# Community Structure And Competition Between Hydrilla And Vallisneria[1]

WILLIAM T. HALLER and D. L. SUTTON

*Assistant Professors, Main Campus and the Agricultural Research Center at Ft. Lauderdale, University of Florida, Gainesville, Florida 32611*

**ABSTRACT**

Structural relationships of the desirable submersed aquatic plant, vallisneria (*Vallisneria neotropicalis* Marie-Vict.) and the troublesome aquatic weed, hydrilla (*Hydrilla verticillata* Royle) were compared to determine the effects of plant structure on competition. Although both species are members of the Hydrocharitaceae family, they differ considerably in their growth habit. Hydrilla forms a dense canopy at the water surface and limits light penetration by at least 95% in the first 0.3 m of the water column, whereas vallisneria communities are less dense and light penetration is similar to that of open water. The low ratio of root tissue to foliage produced by hydrilla indicates that the majority of fixed carbon is used in the production of competitive standing crop. Hydrilla also produces several million potentially reproductive propagules and meristems per ha, which make control methods difficult and competition from other species almost impossible.

## INTRODUCTION

Hydrilla has continued to spread throughout the waters of the United States since it was first introduced into Florida 15 years ago. It has been found in at least six states and may occur in several others being incorrectly identified as an elodea species (1).

The rapid rate with which hydrilla spreads and dominates the vascular flora of a waterway is causing concern to many aquatic biologists. Sutton reported that 1 year after planting a pond to 25% hydrilla, it had increased its coverage to over 90% of the pond area, crowding out other submersed species.[2] Louisiana biologists reported that hydrilla in a reservoir spread from an area of 5 ha to over 10 ha in just 6 weeks (6). Hydrilla was found in 1 ha of Rodman Reservoir in 1971 and in 5 ha 1 year later (4). At the present time, hydrilla is estimated to cover in excess of 1000 ha in Rodman Reservoir and is severely restricting water use.[3]

[1]This study is a portion of a dissertation presented by the senior author to the Graduate Council of the University of Florida in partial fulfillment of the requirements for the degree of Doctor of Philosophy. The research was supported by a Florida Department of Natural Resources Grant. Published as Journal Series No. 5829 of the Fla. Agr. Exp. Sta.

[2]Sutton, D.L. 1972. Control of aquatic plant growth in earthen ponds by the white amur. Ft. Lauderdale ARC Res. Rept. FL 72-1, 77 pp.

[3]Hestand, R.S. 1974. Personal Communication.

The competitive ability of hydrilla probably results from several combined factors. The purpose of these studies was to compare hydrilla and vallisneria populations to determine the possible effects of community structure on competition between these two species.

## METHODS AND MATERIALS

Plant populations used to compare the characteristics of hydrilla and vallisneria were growing in 0.08 ha earthen ponds in Orange County, Florida. These ponds (1.5 m deep) were established in July 1971, and plant samples were collected in the winter of 1973-74. Both hydrilla and vallisneria populations were well developed and appeared to be typical of natural communities.

The leaf area index (LAI) of hydrilla and vallisneria was measured by harvesting four complete plants of each species. The plants were dissected and their leaves were placed on blueprint paper. The leaves were removed from the paper after exposure to ultraviolet light, and dried. The imprints of the leaves on the blueprint paper were cut out and weighed. The ratio of area (obtained by weighing a paper of known area) of traced leaves to the dry weight of the traced leaves made it possible to calculate the LAI by multiplying the ratio by the weight of the standing crop.

The depth distribution of plant biomass was obtained by removing the plants from the hydrosoil and cutting them into 10-cm sections from the hydrosoil to the water surface. The 10-cm sections were dried and their weights expressed as a percent of the total plant material harvested.

Dry weight of the standing crop was found by sampling a 929 $cm^2$ area of the mat after the ponds were drained in January 1974. After the standing crop was harvested, the roots were removed from the hydrosoil, rinsed, and dry weights determined.

In order to estimate the number of tubers in the hydrilla pond, 16 core samples were collected at random from the 0.08 ha area. The 10.2-cm diameter core sampler was forced into the hydrosoil to a depth of approximately 20 cm. After the core was removed from the sampler it was rinsed with water and the propagules were counted.

Penetration of photosynthetically active radiation (400 to 700 nm) through several hydrilla and vallisneria communities was measured in October 1974 at 0.3-m depth intervals in Rodman Reservoir with a Lamda LI-185 light meter[4] equipped with a submersible sensor. The sensor was modified to fit on a hook made of aluminum conduit. This alteration helped maintain the sensor parallel to the water surface and produced minimal disturbance of plants and water while being lowered into a plant community.

## RESULTS AND DISCUSSION

There have been several attempts to design equipment that would quantitatively sample submersed vegetation (2). The most accurate method is to remove the water from the sampling site. However, this is often impossible and accounts in large measure for the lack of biomass data for submersed plants.

Data obtained from drained ponds is presented in Table 1. The total biomass of vallisneria was greater than hydrilla; however, vallisneria produced much greater amounts of non-photosynthetic tissue (roots) than hydrilla. Over 87% of the hydrilla biomass was standing crop compared to 60% for vallisneria.

The area per unit weight of leaf tissue indicated that vallisneria leaves were thicker and heavier than hydrilla, 2.2 and 8.3 $dm^2$ g dry weight,$^{-1}$ respectively. The LAI of vallisneria was 8.7 compared to 4.8 for hydrilla. The LAI of hydrilla is comparable to that of corn (*Zea mays* L.) and that of vallisneria comparable to waterhyacinth (*Eichhornia crassipes* (Mart.) Solms). A LAI of at least 3.0 is necessary for 100% interception of radiant energy (3).

The thick leaves and large amounts of roots produced by vallisneria contribute to its inability to compete successfully with hydrilla, as non-photosynthetic tissue derives its respiratory energy from photosynthetic tissue elsewhere in the plant. The high ratio of non-photosynthetic to photosynthetic tissue in vallisneria negates any advantage that its greater LAI would seemingly give vallisneria over hydrilla. The predominance of thin leaves and few roots among other submersed aquatic plants also suggests the advantage of having low non-photosynthetic to photosynthetic tissue ratios.

The production of reproductive propagules and large numbers of axillary meristems by hydrilla favor its colonization and growth over most other aquatic plants. Hydrilla produced an estimated 257 tubers and 62 turions $m^{-2}$ in the pond during a 2.5-year period. Based on these combined values, 1.0 ha would contain over 3 million propagules. Although the longevity of the hydrilla propagules is not known, a supply of reproductive structures of this number would probably provide a source for reinfestation for many years. The significance of this number becomes apparent when one considers that a typical corn field contains a population of about 75,000 plants $ha^{-1}$.

The horizontal distribution of hydrilla and vallisneria is compared in Figure 1. The depths which encompassed one-half the standing crop were 0.45 m for hydrilla and 1.05 m for vallisneria. Hydrilla formed an extensive canopy on the water surface, having nearly 20% of its total biomass in the top 10 cm of water. The localization of the meristem is believed to be the factor governing the horizontal distribution of aquatic plants (5). The

[4]LAMBDA Instruments Corporation, Lincoln, Nebraska. Mention of a trademark name or proprietary product does not constitute a guarantee or warranty of the product by the University of Florida and does not imply its approval to the exclusion of other products that also may be suitable.

TABLE 1. STRUCTURAL CHARACTERISTICS OF HYDRILLA AND VALLISNERIA DETERMINED FROM NATURAL POPULATIONS IN EARTHEN PONDS 1.5 M DEEP IN ORANGE COUNTY, FLORIDA.

| Characteristic[a] | Hydrilla | Vallisneria |
|---|---|---|
| Dry Weight (g $m^{-2}$) | | |
| Standing Crop | 161.4 | 400.1 |
| Roots | 22.6 | 273.6 |
| Biomass | 184.0 | 673.7 |
| Components of Biomass (%) | | |
| Leaves | 31.1 | 59.4 |
| Stems | 56.5 | — |
| Roots | 12.4 | 40.6 |
| Surface Area[b] | | |
| $dm^2 g$ dry $leaf^{-1}$ | 8.3 | 2.2 |
| Leaf Area Index (LAI) | 4.8 | 8.7 |
| Vegetative Propagules ($m^2$) | | |
| Tubers | 257 | — |
| Turions | 62 | — |

[a] Values for each characteristic are the mean of at least four samples.
[b] Surface area and LAI are calculated on the basis of one side of the leaf only.

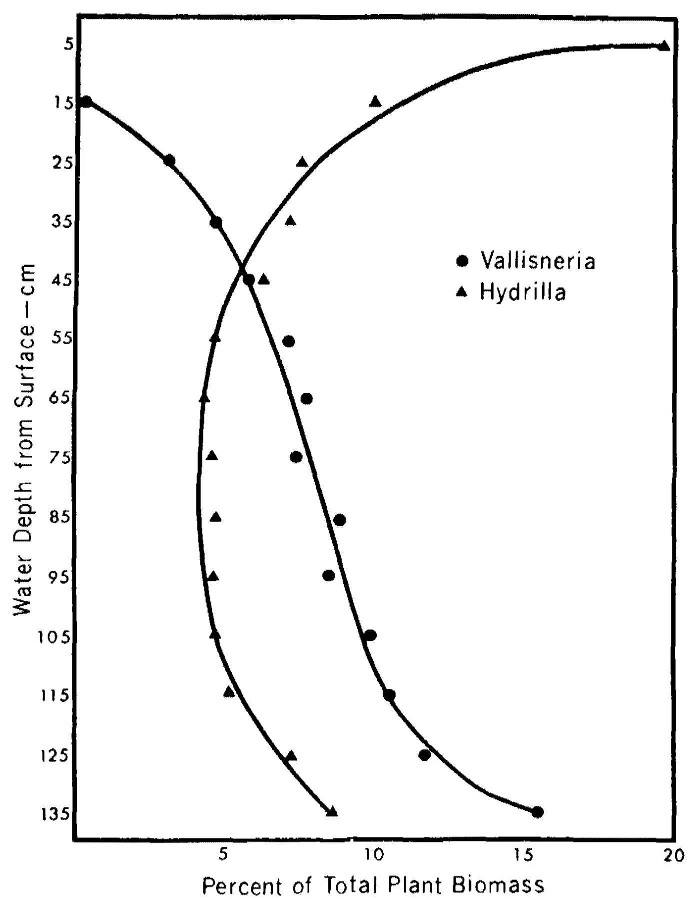


Figure 1. Distribution of hydrilla and vallisneria standing crop grown in ponds 1.5 m deep.

single meristem of vallisneria is located at the base of the plant. The dominant meristem in hydrilla is at the shoot apex, but hydrilla also has several lateral meristems which produce additional branches as they grow near the water surface. The canopy formed by hydrilla has been thought to be a major factor limiting competition from other submersed species.

Penetration of photosynthetically active radiation through open water and hydrilla and vallisneria communities is presented in Figure 2. Nearly 20% of the surface radiation was detected at a depth of 2 m in open water. The values for light penetration in the vallisneria community followed a pattern similar to that of open water, but the values obtained were lower. Radiation in depths over 1 m was less than 5% of surface values.

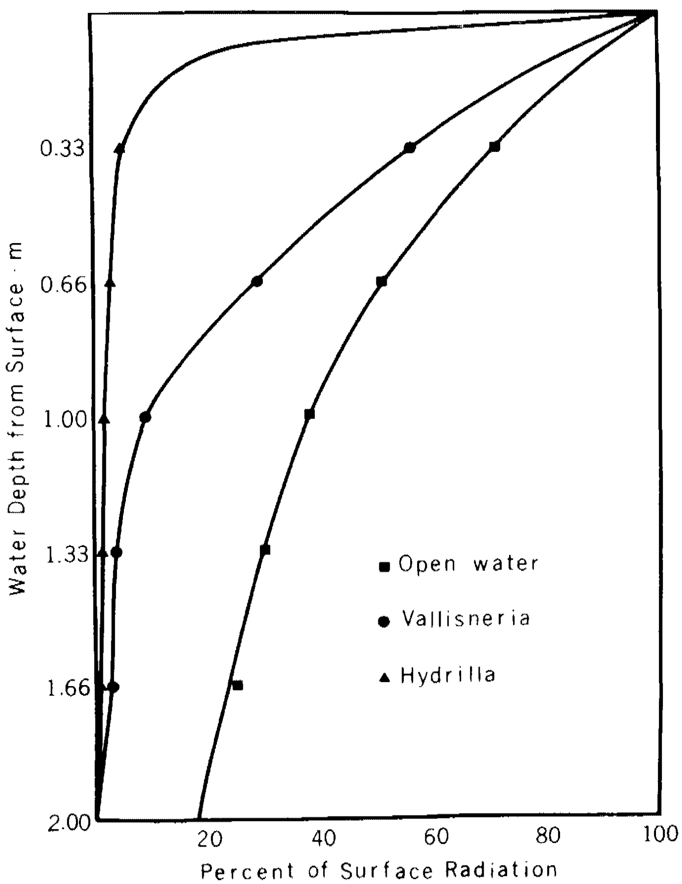


Figure 2. Light penetration through water and plant communities in Rodman Reservoir. Light measurements in the hydrilla community were made through small (20 $cm^2$) openings in the canopy.

Measurement of light penetration through hydrilla was difficult due to the entangled canopy. It was impossible to lower the sensor through the canopy without disturbing it; thus the sensor was lowered in one place and raised through the canopy in another position. There was essentially no light penetration through the canopy to a depth of 0.33 m. The sensor was then lowered through small 20-$cm^2$ openings in the hydrilla and the data obtained was plotted (Figure 2) to be compared to light penetration in open water and vallisneria communities. The greatest decrease in light penetration occurred between the surface and a depth of 0.33 m. Radiation decreased from 1500 to 70 microeinsteins $m^{-2}$ $sec^{-1}$ for a 95% decrease in this depth interval. Light penetration in the first 0.3 m decreased only 29% in open water, and 43% in the vallisneria population.

Competition from other plants in a hydrilla community is virtually impossible due to the canopy produced by this species. The canopy not only intercepts radiation, but provides support for filamentous algae and other small floating aquatic plants which further limit light penetration.

Hydrilla and vallisneria have entirely different growth characteristics even though both species are members of the Hydrocharitaceae family. The large distribution of hydrilla biomass in the top few cm of water not only prohibits competition from other submersed plants, but takes advantage of the maximum levels of light for growth which occur at the water surface. The presence of millions of meristematic tissues per ha virtually assures the continued dominance and spread of this species through aquatic systems.

## REFERENCES


1. Blackburn, R.D., L.W. Weldon, R.R. Yeo, and T.M. Taylor. 1969. Identification and distribution of similar appearing aquatic weeds in Florida. Hyacinth Contr. J. 8:11-21.
2. Fosberg, C. 1959. Quantitative sampling of sub-aquatic vegetation. Oikos 10:233-240.
3. Haller, W.T. 1974. Photosynthetic characteristics of the submersed aquatic plants hydrilla, southern naiad, and vallisneria. Doctoral Diss. Univ. of Florida, Gainesville. 88 pp.
4. Hestand, R.S., B.E. May, D.P. Shultz, and C.R. Walker. 1973. Ecological implications of water levels on plant growth in a shallow water reservoir. Hyacinth Contr. J. 11:54-58.
5. Ikusima, I. 1966. Ecological studies on the productivity of aquatic plant communities II. Seasonal changes in standing crop and productivity of a natural submerged community of *Vallisneria denserrulata*. Bot. Mag. Tokyo 79:7-19.
6. Johnson, B. and J. Manning. 1971. Hydrilla—the most serious threat to Louisiana's water resources. Louisiana Conservationist 26:26-29.