RELATIONSHIP OF UTRICLE AND TRAP DOOR SIZE ON COMMON BLADDERWORTS *UTRICULARIA MACRORHIZA*

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***Abstract*—The common bladderwort *Utricularia macrorhiza* is a carnivorous aquatic plant that captures organisms with its bladders. This study was aimed at setting the stage for future research which might determine if *U. macrorhiza* could be a biological method of control for invasive species. The objective of this study was to determine the relationship between utricle and trap door sizes and to gather data on the size ranges of these two morphological features. A regression analysis was used to obtain results which showed there was enough evidence to suggest that the size of bladderwort trap doors have a significant, positive relationship with the size of its utricles ($P < 0.01$). Additionally, the size of utricles ranged from 2.00 - 3.87 mm, and the size of utricle trap doors ranged from 0.53 - 1.47 mm. When looking at future samples of *U. macrorhiza,* the relationship between the two morphological features can be used to easily estimate trap door size which is a time-consuming measurement to obtain. Knowing trap door size is important when determining if the common bladderwort might consume an invasive species, such as the spiny water flea *Bythotrephes longimanus*, or if the trap is limited by the size of the invasive organism.**

I. Introduction

The carnivorous aquatic plant *Utricularia macrorhiza*, also known as the common bladderwort, belongs to the lentibulariaceae family. The common bladderwort is one of 250 carnivorous plants belonging to the *Utricularia* genus. Only about 20% of *Utricularia* species are aquatic. (Miranda et at. 2021). The bladders, or traps, on these plants are often referred to as utricles and are what make this species distinct as the traps are how the bladderwort obtains its prey. To catch its food, the utricles first actively pump water out of themselves. Then, trap doors on the utricles are activated when trigger hairs on the outside are stimulated by prey. This sets off a suctioning mechanism used to acquire the bladderwort's food (Castaldi et al. 2023). Once prey is trapped inside the utricle, hydrolytic enzymes are used to digest the organism. The utricles of *Utricularia* species have also been shown to spontaneously be set off which incidentally can result in the apprehension of prey. The diet of *Utricularia* species has been shown to consist of micro-crustaceans, nematodes, rotifers, and insect larva along with many other organisms (Miranda et at. 2021).

The goal of this study is to set the stage for further research on common bladderworts which may help determine whether they are a plausible method of control for invasive species. A study by Couret et al. (2020) was conducted to test whether or not *U. macrorhiza* could be a potential solution to regulate mosquitos. This was done by evaluating the proficiency of the plant's consumption of mosquito larva from two different species, *Aedes aegypti* and *Aedes albopictus*. The study showed that the common bladderwort had a high predation efficiency on the larva, and thus should be explored as an option for biological control of mosquitos. This study introduces the idea that the common bladderwort might be used as a means to control unwanted species. Something to consider is whether the desired species to be controlled would be a potential choice of prey. A study done by Harms & Johannson (2000) demonstrated that the common bladderwort exhibited a preference for cyclopoid copepod *Eucyclops serrulatus* over cladocerans *Polyphemus pediculus*, suggesting that *U. macrorhiza* actively selects for its prey. Another study (Ceschin et al. 2021), highlights that the feeding strategy of *U. australis* is highly dependent upon prey availability and size. An invasive species will more than likely be in abundance; therefore, an important factor to look at in future studies would be size.

This being said, the size of utricles and trap door openings on *U. macrorhiza* should further be studied to help rule out whether an invasive species that scientists desire to control would be actively selected for. This study can be used as a basis for future research which might look at the characteristics of invasive species to determine if the common bladderwort would be able to consume them.

Furthermore, the relationship between utricle and trap door size may be useful when looking at bladderworts in other water systems or when they are at different stages in their life cycle. These factors may have an influence on trap door size which is a difficult measurement to obtain. Knowing the relationship between the utricle and the trap door would make it simple to estimate trap door size since utricles can easily be measured. The objective of this study is to determine the relationship between utricle size and trap door size and to gather data on the size ranges of these two morphological features.

II. Methods

Samples of *U. macrorhiza* were pulled from two locations on Lake Bemidji using a rake with a rope attached to the end. One area of sampling was conducted on the lake side of the bridge near the inlet where the Mississippi flows into Lake Bemidji. The other area of sampling was conducted in the outlet where Lake Bemidji flows into Lake Irvine near the wastewater treatment plant. Three plants were selected from the samples taken at each location, and five utricles were carefully pulled off the plant at random. The traps from each location were placed into a plastic sample container to which 95% ethanol was added to preserve the bladders.

The bladderwort samples were processed by placing them under a compound microscope. Each of the 30 utricles were observed under the lowest power objective lens of 4x. A microscope with lenses containing a scale was chosen so measurements could be made. Using a calibration slide, a conversion factor was created to convert all measurements into millimeters. The size of the utricle while laying on its side was recorded to the hundredth place using the scale within the microscope, and the same was done for the trap door when the utricle was held upright in order to see the opening. To find out if there was a significant relationship between utricle and trap door size, a regression analysis was used.

III. Results

The size of utricles ranged from 2.00 - 3.87 mm, and the size of utricle trap doors ranged from 0.53 - 1.47 mm. There is enough evidence to suggest that the size of common bladderwort trap doors have a significant, positive relationship with the size of the utricles (Figure 1; $P < 0.01$).

IV. Discussion

In this study, it was found that the size of the utricles on *U. macrorhiza* were directly correlated to the size of the openings on the traps. The two features had a positive, linear relationship, meaning as utricle size increased, trap door size increased. Numerous other studies of organisms have shown similar findings when looking at relationships between morphological structures. At times, certain physical characteristics are loosely, yet not significantly, correlated. Nevertheless, there are many studies that have found significant relationships between the sizes of morphological traits. The relationship between a plant's features can be useful for scientists in many ways. For example, several taxonomic keys use relationships between important characteristics, like petiole and leaf length, as ways to identify plants.

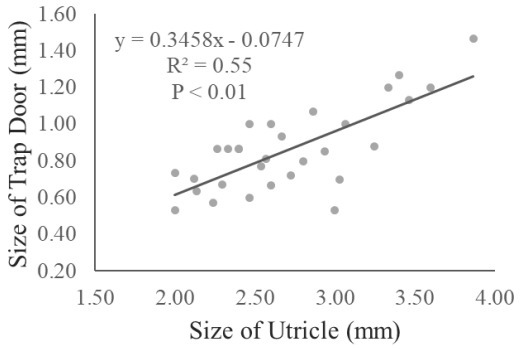

Fig. 1. Measurements of 30 utricles and their trap doors from collected *U. macrorhiza* samples represented in a scatterplot with a positive, linear trendline ($P < 0.01$).

The findings of this study are significant because in future studies, the size of trap door openings on the common bladderwort can easily be estimated. This would be important to know when determining if certain invasive species might be subject to consumption by the carnivorous plant. The feeding of *U. macrorhiza* is largely influenced by the size of its prey (Ceschin et al. 2021). This limits the selection of organisms that bladderworts may feed upon which becomes of interest when considering if the common bladderwort could be a method of control for spiny water fleas, *Bythotrephes longimanus*.

The spiny water flea is a particularly large planktonic crustacean that creates detrimental effects on zooplankton communities. It is a sight predator and surfaces at night to feed on zooplankton smaller than itself. The disruption of native zooplankton communities can then negatively affect native fish populations. Spiny water fleas are characterized by the barbs on their singular long tail. This tail may have one to four barbs, and they make it difficult for small fish that feed on zooplankton to consume the water fleas (Noreen et al. 2013). Spiny water flea eggs are resistant to drying and freezing, and they may pass through the digestive tract of fish (Kerfoot et al. 2011).

In future studies, the size of spiny water fleas may be looked at to determine whether they would be able to enter and fit into the utricles of *U. macrorhiza*. Similar to the study conducted to test if common bladderworts could be a biological method of control for mosquito species, the larva of spiny water flea would most likely be looked at. This is due to the fact

that adults may reach up to 12 mm (Noreen et al. 2013), which is much larger than the size of *U. macrorhiza* utricles. Since this study has already obtained data on utricle and trap door opening size, it should be easy to determine if size is or isn't a limiting factor when considering if bladderworts could be a method of control for spiny water fleas.

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REFERENCES

[1] Castaldi, V., A. Bellino, and D. Baldantoni. 2023. The ecology of bladderworts: The unique hunting-gathering-farming strategy in plants. Food Webs 35:1-9.

[2] Ceschin, S., A. Bellini, A. Salituro, L. Traversetti and N. T. W. Ellwood. 2021. Is the capture of invertebrate prey by the aquatic carnivorous plant *Utricularia australis* selective? Plant Biosystems - An International Journal Dealing with All Aspects of Plant Biology 156:572-580.

[3] Couret, J., M. Notarangelo, S. Veera, N. LeClaire-Conway, H. S. Ginsberg, and R. L. LeBrun. 2020. Biological control of *Aedes* mosquito larvae with carnivorous aquatic plant, *Utricularia macrorhiza*. Parasites Vectors 13:1-11.

[4] Harms, S. and F. Johansson. 2000. The influence of prey behaviour on prey selection of the carnivorous plant *Utricularia vulgaris*. Hydrobiologia 427:113-120.

[5] Kerfoot, W. C., F. Yousef, M. M. Hobmeier, R. P. Maki, S. T. Jarnagin, and K. H. Churchill. 2011. Temperature, recreational fishing and diapause egg connections: dispersal of spiny water fleas (*Bythotrephes longimanus*). Biological Invasions 13:2513-2531.

[6] Miranda, V. F. O., S. R. Silva, M. S. Reut, H. Dolsan, P. Stolarczyk, R. Rutishauser, and B. J. Plachno. 2021. A historical perspective of bladderworts (*Utricularia*): traps, carnivory and body architecture. Plants 10:1-11.

[7] Noreen, E. K., J. D. Young, J. G. Winter, and N. D. Yan. 2013. Dynamics of the invasive spiny water flea, *Bythotrephes longimanus*, in Lake Simcoe, Ontario, Canada. Inland Waters 3:75-92.