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Regrowth of Hydrilla from Axillary Buds[1]

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ABSTRACT

Hydrilla (*Hydrilla verticillata* Royle) reproduced vegetatively under controlled conditions and under field conditions by development of axillary buds from sub-apical fragments. Fragments with a single node were capable of regrowth under both controlled and field conditions. Forty percent of fragments with one or two nodes were capable of regrowth. Regrowth occurred from 68% or more fragments with three to five nodes. Under field conditions, dry weight increases of 3 and 11 fold of the original weight were noted for the one and four-node fragments, respectively. Evidence was observed for environmental stimulus of root production. Roots were produced sporadically, and sometimes degenerated in nutrient solution culture, while roots were always formed when regrowth occurred under field conditions.

INTRODUCTION

Mature angiosperms form branches from lateral buds which appear to originate in the axils of the leaves. These buds generally arise on the stem and become displaced closer to the leaf base through subsequent growth, hence, they are also referred to as axillary buds (2).

The physiological control of axillary bud development is complex (1). It is a well established fact that, in most plants, removal of the apical bud results in increased axillary bud development (5).

The ability of the submersed aquatic macrophyte hydrilla to rapidly infest new areas may be principally due to vegetative reproduction by fragmentation. An apical fragment consisting of a single node is theoretically capable of developing into a mature plant.[1] Considering the large number of nodes, with associated axillary buds present with each plant apex, reproduction from sub-apical fragments could prove to be as important or more so than that from apical fragments. If sub-apical fragments have the ability to develop into mature plants from axillary buds, then reproduction in this manner would be particularly important after harvesting operations where many fragments of various size are generated.

The experiments were designed to demonstrate the ability of subapical hydrilla fragments to reproduce vegetatively from axillary buds, and to determine if there is a minimum number of nodes necessary to initiate regrowth.

MATERIALS AND METHODS

Hydrilla fragments, consisting of one to five nodes, were cut from plant material collected from a small lake in Davie, Fla. or, from plants grown outdoors in plastic-lined pools. To provide for uniformity, the top of each fragment was cut approximately 10 cm from a shoot apex and, only from sections which had an internode length of 6 to 10 cm, 10 cm from the apex.

Each time an experiment was repeated, 10 fragments of each node-number were dessicated and weighed. These weights were used as estimates of initial fragment dry weights.

Two separate experiments were conducted: one under controlled conditions, and one under field conditions.

The data were analyzed at the Northeast Regional Data Center in Gainesville, Fla. using the Statistical Analysis System (SAS) programs. Where analyses involved percentages, an arcsine transformation of the data was employed.

Controlled Condition Experiment

Individual hydrilla cuttings and 50 ml of Gerloff medium were placed in 25 by 150 mm glass tubes (3). The iron concentration of the nutrient medium was increased to 5.6 ppm, and 50 ppm of HCO_3^- was added as $NaHCO_3$. The tubes were then placed in a water bath and maintained at 30 C for 4 weeks. The nutrient medium was changed weekly. A 14-hr light period of 168 $\mu E \cdot m^{-2} \cdot s^{-1}$ at the top of the tubes was provided by eight fluorescent growth lamps. Treatments consisted of one to five-node fragments arranged in a randomized design in the water bath. A replication was composed of 10 tubes for each treatment. The experiment was repeated four times and analyzed as a completely random design.

Evidence of axillary bud development and root initiation on each fragment was recorded daily. At the end of the 4-week period the new growth was removed from the original fragment, dessicated, and weighed.

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[1]Haller, W. T. 1977. *Hydrilla, A Rapidly Spreading Aquatic Weed Problem*, University of Florida, IFAS, Circular S-245.

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Field Condition Experiment

Cylindrical enclosures, 19 cm in diameter by 91 cm in length were formed from plastic netting with a mesh of 0.33 cm. The enclosures were inserted into plastic containers with dimensions of 21 cm in depth by 20 cm in diameter. These containers were filled with soil (30% muck and 70% sand) and placed in outdoor pools with dimensions of 0.9 m in depth by 3.6 m in diameter and filled with 8.8 x 10^3 liters of pondwater at a depth of 0.8 m. Pondwater was constantly flowing through the pools and adjusted so that flow was sufficient to provide for an exchange of pondwater approximately every 24 hr. Treatments consisted of fragments of different node-numbers from one to five. Five fragments of the same node-number were placed, at the water surface, in an enclosure. Four replicate enclosures of each treatment were randomized in the pool for each experiment. The fragments were removed after 4 weeks. The number of fragments which produced new growth was counted in each enclosure, and the vegetation was dessicated and weighed. The experiment was repeated in March, April, and May 1979. The data was analyzed as a randomized block design with the three experiments treated as blocks.

RESULTS AND DISCUSSION

Sub-apical hydrilla fragments consisting of a single node were shown to be capable of regrowth under both controlled and field conditions. However, based on the percentage of fragments which regrew from axillary buds in these experiments, there is a difference in the ability of fragments consisting of one to five nodes to regrow (Figure 1); these ranged from 28% of the one-node fragments under both controlled and field conditions to 100% and 98% for the five-node fragments under controlled and field conditions, respectively. Since 98% of fragments consisting of only five nodes, and 28 to 85% of the one to four-node fragments, respectively, regrew into mature plants under field conditions, the ability of hydrilla to infest new areas from extremely small vegetative fragments is demonstrated.

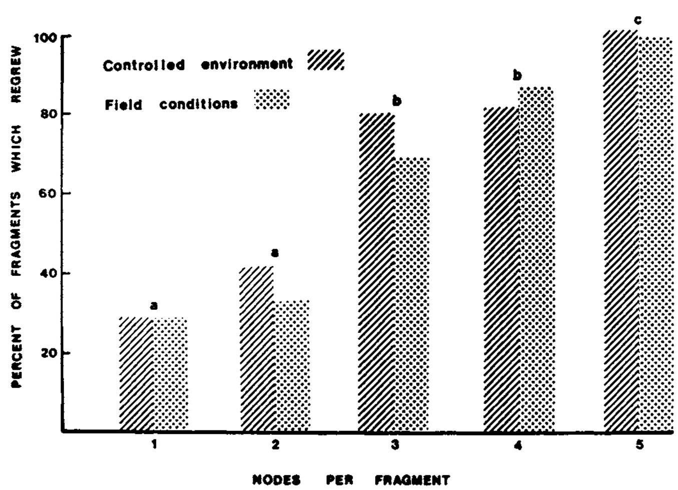

Figure 1. Percent of hydrilla fragments which regrew from axillary buds. Bars with the same letter indicate means which are not significantly different at the 95% confidence level according to Duncan's multiple range procedure (controlled conditions are not compared to field conditions).

The influence of node number per fragment on reproduction by axillary bud development is also reflected in the dry weight of new growth produced over the 4-week growth period. These differences were, again, observed under both controlled conditions (Figure 2) and field conditions (Figure 3). Growth of new shoots was probably restricted somewhat by the size of the glass tubes used under controlled conditions; therefore, dry weight of growth produced under field conditions was used to evaluate the relationship between node-number per fragment and regrowth. If the values of Figure 3 are divided by the estimated initial weights of five fragments (12, 21, 37, 55, and 61 mg for one, two, three, four, and five-node fragments, respectively), weight increases of 3, 4, 9, 11, and 11-fold are obtained for one through five-node fragments, respectively. The importance of reproduction by sub-apical fragments can be illustrated with the estimates of 11-fold increases for four and five-node fragments.

Given the hypothetical situation where 10^4 sub-apical hydrilla fragments of four to five nodes and weighing some

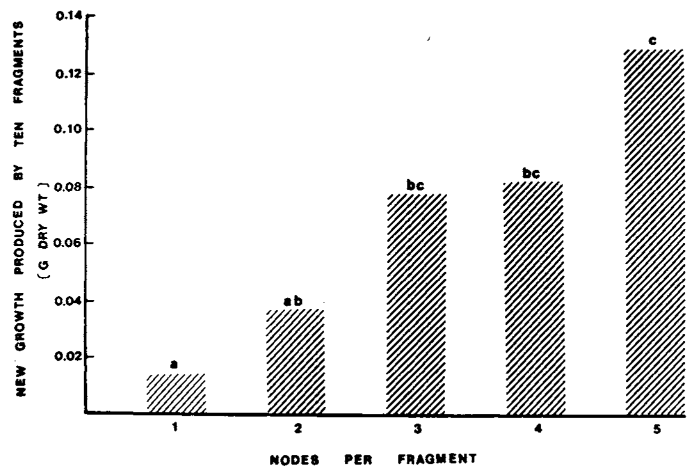

Figure 2. New growth produced by ten hydrilla fragments under controlled environmental conditions. Bars with the same letter indicate means which are not significantly different at the 95% confidence level according to Duncan's multiple range procedure.

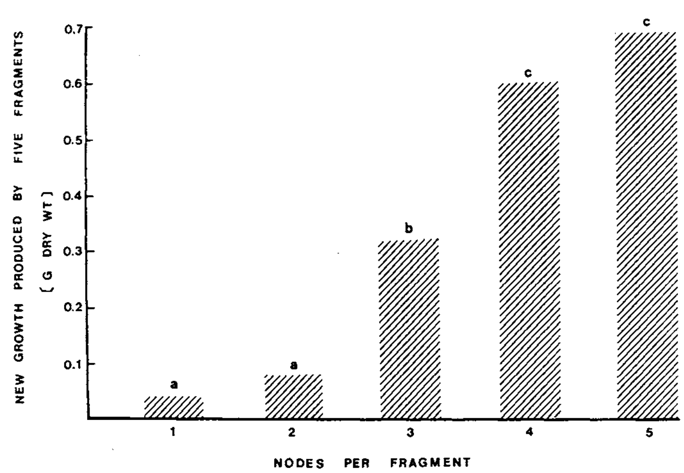

Figure 3. New growth produced by five hydrilla fragments under field conditions. Bars with the same letter indicate means which are not significantly different at the 95% confidence level according to Duncan's multiple range procedure.

12 mg per fragment are generated by boat propellers or harvesting operations and transported to a suitable environment, 1.3 kg of dry weight of new hydrilla growth would be expected to be produced in only a 4-week period. Considering the growth habit and competitive ability of hydrilla (4), one can easily perceive how such an infestation has the ability to develop into a typical monocultural hydrilla community during a growing season.

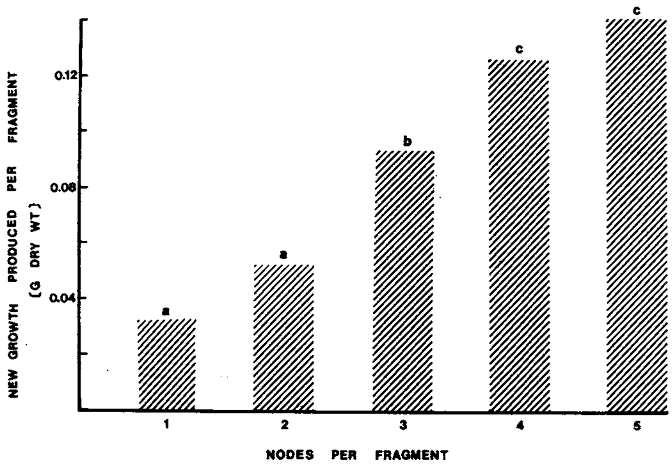

Figure 4. New growth produced per hydrilla fragment which regrew under field conditions. Bars with the same letter are not significantly different at the 95% confidence level according to Duncan's multiple range procedure.

The data presented in Figure 4 represents the average dry weights of plant material produced by five fragments of each node-number, without regard to the number of these fragments which regrew. To determine if there was a relationship between the number of nodes per fragment and the amount of growth produced by individual fragments which produced new growth, the total dry weight of each treatment replication was divided by the number of fragments in that replication which produced new growth and, the data was re-analyzed. This analysis demonstrated that individual fragments consisting of four and five nodes produced significantly more growth per fragment than those consisting of three nodes and, three-node fragments more than one and two-node fragments. This observation, along with the relationship discussed earlier between node-number and the percent of fragments which regrew, raises interesting questions concerning the physiology of regrowth by axillary bud development.

When hydrilla fragments are initially cut they are buoyant, probably due to air trapped in lacunae. A question in mind at the beginning of this investigation was whether fragments sink to the bottom of a water body and become rooted in the hydrosoil or, is it necessary that they drift to shore before rooting? Under controlled conditions, most fragments appeared to lose buoyancy, however, an evaluation was difficult to make because the sides of the test tubes interfered with vertical movement of the fragments. In field condition experiments all fragments were observed to sink to the surface of the hydrosoil within 4 days after being placed at the water surface. At the end of the 4-week period, all fragments which had produced new growth had rooted in the soil. Interestingly, roots were produced only sporadically under controlled conditions, and in some cases were produced and then degenerated. Roots were never produced where axillary buds did not develop but were not necessarily produced subsequent to bud development. This contrast in root development under different environmental conditions presents evidence for environmental stimulus of root production in hydrophytes which may relate to the nutrient status of the bathing medium, light relationships, or the presence or absence of a suitable rooting medium.

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