A Simple, Efficient Method for Extracting Neochetina eichhorniae and N. bruchi (Coleoptera: Curculionidae) from Waterhyacinth (Eichhornia crassipes: Pontederiaceae)

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Source: Florida Entomologist, 93(2) : 315-316

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.093.0227

A SIMPLE, EFFICIENT METHOD FOR EXTRACTING *NEOCHETINA EICHHORNIAE* AND *N. BRUCHI* (COLEOPTERA: CURCULIONIDAE) FROM WATERHYACINTH (*EICHHORNIA CRASSIPES*: PONTEDERIACEAE)

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The weevils *Neochetina eichhorniae* Warner and *N. bruchi* Hustache were released in Florida during 1972 and 1974, respectively, in an attempt to control waterhyacinth (*Eichhornia crassipes* (Mart.) Solms.) (Center 1994). Populations established readily but results were variable, with excellent control produced in some cases whereas poor control was manifested in others (Center et al. 1999). Explanations for the lack of control include, among other things, poor host quality leading to low weevil population growth, or eutrophication leading to excessive plant productivity able to outgrow the weevil populations (Julien 2001). We have been examining the relationship between weevils and plant quality over the past few years to investigate this and have found that poor host quality, i.e., tissue nitrogen levels inadequate for egg production, seems the most likely explanation for low weevil populations and the failure to achieve adequate control in some areas (Center & Dray 2010). One approach to overcoming this difficulty might be to mass rear large numbers of reproductively viable weevils on high quality plants and use them to supplement field populations after reducing plant biomass with other means (e.g., herbicides or mechanical removal). This could render greater permanency to more traditional control methods. Our intention is to conduct field trials but before investigating this further, we needed an expedient means of producing thousands of weevils and extracting them from the host plant. These extractions would ideally be done in a manner that leaves the plants intact so that they can be used repeatedly over time to recover successive generations of adult weevils. This disqualifies methods such as Berlese funnel extractions which destroy the plants and stress the insects, so we elected to investigate submergence techniques. The weevils are not fully aquatic, so we reasoned that we could push the plants underwater and collect adults as they rise to the surface. This would enable the endophagous larvae to survive in air spaces within the plants so long as the submergence period was not excessive.

The trials were carried out in large concrete tanks (burial vaults) that measured 0.8 m wide × 2.2 m long × 0.65 m deep; water depth was maintained at 0.5 m (volume 0.88 m^3). Waterhyacinth plants from local sites had been cultured in these tanks for several weeks. Each tank was treated with a slow-release fertilizer (300 g Scotts® Osmocote Plus 15-9-12 N:P:K, Southern 8-9 month formulation) provided in screen packets suspended within the root zone of the floating plants. This fertilizer treatment was supplemented with 18 g Miller® Iron Chelate DP 10% Fe. One hundred field-collected waterhyacinth weevils of either species (*N. bruchi* or *N. eichhorniae*) were released in 1 of 2 tanks either in the early morning hours (about 4 AM) or after dark the evening before. The weevils are most active at night so this schedule was intended to allow them to disperse and distribute themselves among the plants before daylight. A 1-m tall cage constructed from PVC pipe and window screen (mesh: 7 × 5.5 strands/cm^2) was mounted over each tank to retain the weevils and exclude predators. The plants were submerged 4-12 h after release. This procedure was replicated 5 times in different tanks with different groups of weevils on different days during 29 Sep to 9 Oct 2009. In order to submerge the plants, the cage was removed and a frame made of 1.9 cm (¾" standard supply) PVC pipe, which conformed to the inside dimensions of the tanks, was placed over the plants. Thin (0.33 mm) flat plastic fencing (All Plastic Guardian® Warning Barrier) covered the open area of the frame. The fencing had border strips 1.3 cm wide along one side and 0.5 cm wide on the other side and with round 5 cm diameter openings spaced on 5.4 cm centers (i.e., 4 mm apart). The frame was forced below water by using 2 vertical handles (70 cm tall) mounted near either end. A board was placed across the handles after the plants were entirely submerged and concrete blocks (39.5 × 19.2 × 19.2 cm, 16.24 kg) were placed on the board to hold the plants under water. Floating panels of white expanded-bead polystyrene foam (122 × 36.7 × 1.8 cm) were placed in the tanks covering most of the water surface. This provided a substrate for the ascending weevils and the contrast between their dark color and the white polystyrene facilitated their recovery. The polystyrene was inverted at intervals and the weevils were picked off by hand. The cumulative percentages of the total numbers of weevils that were recovered and extracted from the tanks are shown in Fig. 1. Recovery rates were independent of weevil species ($F = 0.00$, $P = 0.964$). Ninety-three percent of the weevils initially placed in the tanks were recovered after 3 h (range 84% to 98%), with more than 90% surfacing within 30 min. This differs from the data as shown in Fig. 1, which depicts percentages based on cumulative numbers accounted for, inasmuch as a portion were not recov-

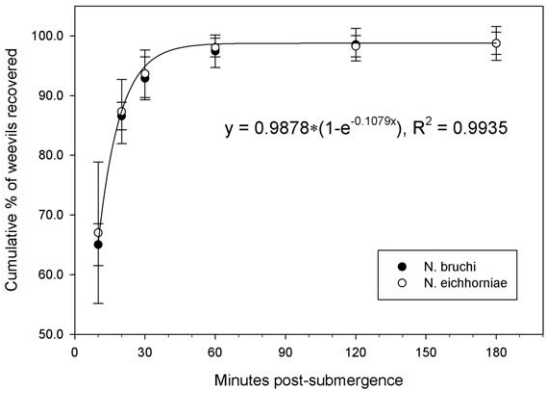

Fig. 1. The percentage of the recovered weevils extracted over time. The regression line is fitted to the pooled data for both weevil species.

ered. These data clearly show that this submergence technique is highly effective at extracting adult *Neochetina* sp. weevils from waterhyacinth plants with a minimum of effort. Thus, if large numbers can be reared in tanks such as these, this will provide an efficient method of collecting them while allowing for later collections of subsequent generations. This technique could also be used, with some modification, to census field populations of weevils by submerging plants *in situ*.

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