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# Comparisons of Potential Allelopathy of Seven Freshwater Species of Spikerushes (*Eleocharis*)

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## ABSTRACT

Aqueous extracts of seven species of freshwater *Eleocharis* spp. were tested for allelopathic activity using lettuce (*Lactuca sativa* L. var. black seeded Simpson) seedling and common duckweed (*Lemna minor* L.) assay systems. All extracts affected growth of lettuce seedling radicles compared to the control means except the lowest concentration (25 ppt) of *E. acicularis, E. equisetoides, E. flavescens, E. obtusa,* and the 125 ppt concentration of *E. equisetoides.* Mean radicle lengths resulting from 25 ppt extract were different from means resulting from 125 ppt of extract. Results from the common duckweed frond growth method were: inhibition of growth at 125 and 250 ppt of extract from *E. montana,* and 250 ppt of extract from both *E. obtusa* and *E. tuberculosa.* Within treatment comparisons indicated that the 25 and 125 ppt extracts did not affect growth differently except for *E. quadrangulata*; the 25 ppt of extract produced significantly different growth than the 250 ppt concentration except in *E. obtusa* and *E. tuberculosa.* Compared to results from other aquatic and wetland plants, these extracts were not very effective at reducing duckweed growth.


*Key words*: *Lemna minor,* duckweed, lettuce seedling assay, bioassays, growth inhibition.

## INTRODUCTION

Species of *Eleocharis* often appear in monoculture in their undisturbed natural habitats and have been observed to "displace" other hydrophytes (Stevens and Merrill, 1980). These characteristics have resulted in efforts to determine if allelopathy is a factor in the establishment and the maintenance of populations of these species. Nichols and Shaw (1983) reviewed management tactics for integrated aquatic weed management and noted that *E. coloradoensis* (Britt.) Gilly, *E. acicularis* (L.) R. & S., and *E. parvula* (R. & S.) Link displaced other aquatic weeds based on field and greenhouse observations such as those of Oborn *et al.* (1954) and Yeo (1980). Frank and Dechoretz (1980), using plant leachate from terraria containing *E. coloradoensis,* and Yeo and Thurston (1984), using outdoor planted tubs, reported reduction in plant biomass of target plants when cultured with *E. coloradoensis.* A phytotoxic compound, dihydroactinidiolide, was isolated from mowed, dried, and threshed *E. coloradoensis* plants. This compound was synthesized, and shown to inhibit root elongation of *Nasturtium officinale* (watercress) (Stevens and Merrill, 1980). Ashton *et al.* (1985) axenicly cultured *E. coloradoensis,* periodically removed the culture media, and separated the leached organics into several fractions. The fractions, separately assayed at 250 parts per million by weight, were inhibitory toward *Hydrilla verticillata* (L.f.) Royle, *Potamogeton pectinatus* L., and lettuce seedling roots (3 to 85 percent inhibition).

Yeo and Fisher (1970) reported that *P. pectinatus* disappeared in three years in an irrigation canal planted with *E. acicularis.* Shoot weight of *H. verticillata* was not reduced by culture with *E. geniculata* (L.) R. & S. in one experiment but in two duplicated experiments, shoot weight, root weight, and number of tubers were all reduced (Sutton, 1986). Elakovich and Wooten (1989) reported that aqueous extracts of entire *E. acicularis* and *E. obtusa* (Willd.) Schultes plants inhibited growth of lettuce seedling radicles at 125 and 250 ppt of extract and common duckweed (strain 5) frond growth was significantly reduced at 114 ppt of extract of *E. acicularis.* Aqueous extracts of *E. interstincta* (Vahl) R. & S. and *E. cellulosa* Torr. shoots were shown to retard growth of *Lemna paucicostata* Hegelm. when results were evaluated using general linear models procedures (Sutton and Portier, 1989).

This study was conducted to determine if aqueous extracts of seven Mississippi species of spikerushes exhibited allelopathic activity. Two commonly used bioassay methods were employed so that the results could be compared to each other and with information in the literature.

## MATERIALS AND METHODS

Entire plants from Mississippi populations of *E. acicularis, E. equisetoides* (Ell.) Torr., *E. flavescens* (Poir.) Urban, *E. montana* (HBK.) R. & S., *E. obtusa, E. quandrangulata* (Michx.) R. & S., and *E. tuberculosa* (Michx.) R. & S. were collected, washed free of debris and drained of excess water. A 200 g fresh weight aliquot of each sample was blended with 400 ml of distilled, deionized water (except 200 ml for *E. obtusa*). The mixtures were treated and bioassayed using lettuce seedling radicle and common duckweed frond growth methods at extract concentrations of 25, 125, and 250 parts per thousand (ppt) as previously described (Elakovich and Wooten, 1989). The extract obtained from blending equal weights of fresh plant material and water was taken as 100% extract, and test concentrations were appropriate dilutions of this 100% extract.

The pH and osmolarity of each extract was measured prior to testing. The results of the lettuce seedling and common duckweed assays were subjected to analysis of variance and Dunnett's procedure for comparing all means

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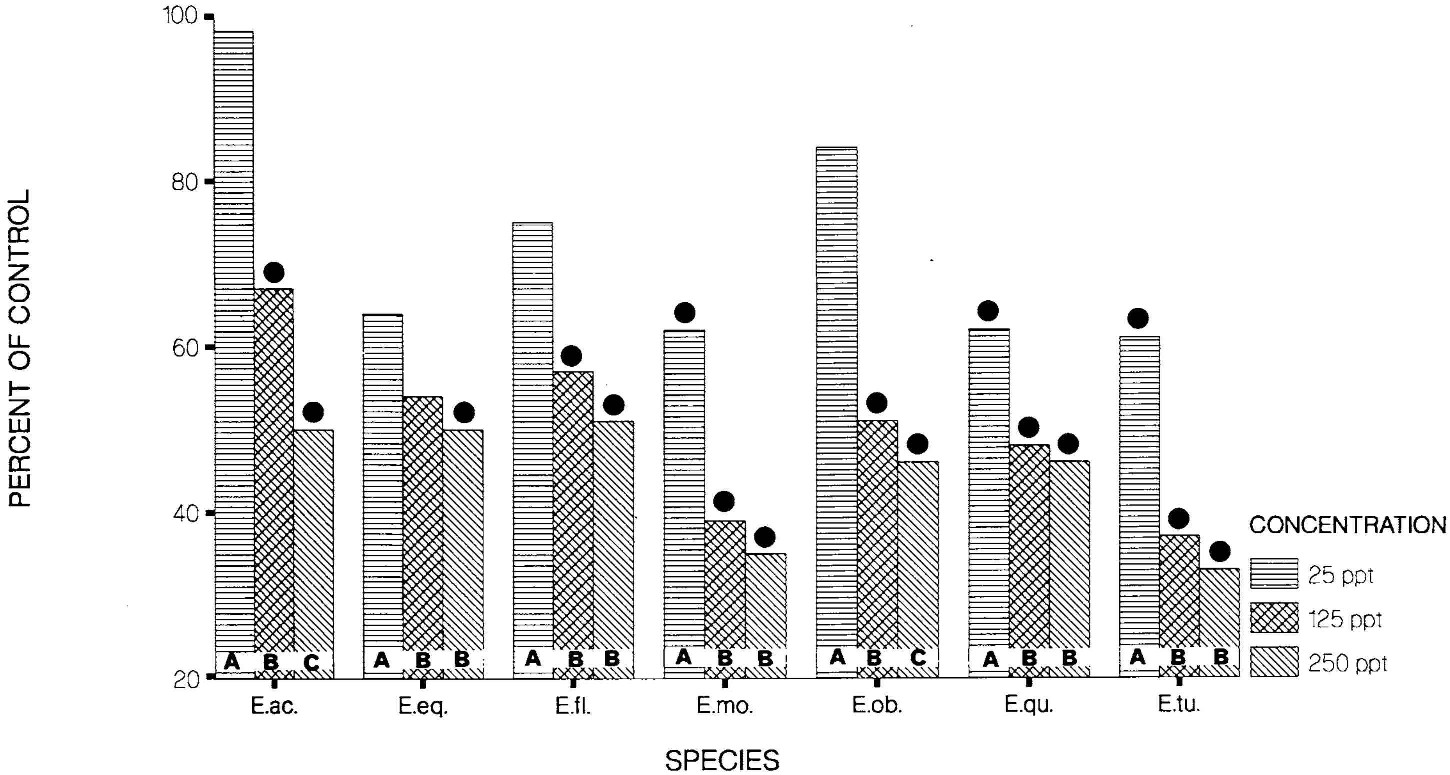


Figure 1. Lettuce seedling radicle bioassay of aqueous extracts of *Eleocharis*. Species abbreviations are ac., *acicularis*, eq., *equisetoides*, fl., *flavescens*, mo., *montana*, ob., *obtusa*, qu., *quadrangulata*, tu., *tuberculosa*. Bars with a dot indicate means significantly different from the control at $p \leq 0.05$ according to Dunnett's procedure for comparing all means with a control. Bars with the same letter are not significantly different (within treatments) according to the Duncan multiple range test at $p \leq 0.05$.

with a control. Comparisons among treatment means were made using the Duncan's multiple range test.

## RESULTS AND DISCUSSION

The pH of the frond growth medium was 4.65 and the osmotic potential was 60 milliosmoles per kilogram (mOs/kg). The pH of the undiluted extracts ranged from 5.5 to 7.1 and the osmotic potentials were 25 to 88 mOs/kg. Cheng and Riemer (1988) have shown that osmotic potentials of less than 70 mOs/kg and pH of plant extracts have no effect on lettuce growth. We have unpublished experimental data showing that osmolarity of less than 143 mOs/kg has no effect on common duckweed frond growth and growth is not sensitive to pH in the range of 4.0 to 6.0 (Einhellig *et al.*, 1985). These two properties of the tested extracts would not be expected to affect the results reported herein.

All concentrations of extracts affected growth of lettuce seedling radicles except the 25 ppt concentration of *E. acicularis, E. equisetoides, E. flavescens* and *E. obtusa* extracts, and the 125 ppt concentration of *E. equisetoides* extract. Growth as percent of control ranged from 98 to 61 at 25 ppt of extract, 67 to 37 at 125 ppt, and 51 to 33 at 250 ppt (Figure 1). Extracts from the species *montana* and *tuberculosa* showed the greatest inhibition. The radicle growth means of all extracts at 25 and 125 ppt were different, whereas at 125 and 250 ppt only *E. acicularis* and *E. obtusa* extracts gave different radical growth means (Figure 1).

Duckwood frond growth results were quite different. Only three species at extract concnetrations of 250 ppt and one at 125 ppt were inhibitory compared to the controls, and these showed 80 to 88 percent growth of the control (12 to 20 percent growth reduction) (Figure 2). Extracts of five species appeared to stimulate duckweed frond production but these means did not differ significantly compared with the control means (Figure 2). The *E. acicularis* extract did not inhibit frond growth in contrast to frond inhibition at 114 ppt found in our previous study (Elakovich and Wooten, 1989). Plants for these two studies were collected from different localities at different times of year. Additionally, the phenology was a reflection of time of collection; June for the original test with plants in fruit and October for the latter with plants vegetative. The effects of these factors on bioassay results are not known so we are currently evaluating them. Comparisons among treatment means showed that extracts at 25 ppt and 125 ppt did not differ except for that of *E. quadrangulata*; the mean growth from 250 ppt of extract differed from the means of 25 ppt of extract in all cases except in *E. obtusa* and *E. tuberculosa*.

Chemical inhibition may have a role in eliminating competitors in field situations. Competitive interactions have long been considered to control community structure; however, ecologists are divided in their opinion of their importance. Direct demonstrations of competition in natural populations of hydrophytes are few. Properly designed laboratory studies can detect competition but do

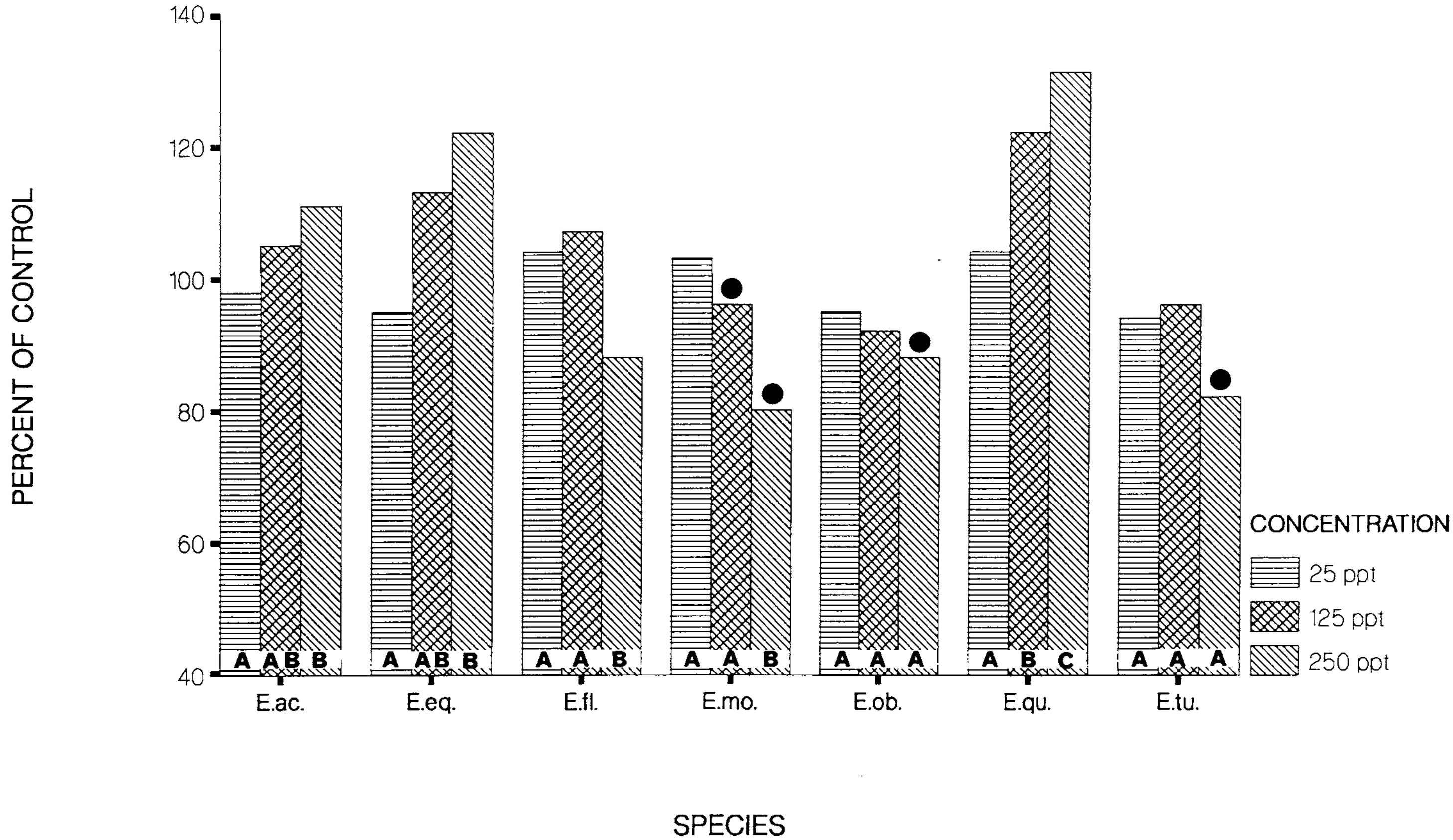


Figure 2. Common duckweed frond growth bioassay of aqueous extracts of *Eleocharis*. Species abbreviations are ac, *acicularis*, eq., *equisetoides*, fl., *flavescens*, mo., *montana*, ob., *obtusa*, qu., *quadrangulata*, tu., *tuberculosa*. Bars with a dot indicate means significantly different from the control at $p \leq 0.05$ according to Dunnett's procedure for comparing all means with a control. Bars with the same letter are not significantly different (within treatments) according to the Duncan multiple range test at p. $\leq$ 0.05.

not prove its importance in plant distributions in field sites. McCreary *et al.* (1983) clearly demonstrated from both laboratory and field studies that *E. acicularis* and *Juncus pelocarpus* forma *submersus* Fassett coexist as codominants in Roach Lake, Wisconsin. Bilateral negative relationships that seem to be of an allelopathic nature exist between *Najas marina* L. and *Myriophyllum spicatum* L. (Agami and Waisel, 1985).

Results of this work showed that the lettuce seedling assay was more sensitive than the common duckweed assay, as was shown previously, and overall, the extracts were not very active compared to results from bioassays of other aquatic and wetland species (Elakovich and Wooten, 1989). Entire *Eleocharis* plants were used in this study in contrast to the use of stems with no seeds (Stevens and Merrill, 1980) and shoots (Sutton and Portier, 1989). It is not known if different *Eleocharis* plant parts would exhibit varying inhibitory activity in bioassays using lettuce and duckweed. *Nymphaea odorata* Ait. leaves and petioles produce different levels of inhibitory activity than do the roots and rhizomes but extracts of both materials were highly inhibitory using lettuce and duckweed assays (Elakovich and Wooten, 1989). Perhaps it would be of value to consider other plant parameters, excepting those commonly used, such as size and mortality, as indicators of allelopathy since allelopathy could reasonably be expected to reduce plant productivity by lessening the ability of plants to compete in nature. If results of competition can be validly viewed along a continuum, then it would appear logical to so view effects of allelopathy.

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