of the upper side of the leaf blade. The newly hatched larva mines the central vein of the leaf blade downward into the petiole float where it finishes feeding and pupates. There is only one larva per leaf and even though almost all leaves of some plants may be attacked, the leaves and plants remain normal and healthy. Adult feeding on the leaves is minor. The developmental periods (from egg to adult) for both of these weevils appear to be the same as the life span of a single leaf in which the development takes place, which is usually one to two weeks depending on the temperature. The eggs of both weevils are laid in young recently expanded leaves near the center of the rosette and the pupae of both species are found in old submerged leaves on the stem below the water's surface. This synchrony of weevil development with leaf age suggests extreme host specialization. *N. japonica* has not been recorded from plants other than *Trapa* and it seems that both of these weevils are limited to *Trapa* species. They are the most specialized natural enemies of *Trapa* species found in northeast Asia.

Conclusion

The seed of the plants has nutritional value and medicinal value. So it is consumed to get many health benefits. The seed also used for the preparation of many Ayurvedic formulations to cure different diseases. Besides this, the plant is a threat for other aquatic creatures when it grow more. So further study is needed to explore more knowledge and its control.

References

Alfasane MA, Khondken M, Rahman MM. (2011). Biochemical composition of the fruits of water chestnut (*Trapa bispinosa* Roxb.) *Dhaka Univ. J. Biol. Sci.* 20(1): 95-98.

Cook CDK. (1978). Flowering Plants of the World. Trapaceae, In: Heywood VH (edn.). Mayflower Books, New York, pp. 156.

Sen SK, Behera LM. (2018). Ethnomedicinal uses of some aquatic plants in Bargarh district of western Odisha. *World Journal of Pharmaceutical and Medical Research* 4(4): 217-221.

Shalini, Raghav PK, Singh P. (2019). Therapeutic properties of water chestnut: A Review, *Journal of Emerging Technologies and Innovative Research* 6(6): 159-165.